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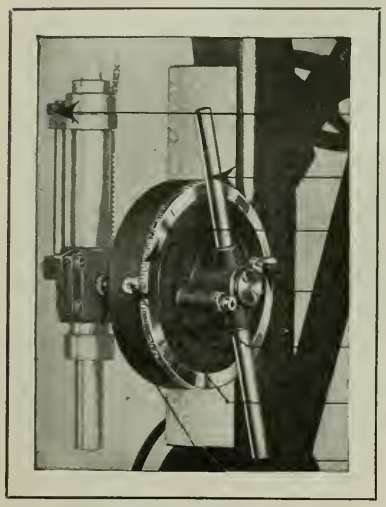
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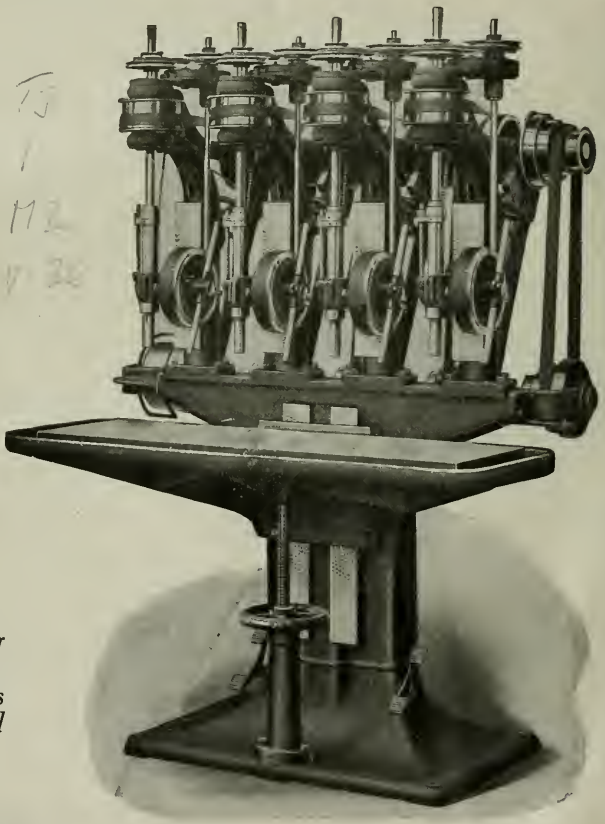
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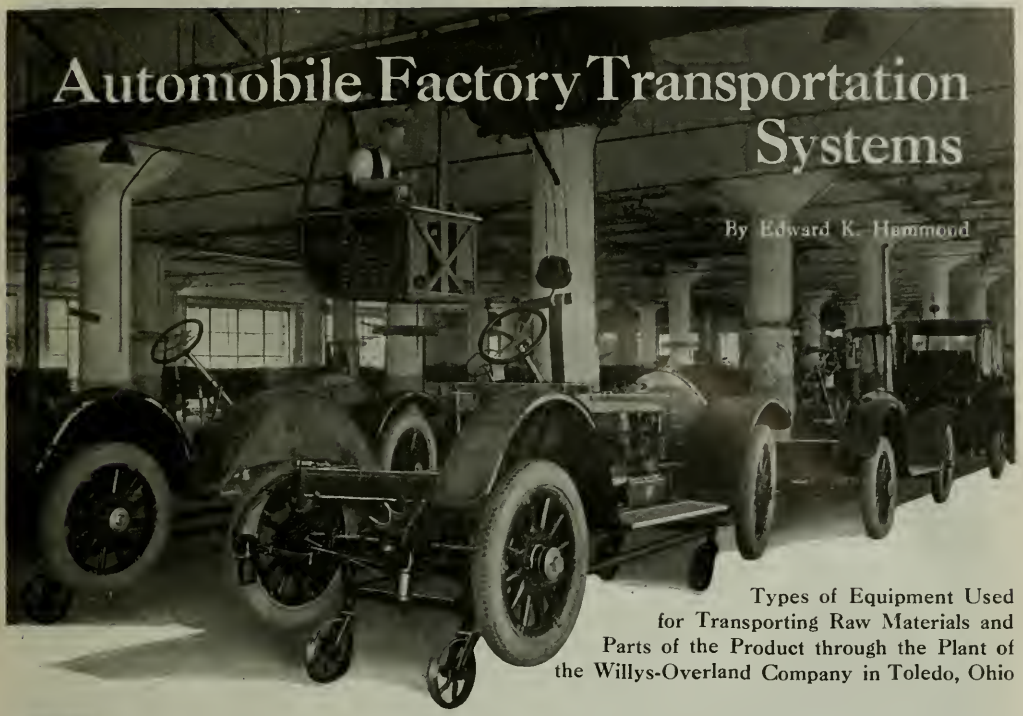
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Automobile Factory Transportation Systems

By Edward K. Hammond



Types of Equipment Used for Transporting Raw Materials and Parts of the Product through the Plant of the Willys-Overland Company in Toledo, Ohio

IT seldom happens after the occurrence of a railroad wreck, when some enterprising newspaper man has been assigned to the task of writing an account of the accident before the responsibility for its cause has been definitely fixed, that some reference is not made to the failure of the train dispatcher to do his work efficiently. From such references, most readers of the daily papers have a vague idea of the train dispatcher's office as the center from which orders are issued by telegraph to keep freight and passenger trains, operated by the railroad, running without the occurrence of accidents or interruptions of the service. Probably it is safe to say, however, that there are relatively few people who have any knowledge of the highly organized department that is maintained in every large industrial plant to supervise the transfer of raw materials and parts of the product from department to department in the factory.

Although the work of directing the service rendered by inter-department transportation systems in large manufacturing plants never receives the publicity which is accorded to its counterpart in the operation of a railroad, the complexity of the problem involved and the importance of efficient supervision ot the operation of transportation facilities in the large manufacturing organization are fully as great. Very little consideration need be given to the subject in order to see that industrial plants in which twenty or thirty thousand men are employed and which produce hundreds of complete automobiles a day (or an equal volume of some other product) must be managed with the greatest skill in order to avoid the occurrence of costly delays in the delivery of raw material and partially finished product to the various departments of the plant in which each part of the work is done.

Reference is frequently made by successful business men to the value of *team work* among those who are responsible for the management of any form of commercial or industrial enterprise, and this is especially true of the transportation of raw materials and product through a manufacturing establishment. Probably there are few better comparisons of the way in which materials are transferred from department to department of a well-managed factory than to compare the duties of those men who are responsible for directing this work to the play of members of a well-trained football team. In football, each of the eleven players has a definite part in the game. Quick decisions and prompt actions are constantly required of him, if the ball is to be carried between the goal posts of the opposing team. But no one player can win the game single-handed.

In the game of production that is played in an industrial plant, all conditions which retard the work correspond to players of the opposing team; and if this opposition is to be successfully overcome, the work of each department must be organized with the same degree of perfection which is attained in the timing of a high-grade motor car engine. Each

In all large industrial plants engaged upon the manufacture of a product of standard design that is made in large quantities, it is necessary to provide special means for carrying raw materials and parts of the product from one department to another. This is particularly true of automobile factories, in which the use of carefully organized transportation systems is essential in order to handle the vast quantities of materials and parts that go through these plants every day. This article describes the conveyor systems, trolley hoists, etc., which have been installed at the plant of the Willys-Overland Company in Toledo, Ohio, by the Link-Belt Company, 39th St. and Stewart Ave., Chicago, Ill.



Fig. 1. Apron Conveyor for carrying Parts up from the Central Storeroom in the Basement to the Engine Assembling Department on the First Floor



Fig. 2. Upper End of Conveyor shown in Fig. 1, and Apron Conveyor for carrying Work from Station to Station in Engine Assembling Department

department must complete its work on schedule time; and when the work is finished, it must be promptly sent on to the department where the next operation is to be performed on the same pieces, or where the finished parts are to be assembled into the product ready for delivery to the buyer. If there is any delay in transportation, the work of successive departments will be held up, and the attainment of a normal day's production will be seriously endangered.

Features of Factory Transportation Systems

The difficulty of devising efficient methods of assuring the prompt transfer of materials and partially finished products from department to department increases in direct proportion to the size of the plant and volume of product which is turned out during each working day. In small shops, the question of transferring materials is relatively simple, because the entire organization is usually under the jurisdiction of a superintendent who is able to keep himself informed at all times concerning the exact progress that is being made by each department of the shop, and so he is able to promptly apply a remedy that will offset the effect of any condition that would otherwise hold up production. It is in the case of large manufacturing establishments, where the departments that perform successive operations on the work are often widely separated, that the value of efficient team work among department heads and their assistants becomes most pronounced. The management of each department must look further ahead than merely getting out its share of the day's work. As rapidly as pieces of the product are finished, they must be sent on without unnecessary delay to the department where the following operation is performed on the same parts. Finally, the production



Fig. 3. View of Apron Conveyor shown in Fig. 2 at a Point where the Work of Engine Assembling is further advanced

department must be notified of every shipment of completed parts, which is made from each department in the plant, at the time the shipment is made.

Probably there are few manufacturing companies in the country which have given more thought to the development of factory transportation systems leading through individual departments of the plant, and also from department to department, than the Willys-Overland Co. of Toledo, Ohio. Detroit is usually regarded as the center of the automobile trade, and, as a general proposition, it is undeniably true that the facilities found in that city for building motor cars are unsurpassed. But there are no factories in Detroit which have worked out a more complete inter-department transportation system for handling materials and product than has the Willys-Overland Co. The equipment used by this firm was built and installed by the Link-Belt Co., 39th St. and Stewart Ave., Chicago, Ill., and after four years of extremely severe service, it has demonstrated its ability both to handle the required volume of work without serious interruptions of the service, and to possess a degree of strength and durability that is entirely adequate to allow the conveyors, elevators, hoists, etc., to stand up under the required service.



Fig. 4. Work-benches covered with Sheet Metal on which the Final Operations of assembling the Engines are performed

Classes of Service Rendered by Conveyor Systems

In their simplest form, conveyor systems merely represent a method of carrying parts to specified points, but in the industrial plant, the conveyor may also serve many other useful purposes. Important among these is the so-called method of *progressive assembly*. For the application of this method, a conveyor system is utilized that travels at a specified speed and carries the work past men who are employed to mount successive parts on the product as it is carried past them by the conveyor. Where the progressive assembling method is employed, various parts to be assembled are delivered at the proper points along the assembling line. The speed of the conveyor has been carefully calculated in order to allow a safe margin over the required daily output of the plant; and if the men keep up with the pace set by the conveyor, there is little danger of the rate of output falling below normal. This method of assembling was originated in the automobile industry, and the results obtained were so successful that it has since been adapted to meet the requirements of other lines of manufacturing.

There are many other highly important applications of conveyor systems in addition to their use in progressive assembling. Where there are large numbers of different parts to be handled, the conveyors which carry such parts from one department of the plant to another, sometimes have the additional advantage of constituting the equivalent of a storage space in which a reserve supply of these parts can be held pending their assembly into the finished product; also, it is usually possible to have the conveyors mounted at a point just under the ceiling, so that sufficient head room is allowed on the floor, and the transfer and storage of excess parts is thus accomplished without taking up any floor space in the plant. Last, but far from least, the conveyor system makes it possible for parts to be handled with a greatly reduced labor cost, and without such serious fluctuations in service as those that are bound to occur where the transportation system is entirely subject to the influence of the personal equation.

Methods of Transferring Materials and Partially Finished Product through Plant

In order to describe the methods used by the Willys-Overland Co. for transferring materials and partially finished product through its plant, the best method of procedure will probably be to first show some of the conveyors and auxiliary equipments that are used for carrying representative parts of a Willys-Overland car from the machine shop in which they are made to the finished parts store-rooms, and then the way in which these parts, or so-called "partial assemblies," are conveyed to the final assembling department where the finished cars are put together ready for shipment. As the engine of a motor car is its most vital member, it is natural that the equipment for assembling and transporting this part of the car should receive early consideration. In Fig. 1 is shown a simple apron conveyor which passes up from the basement in which surplus engine parts are stored.



Fig. 5. Trolley Hoist System on which Finished Engines and Steering Posts are carried away from Assembling Department

These parts have been delivered to the storage department by means of gravity conveyors running down from the different shops in which these parts were machined, and the feature of this apron conveyor is that it provides for carrying the parts up to the engine assembling department without requiring them to be placed on trucks which would have to be pulled to an elevator, and carried upstairs in that way. Small parts of the engine are packed in tote boxes in which they are carried up to the first floor by this conveyor. Obviously, the conveyor serves the double purpose of saving floor space and preventing the possibility of delays which would otherwise prove unavoidable while truckmen were waiting for elevator service. Also, the elimination of trucks and truck-pushers avoids a lot of confusion in both the finished parts store-room and in the engine assembling department. A little experience on the part of the store-room attendant soon enables him to judge how rapidly the various parts can be sent up on the conveyor, in order that they



Fig. 6. Apron Conveyor which runs through a Tunnel from the Engine Shop to the Main Assembling Department of the Plant

may be absorbed by the assembling department as rapidly as they are received. These parts are, of course, sent up in the regular sequence in which they are assembled in the engine. Fig. 2 shows the opposite end of the same apron conveyor at the point where it reaches the first floor on which the engine assembling department is located. Parts which are sent up on this conveyor are delivered to a short section of gravity carrier that transfers them to the end of another apron conveyor, which constitutes the first progressive assembling line of the engine department.

Distributed along the line of this apron conveyor there are stations at which specified parts of the work of assembling various members of the engine are performed. As the partially finished engine members reach these different stations, they are lifted off the conveyor to have the required parts mounted on them. Then the partial assembly is put back on the conveyor to go to the next station, this process being repeated until the work reaches the opposite end of the line. Fig. 3 shows a view of the same conveyor at a point where the assembling operation has progressed nearer to completion. At either side of the conveyor there will be seen the assembling stands on which the work is mounted. These stands may be swiveled, so that the engine can be turned over to facilitate reaching any desired part of the mechanism. After completing the work of making partial assemblies of engine parts on the apron conveyor which is shown in Figs. 2 and 3, the final work of assembling engines is conducted on three lines of parallel benches, which are shown in Fig. 4. These benches are metal faced so that the work, which is of considerable weight, may be slid along them without doing any damage. A progressive method of assembling is also used in this department. Overhead conveyors bring various parts that are required to the proper positions along these benches, and the men employed at the various stations secure the parts in place. Then, as rapidly as the work is finished, the motor is pushed along the bench to the next station, where subsequent parts are assembled to it, this process being continued until the finished motor arrives at the opposite end of the bench. The apron conveyor on which the preliminary work of motor assembling was conducted can be seen in the background.

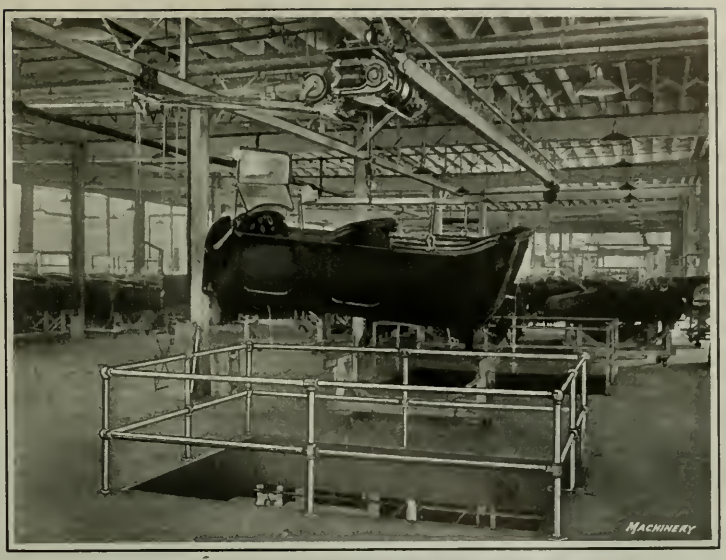


Fig. 7. General View of Body Department where Upholstering is done and where Windshields and Other Accessories are mounted on the Bodies

Fig. 5 shows the overhead trolley hoist system on which completely assembled engines and steering posts are carried away from the benches. The engine assembling department is located in a different building from that in which the final assembling of the cars is done, and to provide for the transfer of finished engines to the final assembling department, use is made of an apron conveyor which runs through a tunnel connecting the two buildings. In the illustration Fig. 6 may be seen the apron conveyor as it is entering this tunnel, and it will be apparent by referring to this illustration that this transportation system affords space for the storage of a large surplus number of finished engines. With such an excess supply constantly passing through the tunnel leading to the assembling department, there is relatively little danger of a serious delay in the delivery of engines because of the occurrence of any unexpected interruption of the work in the engine assembling department or in any of those sections of the plant upon the product of which this department is dependent. Active measures may at once be instituted to overcome any such cause of

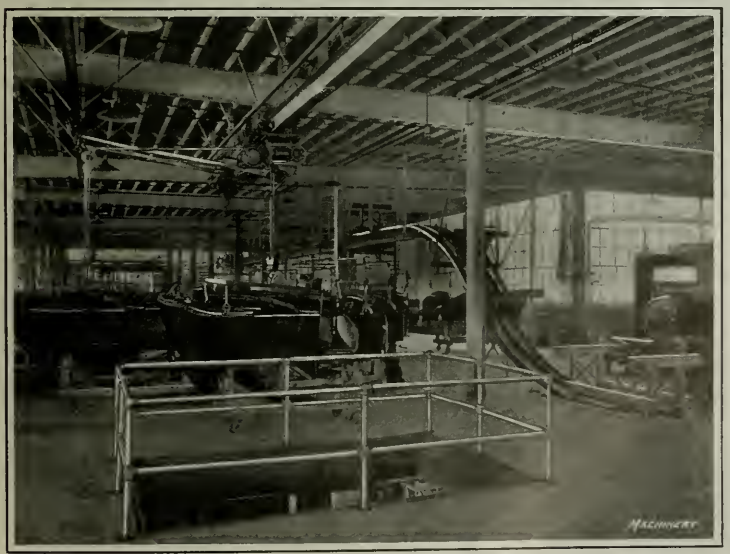


Fig. 8. Overhead Conveyor System provided in the Body Department for returning the Empty Trucks to Starting Point of the Assembling Line

trouble, and once more get things running smoothly before the surplus supply of finished engines carried by the conveyor leading to the final assembling department has been exhausted. This conveyor system replaces several trucks that were formerly used to carry motors from the building in which they are assembled to that building in which the motors are put in place in the finished cars. It is 500 feet long and passes under a road, through the basement of a building, under four railroad tracks, and then into the basement of another building, from which the engines are carried up to the assembling department on the first floor. This gives a good idea of the complexity and magnitude of some of these industrial transportation systems.

Assembling and Upholstering the Car Bodies

The body department of the Willys-Overland plant is quite a complex organization. The preliminary work of this department consists of taking pressed steel shells for the bodies and mounting in them such auxiliary apparatus as windshields, seats, clocks, speedometers, etc. Also, it is necessary to upholster the seats. As in the case of the engine department, this work is done by a method of progressive assembling, although a power-driven conveyor is not used. For handling the bodies, use is made of special four-wheeled trucks, provided with trestles on which each body rests. Directly a steel shell is received in the body department, it is placed on one of these trucks, with the body running crosswise to the direction of travel of a continuous line of bodies that is always passing through the shop. Each truck is gradually pushed along the assembling line and during its steady progress through the shop, various parts of the body are secured in place; also, the seats and inside of the bodies are upholstered at this time, so that when the bodies reach the opposite end of the department, they are ready to be assembled into a finished car.

Fig. 7 shows a view of the body department at the finishing end of the assembling line, and in the foreground there will be seen a finished body which has been picked up by an electric trolley hoist and carried to a point above an opening in the floor. The body department is located on the second floor of the plant, and this hoist will lower the body through the floor to a conveyor hung just beneath the ceiling of the first floor, so that this body may be carried over to the point where it will be assembled on a chassis. Another view of the body department is shown in Fig. 8, which gives a good idea of the careful way in which every detail of the transportation system has been worked out. Years ago, a practice was made of taking each empty truck, after the finished body had been lifted off it by an electric hoist, and having a man push this truck back to the starting point of the body assembling line. Two obvious objections to this plan were that wages had to be paid to five men who were required for doing this part of the work, and, what was a more important consideration, that floor space had to be set aside for the return of these trucks to the starting point of the body assembling line. These difficulties were both effectually overcome through the provision of an overhead conveyor system which will be seen at the right-hand side of Fig. 8. As each finished body is lifted off its truck, the truck is pushed against the end of the runways of the conveyor, and in due course of time one of the hooks carried by the power-driven Link-Belt chain comes up and catches the truck, drawing it up an incline to the horizontal rails, over which it is pulled back to the starting point.

Methods of Handling Wheels, Rims, and Tires

In Fig. 9 is shown a duplex conveyor system which is used for carrying freshly enameled wheels through the ovens in which they are baked. At the right-hand side of this illustration there will be seen several trucks loaded with wheels, on which enamel has just been applied. These trucks are pushed on the runways of the conveyor system at the right, and the hooks on the power-driven Link-Belt chain catch the lower cross-bar to provide for pushing the truck through the oven, the wheels being exposed to the heat for a length of time sufficient to bake the enamel. After passing out at the opposite end of the right-hand oven, the wheels are removed from the trucks and given a second coat of enamel, after which they are again placed on the trucks and pushed on runways of the conveyor which will be seen at the left. These two conveyors run in opposite directions, so that the truck which is seen emerging from the furnace at the left is moving in an opposite direction to the one entering the right-hand furnace.

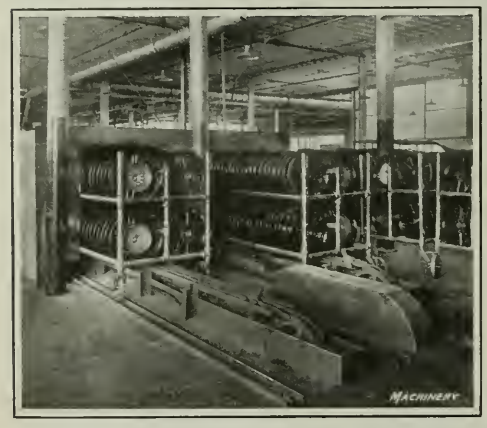


Fig. 9. Trucks and Conveyor Systems used for carrying Enameled Wheels through Ovens in which the Enamel is baked. The Conveyors run in Opposite Directions and the Work is repainted before coming back through the Second Oven

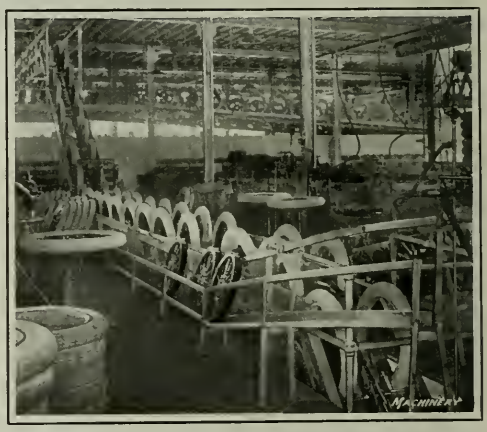


Fig. 10. Conveyor System used in handling Wheels, Rims, and Tires. At the Point where Three Wheels are standing, the Rim and Tire are assembled on the Wheel, after which the Conveyor carries the Complete Assembly to a Storage Space

The end of the left-hand conveyor system shown in this illustration is located at a point close to the entrance of a runway which carries wheels down to the position occupied by the three wheels shown in Fig. 10. This illustration shows the first floor of the plant, and in the foreground there will be seen a conveyor system coming up through the floor from the basement. This apparatus provides for carrying tires and rims up from a storage space, and just after coming through the floor they are removed from the conveyor and assembled on wheels, and then put back on the conveyor so that the completely assembled wheels may be carried up to a storage space located above the point on the main assembling line where the wheels are mounted on the axles of the cars.

Conveyors for Serving Enameling Tanks and Baking Ovens

Another good example of the care which has been taken by the Willys-Overland Co. in working out methods of handling partially finished product in order to eliminate all avoidable sources of delay is shown in Fig. 11, which illustrates the conveyor system used for dipping fenders into the enameling tanks, and after allowing sufficient time to drain, carrying them into the baking ovens. The design of this apparatus is credited to John Lowe, master mechanic of the company. The saving of time accomplished by this equipment is due to the fact that the length of each conveyor is made twice that of the baking ovens, and that enameling tanks are provided at each end of the ovens. The method of procedure in operating this equipment is as follows: While the work held on one half of the conveyor system is being baked, fenders which will be loaded on the other half of the conveyor are first dipped into the enamel and then allowed to hang stationary, so the surplus enamel will drip back into the tanks. After the work in the oven has been baked for a sufficient length of time, the freshly enameled fenders have also been allowed sufficient time to drain. Then the doors are opened and the conveyor is started to carry the freshly dipped work into the oven. There is practically no time lost through the operation of this apparatus, because the direction of travel of the conveyor is reversible, and so the fenders which are carried out of the oven may be removed and other parts dipped in the enameling tank at that end and hung from the conveyor to drain. Then when the enameled parts in the oven have been baked to the proper degree, the conveyor is run in the opposite direction in order to carry the freshly dipped fenders into the oven, ready for baking. As rapidly as the finished fenders are removed from the oven, they are loaded on a conveyor system which carries them to that point over the main assembling line where the fenders are mounted on the motor car.

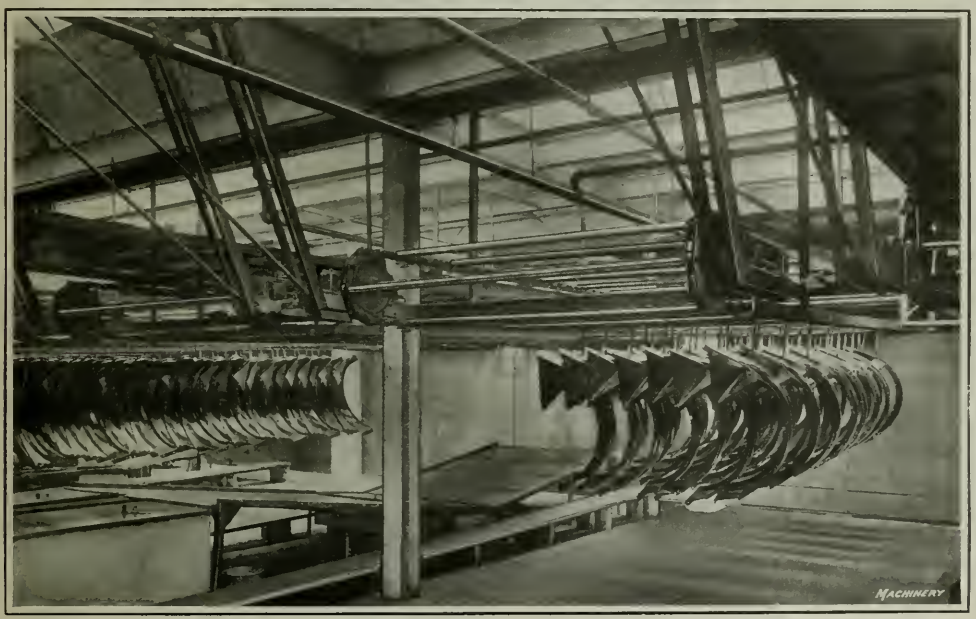


Fig. 11. Conveyor System used for baking Enamel on Fenders. The Conveyor is Twice the Length of the Drying Oven and runs in Either Direction. Work may be dipped and drained at Each End of the Oven, so that the Operation is practically Continuous

* * *

It was ruled by a justice of the Supreme Court, in a case involving awards in damage suits, that compensation in such cases must be based upon the increased cost of living.

THE AMERICAN STANDARD OF LIVING

An attempt to formulate the "American standard of living," recently undertaken by Royal Meeker, United States Commissioner of Labor Statistics, has led him to the conclusion that there is no such thing. From a statistician's standpoint this is probably true—that is to say, no unyielding minimum can be discovered, nor will any average taken express a truth of any particular value. There is, nevertheless, a standard of living in the United States that is definitely superior, class for class, to that of other countries. It is a standard easily lowered by hasty legislation, uneconomic "reforms," and a false public attitude toward business activities; in fact, it is much easier to lower this standard than to raise it. Although it is well to look forward to higher attainments, such an attitude may even become dangerous if it blinds us to the value of what has already been accomplished, or to the difficulties of maintaining American standards against the storm of foreign competition that must inevitably ensue. The price that must be paid for "the American standard of living" is continuous production and uninterrupted operation of all forms of public service.

—*Industrial News Survey*

* * *

The wage increases of steel workers in Great Britain during the past five years vary from 70 to 160 per cent. The wages of the English iron and steel workers are now based on the selling price of the product, following a quarterly examination of the manufacturers' books. The quotations on most of the iron and steel products are now from $10 to $20 a ton higher than in the United States. In changing from the twelve-hour to the eight-hour time in the British steel mills, an interesting agreement was made between the employers and the employes, according to which the workers shared with the employers the wage cost of the additional help involved, the arrangement being based on a sliding scale according to which a wage of $11.70 per week is regarded as a minimum and is not required to contribute to the additional expense, whereas when the wage is $28.08 and upward the employes assume the entire cost of the additional help necessary.

Machine Design in Interchangeable Manufacturing Practice



By Earle Buckingham
Engineer
Pratt & Whitney Co.,
Hartford, Conn.

IN early days, the design of a new mechanism existed only in the mind of the mechanic engaged in its construction. It was made piece by piece, each detail taking definite shape as it was constructed. The original mechanism was completed, tested, and corrected or rebuilt before the design was finished. Duplicate mechanisms that might be constructed were patterned after the original, and modified or improved as suited the ideas of the mechanics who performed the actual work. Needless to say, interchangeability and quantity production were non-existent factors.

Sketches and drawings were next employed to express the ideas of the inventor, but little attempt was made to indicate more than the general idea and construction. The details of the design and the dimensions of the individual parts were matters for the workmen to decide. A competent mechanic was required to determine these for himself. It was part of his training. Details and dimensions, more or less complete and consistent, made their appearance on the drawings later. Errors and omissions were of little moment, as the mechanic who worked to the drawings expected to select and use the proper information given and to ignore the incorrect, supplying all omissions from his own store of mechanical knowledge and experience. The quantity of production was small. Little or no importance was placed on interchangeability. A few workmen thoroughly acquainted with the requirements of the mechanism or with the intentions of the designer performed all the actual work of construction. Under these conditions, functional drawings, which make no pretense of giving more than the general construction or combination of mechanical movements and the general outline of the detailed parts, are sufficient.

Function of Design

Under present manufacturing conditions, with productive operations subdivided into elementary tasks, with productive labor trained along specialized lines, with productive equipment specialized and more nearly complete, with the rate of production greatly increased, with larger organizations in which but few individuals are thoroughly conversant with all the detailed requirements of the mechanism, the design must cover a wider field and be much more comprehensive and accurate. In addition to expressing the ideas of the inventor, it must supply most of the knowledge and experience formerly brought to this work by the mechanic.

We now have, therefore, two types of designing to consider, which we will call the functional design and the manufacturing design. The manufacturing design is a detailed development of the functional design. It corrects and modifies the functional design where necessary, to facilitate the economical production of the mechanism, giving as much as possible of the information previously supplied by the workman. It is evident that the manufacturing design will always be incomplete to a certain extent. Suitable provision for its modification must be made to obtain the advantage of the new and improved methods of manufacture which are constantly developed. Changes, however, in proved manufacturing designs should be avoided when possible. As much or greater care should be taken in adopting changes as is exercised in establishing the original manufacturing design. After equipment has been completed, changes are very costly. A change which might be justified in the early stages of work often costs more than it is worth in the later stages. This makes it of the utmost importance that great care be exercised in the development of the original manufacturing design of a new commodity which is to be manufactured in large quantities on an interchangeable basis.

The improvement in manufacturing methods and facilities during the past forty or fifty years has been very rapid. Quantity production is now the order of the day. New problems have arisen and old ones must be constantly re-solved to meet the situations thus created. Manufacturing on an interchangeable basis has been a direct development of this advance. The purpose of the present article is to discuss the effects of this development on the design of a machine or device, and to emphasize those practices which will promote economical manufacture on an interchangeable basis. Other phases will be taken up later.

Classes of Design—Functional and Manufacturing

For the construction of a small number of special machines, or tools and fixtures, which are built in a general machine shop or tool-room, the functional design is all that is required. The number of men engaged in the production is small, their training is general, and the requirements of the mechanisms can be explained to them personally by the designer as questions arise; therefore, the additional expense of a manufacturing design is not justified. However, in the manufacture of a large quantity of any article, particularly if interchangeability is sought, a complete manufacturing design is necessary. True, this design will work itself out in practice in the course of time, but this is a very slow and expensive method. It means that experimental work on a large scale is carried on, whereas it can be done on a smaller scale with better and speedier results. Furthermore, this method results in continual alterations in the equipment and a loss of interchangeability. However, this article is not concerned with designs of special mechanisms, tools, fixtures, etc.; attention will here be given to the requirements of designing as applied to the manufacture of a product in large quantities.

In both types of designing, the end in view is the same as far as the functioning of the mechanism is concerned. This is to develop a product capable of performing certain results which will fill or create a public demand for itself. The means of attaining this are governed by various considerations. For the functional design, any solution is satisfactory. As regards the manufacturing design, the methods adopted must result in ultimate economy. Also,

the manufacturing design must resemble the functional to such an extent that all patents will be retained, while those of competitors must not be infringed. This is one of the commercial difficulties that, at times, prevents the true economic development of a commodity.

It is plain that the manufacturing designer must take into consideration every circumstance involved in the production of the commodity. To be successful, he must work in close cooperation with all who will be engaged in the development and operation of the manufacturing equipment. This will include the tool designers, and the superintendents and foremen of the various manufacturing and assembling departments. In general, there is too much detail involved for any one person to carry it alone to a successful completion.

Simplifying Design to Enable Standard Equipment to be Used

When considering the manufacture of a new product, one of two conditions usually obtains. Either it is to be produced in an established plant with an existing variety of manufacturing equipment, or a new plant must be created. In the first case, the designer must be familiar with the available equipment and must modify the functional design so as to utilize these facilities to the best advantage. In the second case, he is not restricted to the use of any specified equipment. In either case, unless the volume of production is to be extremely large with many automatic operations, every effort must be made to reduce the machined surfaces of the various components to simple, elementary surfaces which can be readily machined on standard machine tools with simple, rugged, and inexpensive tools, jigs, and fixtures. If, in the manufacturing design, the component parts are thus simplified, a further advantage is gained. The productive operations on these parts are resolved into simple, elementary tasks, and this simplifies the problem of securing and training the necessary productive labor. Simplicity is a primary source of economy. The number of machining operations is reduced and the direct labor cost thereby lowered. The amount of time that raw material is tied up in process of manufacture is reduced and quicker returns are secured on the money invested in direct labor and materials. The many other economies resulting from simplicity in design, such as lower equipment and maintenance costs are obvious.

Under present manufacturing conditions, with productive operations subdivided into elementary tasks, with productive labor trained along specialized lines, with productive equipment specialized and more nearly complete, with the rate of production greatly increased, with larger organizations in which but few individuals are thoroughly conversant with all the detailed requirements of the mechanism, the design must cover a wider field and be much more comprehensive and accurate than previously. In addition to expressing the ideas of the inventor, it must supply most of the knowledge and experience that were formerly brought to this work by the mechanic.

Factors Governing Choice of Materials

Those responsible for the manufacturing design must pay close attention to the character of the materials they specify for the individual components. Ultimate economy is the desired end. This is affected by many different and sometimes opposing factors. The first cost of the material is one of these. When several thousand duplicate mechanisms are manufactured, the slightest saving in the cost of direct materials is multiplied over and over again in the course of time. As many parts as possible should be made of the same size and kind of material. This permits purchasing in larger quantities and reduces the gross amount of raw material carried in the store-room. As far as possible, this material should be of standard sizes and forms that can be purchased in the open market at the lowest prices.

Due consideration must be given to the possible sources of supply for the materials specified. It is a serious matter when production is held up because of lack of material which has a limited or uncertain source of supply. Every effort must be put forth in making the manufacturing design to specify materials which are readily secured.

The actual economy of low-priced material is governed by the ease with which it can be machined. If a part requires many machining operations, a low initial cost for material is often overbalanced by the greater cost of manufacture. Therefore, if a more expensive material can be machined at a lower cost, ultimate economy dictates its purchase. For this reason, the use of extruded or rolled bars of special form is often adopted in the manufacture of small parts for adding machines, typewriters, counters, and other similar mechanisms.

An illustration of this point occurred in a large plant which makes small duplicate parts. Several of these parts were made of brass castings because of the lower cost of machining, but the price of copper began to rise and was soon about double its normal price. It was decided to substitute cast iron for brass because the difference in the cost of machining was less than the difference in the market price of the materials. Luckily, an investigation was made before the change went into effect. This plant had its own brass foundry but no iron foundry. It was discovered that the foundry had purchased no copper for several years. In fact, a large stock of pig copper had been stored in a shed and was never touched. Another department of this plant was engaged in making copper matrices by a plating process, and the trimmings from these supplied all the pure copper which the foundry required. This, with scrap brass stock from other departments made it unnecessary to purchase any metal for the brass foundry in the open market. Needless to say, no change was made in the material of the castings. This incident indicates in some degree the many factors that must be considered to secure genuine economy. It is not a matter of mere addition and subtraction; every existing condition must be taken into account.

Whenever the weight of a commodity is an important consideration, as with automobiles, etc., the materials used in making it must be of a better grade than when the weight is less important. In every case, the materials specified must be sufficiently strong and rigid to hold their form throughout the normal life of the mechanism. Thus, the detailed design of the various components is governed to a great extent by the nature of the materials which are used in their manufacture. For example, if forged steel is substituted for cast iron, the component will be of much lighter design.

The composition of the materials used is governed by the nature of the service which the part must render. One that is subjected to excessive wear must be made of material hard or tough enough to withstand it. Material for parts liable to corrosion or other chemical action must be of the proper composition to counteract it. Material for parts under constant vibration must not crystallize readily. In every event, the materials must be selected to withstand both the use and abuse which they will eventually meet.

It is of interest to note, as an indication of the importance of materials in relation to the total cost of production, that census statistics show that the cost of materials—direct and indirect—is from 30 to 60 per cent of the selling price of the majority of mechanical products manufactured in this country.

Establishing Suitable Clearances and Tolerances

The establishment of suitable clearances and tolerances is a vital, if not the most vital, factor in the manufacturing design. Tolerances are, in many respects, like laws. There are two classes of laws. One is so severe and exacting in its nature that it cannot be enforced, and soon falls into

disrepute and is disregarded, even though it remains on the statute books. The other is drawn up with a full understanding of existing conditions, and its justice to all concerned is so evident that it is readily and consistently enforced.

Similarly, tolerances fall into two classes. Those which represent the extreme conditions of accuracy obtainable from the equipment under ideal conditions can be specified without regard to the functional requirements of the product. In such cases they, too, soon fall into disrepute and are disregarded, even though they still remain on the drawings. On the other hand, tolerances are readily and consistently maintained when they represent the widest variations that the functioning of the mechanism will safely permit.

Liberal tolerances and clearances result in easier manufacturing conditions of every sort and thus promote economy; they make quantity production possible. The serviceable life of tools depends directly on the extent of the tolerances. Every exacting tolerance is a direct check on the economical and rapid production of the mechanism. On the other hand, if the functional requirements do not permit wide tolerances, the functional requirements must prevail.

It is evident, then, that the construction must be carefully studied so that the manufacturing design will permit the widest possible tolerances. It is only in exceptional cases that a mechanism cannot be modified so as to retain all functional advantages and yet allow liberal tolerances on the majority of its dimensions. Very often, when there is a severe functional requirement to maintain, the introduction of simple means of adjustment promotes easier manufacturing conditions. In other cases, a system of selective assembly is more desirable.

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Applying Interchangeable Principle

The designer must determine which parts will be interchangeable. Interchangeability can be carried too far and thus allowed to defeat its own purpose as noted in a previous article. Interchangeability and liberal maximum clearances are closely connected. Whenever reasonable clearances are out of the question on certain components, these parts are not suitable ones to be manufactured on an interchangeable basis. In this matter, the relative accuracy of the available equipment plays a large part. For example, if the surfaces are elementary and can be finished by a simple grinding operation, much closer tolerances can be economically maintained than if they are composite and require milling or turning operations. The variations on work finished by grinding are about one-third those resulting from milling and one-half those from turning; and the effort expended is no greater. On the other hand, grinding is not always suitable nor possible. Therefore, in determining whether or not certain required conditions permit reasonable tolerances, the designer must consider possible methods of manufacture and be well informed as to the normal variations resulting from them in actual practice. This knowledge is the outcome of experience in checking and analyzing results previously secured. This is a matter to which little attention has been paid in the past. For example, in a large and long-established plant, where many milling operations are performed, it had been assumed that these operations were maintained within a tolerance of 0.001 inch. Actual measurements brought out the fact that the normal variation was over three times as great as that, and always had been. A similar misconception of actual conditions was apparent in the majority of shops engaged in government work during the recent war. When their product was actually checked by limit gages and held to the specified tolerances, a variation of 0.002 or 0.003 inch was found to be an extremely small manufacturing tolerance. It is, therefore, one of the duties of the maker of the manufacturing design to specify the parts which are to be made interchangeable, those to be selectively assembled, and those to be fitted to each other. Careful attention to this detail saves much wasted effort in the shops subsequently.

Advantages of Unit Assembly Construction

Almost every mechanism can be subdivided into smaller units which are distinct in their purpose. For example, an automobile contains an engine, transmission, axle drive, carburetor, magneto, etc., which are assembled and tested as units and later assembled into the completed car. In like manner a typewriter is subdivided into the carriage, the escapement, the type-bar and the segment assembly, etc. The assembly is greatly facilitated if the design of the mechanism permits such unit assembly construction; and efforts should be made to obtain this result whenever practicable.

There are many other advantages of this unit assembly construction. Not only the various manufacturing departments of one factory but also entire plants are specializing more and more. The automobile has hastened this trend more than any other one thing. Where such unit assemblies are of equal value on several articles, separate plants spring up to produce them as a specialty. This gives the benefits of quantity production where otherwise they would not exist. Therefore, we have as a direct result of unit assembly construction, separate plants specializing in engines, rear axles, carburetors, magnetos, etc., for automobiles; ball and roller bearings for all types of machinery; and many other similar specialized products.

Standardization of Parts

Another practice which allows the benefits of quantity production to be obtained in the production of smaller numbers of complete mechanisms is the standardization of many of the individual components. For example, most manufacturing concerns have standardized their screws, nuts, studs, rivets, and other small parts. The majority of machine tool builders also standardize their handwheels, micrometer thimbles, gears, tool-holders, work-arbors, etc. A good illustration of the economy of this practice is found in the experience of one plant which originally manufactured over one hundred and fifty special screws and studs for its particular product. Little effort was required to reduce this number to less than half, thus increasing the rate of production of these parts and also reducing the stock of spare parts. This practice is extending to larger and more important components. Not only are similar parts produced by individual plants being standardized, but parts used in common by several manufacturers are also standardized and often manufactured as specialties by other concerns.

Designing with a View to Assembling and Service Requirements

The design must permit the ready assembly of the product. Parts which require attention in service must be accessible. Attention to these details reduces assembling and service costs, and these must be considered to insure ultimate economy.

The service requirements are the most difficult to determine. Time alone brings the desired information. Experiments and endurance tests in the factory are insufficient to give it. After a mechanism is on the market, it receives use and abuse that the makers never dreamed of. Yet if the product fails under these unforeseen conditions, the manufacturing plant is blamed. Naturally the nature of the commodity determines what sort of service it must render. The service requirements of an automobile are distinct from

those of a typewriter; those of a precision machine tool—which is supposedly used by skilled mechanics only—differ from those of a lawn-mower; etc.

The service requirements include the protection of the working parts from dirt and other foreign matter, the provision of proper lubricating facilities, and the protection of the operator from moving parts. The question of the best preservative finishes, such as japanning, plating, painting, etc., must also be answered to meet the service requirements, both of use and appearance. For these and many other similar problems a solution is sought that will result in the maximum amount of service at a minimum expense.

It should be clearly understood that the manufacturing design is not undertaken with the idea of wilfully altering the functional design, but is made to facilitate manufacture and to furnish as much as possible of that vast amount of detailed information previously brought to the productive work by the mechanic who carried out the inventor's ideas. The alterations made in the functional design by the manufacturing design should not be looked on as any criticism of the original lay-out. Each has its distinct purpose to perform. Many large plants recognize clearly the difference between the two types of designing and maintain separate departments for each. The original research and inventive work is carried on independently of the factory operations. New or improved designs are turned over to the factory organization where they are redesigned to meet the manufacturing and service needs.

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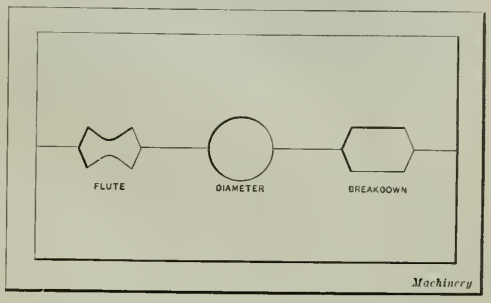
FORGED TWIST DRILLS

The value of the forged twist drill is becoming more and more recognized. One of the advantages is that the cutting edges of the drill, having been worked upon in the forging process, become harder and tougher, and the web of the drill, having also been subjected to a considerable amount of working in the forging process, becomes a great deal stronger, so that the drill as a whole is capable of performing more work without danger of breaking. While some years ago there were comparatively few firms making forged twist drills, at the present time a number of firms are engaged in the manufacture of these drills. The methods of producing these drills as exemplified by the processes used by the Ypsilanti Twist Drill Co., Ypsilanti, Mich., are briefly described in the following paragraphs.

In the practice of the company mentioned, the shanks are made from low-carbon tool steel containing a small percentage of chromium to produce toughness, while the drill proper is made from high-speed steel, and is electrically welded to the shank. The blanks for both the shanks and the drills are cut to length and the first operation is to weld the two blanks together. If the shank is larger in diameter than the drill, the shank is necked so that the end of the blank will present the same cross-sectional area as the drill blank in order that the two blanks may be properly butt-welded. After welding, the weld is slowly cooled in powdered mica. When thoroughly cooled, the welded blanks are placed in an annealing furnace and heated. While hot, the flash produced by the electric weld is sheared off, after which the blanks are permitted to cool slowly in order to anneal the metal at the weld and refine the grain of the steel at the welded portion.

The next operation is to groove the drill, which is done in special dies made as indicated in diagrammatical form in the accompanying illustration, a Bradley hammer being used for the purpose. During the hammering the web gets the most working and hence obtains the greatest strength. The dies, as shown, have three impressions, the one to the right being the breakdown; the one in the center for finishing the outside diameter; and the one to the left for producing the flute. The diameter of the forged drill remains the same as the diameter of the blank, the result of forging the flute being that the drill is made longer than the blank, as the latter is drawn out by the forging.

The next operation is to twist the grooved or fluted forged drill. In this operation the drill is gripped by a holder at the point, while the other end is turned or twisted in a hand-operated machine. The point of the drill must be slightly hotter than the other part in order to obtain the proper kind of twist. The drill is given a separate heating for the twisting operation. After twisting, the drills are annealed in charcoal, being packed in pipes and put into the furnace cold. Care is taken when packing the drills in the charcoal to see that they do not touch each other or the sides of the pipe. After having been placed in the furnace, the latter is brought up gradually, during a period of six hours, to a heat of from 1475 to 1500 degrees F. Drills below ¾ inch in diameter are then held for about three hours at that heat, while larger drills are held up to five and a half hours at the heat mentioned. The drills are then permitted to cool off with the furnace, from twenty to twenty-five hours being required for the cooling. The pipes in which the drills are packed are, of course, capped so that the drills with their packed material are entirely shut off from the influence of the atmosphere. After annealing, a portion at the end of the drill, which is about equal to the diameter, is cut off,



Die with Three Impressions for forming Grooves in Twist Drills

in order to remove the distorted part at the point of the drill where it was held while being twisted.

From this moment on, the operations in finishing the drill are practically the same as are used in the manufacture of ordinary fluted twist drills; these operations have frequently been described in the technical journals and are familiar to most of the readers of MACHINERY.

* * *

FOUNDRYMEN'S CONVENTION AND EXHIBIT

The American Foundrymen's Association will hold its twenty-fourth annual convention at Exhibition Hall, Commercial Museum, Philadelphia, Pa., September 29 to October 3. The fourteenth annual exhibit of foundry and machine shop equipment and supplies will be held in conjunction with the convention. Information concerning rules and regulations governing the 1919 exhibit can be obtained from the American Foundrymen's Association, Department of Exhibits, C. E. Hoyt, manager, Harris Trust Bldg., 111 W. Monroe St., Chicago, Ill.

* * *

The California Industrial Accident Commission, in a report on the economic handicap suffered by permanently injured industrial workers, states that about 40 per cent are able to return to their work and to earn the same, or higher, wages than before the injury, the higher wages being, however, attributed to the war-time demand for labor. About 18 per cent returned to work, but were receiving lower wages than before the injury, and about 30 per cent were unable to return to employment at all. No account is given of the remaining 12 per cent. The average time lost through injuries included in the above report was very nearly one year. The average weekly wage at the time of the injury was $22.34 and after the injury, $16.60.

Temperature Indicating and Controlling Systems

Location and Protection of Thermo-couples—Prevention of Errors in Pyrometer Readings—Apparatus for Determining Hardening Temperatures

Third and Concluding Installment

By FRANKLIN D. JONES

As the object of using a pyrometer in conjunction with a hardening, annealing, or tempering furnace is to indicate the temperature of the steel parts being heat-treated, the thermo-couple should, as far as possible, be so placed that it will be heated to the same temperature as the work in the furnace. If the location of the thermo-couple were such as to bring it into direct contact with the flame in a gas- or oil-fired furnace, naturally it would be heated to a higher temperature than the work, and the pyrometer reading would be misleading. On the contrary, the opposite effect would result if the thermo-couple were placed too far from the source of heat. The thermo-couple is sometimes inserted through the side wall of the furnace as illustrated at *A*, Fig. 33, or it may extend down through the roof as shown at *A*, Fig. 34. Thermo-couples are also placed on or in the furnace floor, as shown at *B*, Fig. 34. In some cases the thermo-couple is laid in a V-shaped groove in the floor, or it may simply rest upon the level floor between two parallel strips upon which the work is supported. The object of placing the thermo-couple on the floor just beneath the work is to locate it as near as possible to the parts being heat-treated without interfering with their removal.

While it has proved advisable, in many cases, to locate the thermo-couple as near the work as practicable, in some instances the thermo-couple, owing to its relatively small mass, is heated more rapidly and to a higher temperature than the product being heat-treated. Sometimes good results have been obtained by placing the thermo-couple in a recess in the furnace wall, so that it is heated by radiation instead of by the direct action of the flame. When the couple simply passes through the wall, it usually extends into the furnace one or two inches. View *B*, Fig. 33, shows the method of applying a thermo-couple to a molten bath. It is good practice to place the end of the thermo-couple about half way between the top and bottom of the molten bath.

The tubes in which thermo-couples are commonly inserted to protect them from the action of gases and to prevent deterioration are made of various materials which are applied under different conditions. The protecting tube not only prolongs the life and accuracy of the thermo-couple, but may protect it from being injured. The protection of the thermo-couple from mechanical injury, however, is not nearly so important as preventing it from absorbing gases while heated to high temperatures, which is the principal reason why protecting tubes are used. The strength of the current generated by the thermo-couple for a given temperature depends upon the composition and structure of the couple; hence, to insure uniformity in the amount of current generated at different periods, the thermo-couple must not be contaminated by the absorption of gases. The protecting tubes are made of such materials as wrought iron, steel, nickel-chromium alloys, pure nickel, graphite, silica or quartz, and porcelain. When selecting a protecting tube, it is advisable to consult pyrometer manufacturers, so that tubes which are selected with reference to the temperatures and the temperature fluctuations in the furnace may be used.

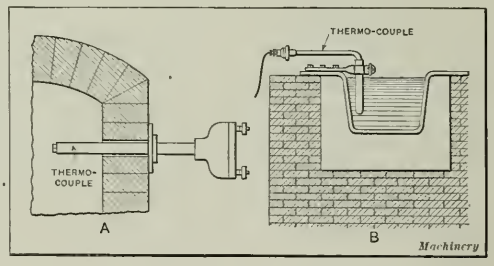


Fig. 33. (A) Thermo-couple inserted through Side Wall of Furnace. (B) Thermo-couple applied to a Molten Bath

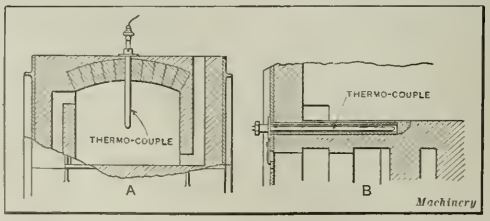


Fig. 34. (A) Thermo-couple inserted through Furnace Roof. (B) Thermo-couple embedded in Furnace Floor

Temperature Variations at Cold End of Thermo-couple

The electromotive force generated by a thermo-couple depends (aside from the kind of metal in the couple) upon the difference between the temperature of the hot and the cold ends, as previously explained. It is apparent, then, that the reading on the pyrometer scale is based upon a certain temperature for the cold end, and that, if this temperature varies considerably, the reading will be inaccurate. For instance, if a pyrometer were calibrated for a cold-end temperature of 75 degrees, and this temperature were increased to 100 degrees, less current would be generated by the thermo-couple and hence the reading on the pyrometer scale would be lower than it should be. The reading of a pyrometer calibrated for a cold-end temperature of 75 degrees should be 75 degrees when the thermo-couple is disconnected and both ends of the couple are at the same temperature.

One method of preventing errors due to cold-end temperature variations is by means of the "zero adjuster," which is used to set the indicator pointer to agree with the temperature of the cold end of the thermo-couple. If a pyrometer is connected to several furnaces or thermo-couples through a selective switch, correction by zero adjustment becomes impracticable when the temperatures of the different cold ends are subject to more or less variation.

Methods of Maintaining a Constant Temperature at the Cold End of Thermo-couple

There are various methods of eliminating cold-end errors. One is to remove the cold end or junction to some point which may vary, say, from 10 to 50 feet from the furnace. This cold end is connected to the thermo-couple in the furnace by means of thermo-couple extensions or compensating leads formed of the same material as the thermo-couple. The object is to place the cold end at a point where the temperature is practically constant, and in order to secure

a more uniform temperature the cold end is sometimes placed at the bottom of a pipe which is driven into the ground. A cold-end well consisting of a 2-inch pipe having a pointed and closed end, may be used for this purpose; this pipe is driven into the ground possibly 10 or 20 feet. The cold end of the thermo-couple, when placed at the bottom of the pipe, remains at a temperature of about 70 degrees F. The pyrometer or indicating instrument is connected with the cold end by means of copper leads in the usual manner. When there are two or more furnaces, there may be a cold-end well for each couple, especially if the furnaces are some distance apart; but if they are grouped together, several thermo-couples may be placed in one well.

The diagram Fig. 35 (from Wilson-Maeulen Co.) shows a method of compensating for cold-end temperatures which differs somewhat from the general method just described. The cold end of the primary thermo-couple, or the one in the furnace, is connected to a zone box. Leading from this zone box there is a flexible auxiliary thermo-couple. The free ends of this auxiliary couple are also attached to the zone box and the opposite or welded end is placed wherever the temperature is fairly constant. The diagram shows the end of the auxiliary couple in a pipe driven into the ground; but in some cases it might be placed at some point on the floor or be provided with a water jacket or regulating thermostat. With this arrangement, the free ends of both the primary and the auxiliary couples at the zone box are always at the same temperature, although that temperature may vary. If there were an increase in the temperature of the zone box, the primary couple would generate less current, but this would be offset by the increase in the current generated by the auxiliary couple; consequently, temperature variations at the zone box do not affect the pyrometer readings. In many installations, this method of compensating for cold-end errors requires considerably less wire than when the thermo-couple is extended to some distant point from which connection is made with the indicator by copper leads. Two different combinations of metals or alloys are used for the auxiliary couples, one being for base metal couples and the other for platinum-rhodium couples.

A constant temperature at the cold end may be maintained by means of boiling water. One arrangement consists of a copper tube which is opened at the upper end for receiving the cold end of the thermo-couple and is surrounded by a steam jacket. Steam is admitted to this jacket through a pipe at the lower end, and at the upper end another pipe serves as an outlet. The steam condenses in the jacket and a temperature of 212 degrees is maintained. The indicating instrument is set by the zero adjuster so that the reading is 212 degrees when the thermo-couple is disconnected.

The Hoskins Mfg. Co. recommends the use of water jackets for cold ends when several thermo-couples are used with a

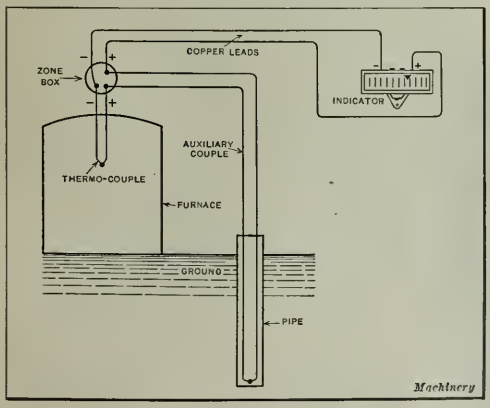


Fig. 35. Diagram illustrating Method of compensating for Cold-end Temperatures



Fig. 36. Pyrometer and Compensating Box or Thermostat for automatically regulating Cold-end Temperature

low-resistance meter, on account of the resistance in the relatively long thermo-couple extension wires employed in conjunction with a cold-end well. The water jacket is an iron casting covered with a layer of heat-insulating material, and there is an opening for receiving the thermo-couple spool. The water jackets for different furnaces may be connected in series to a water line having sufficient pressure to maintain a continuous flow through the system. The temperature of the water as it enters and leaves the water jackets is indicated by thermometers, one thermometer being placed in the water pipe leading to the first water jacket of the series, and another thermometer in the pipe leading from the last water jacket. The mean of the two temperatures thus obtained is taken when setting the indicator by means of the zero adjuster.

An entirely different method of regulating cold-end temperatures is by means of the thermostat or compensating box, such as is shown above the pyrometer and selective switch in Fig. 36. This compensating box (made by the Brown Instrument Co.) is installed when very accurate regulation is required, or where the furnaces are on the upper floor of a building and it is not practicable to place the cold end in a pipe driven into the ground. The compensating leads from the thermo-couple enter the box and copper leads extend to the pyrometer or indicating instrument, the cold junction being within the box. The thermostat is set to maintain whatever cold junction temperature is desired. If this temperature, for instance, is 100 degrees, a lamp within the box and connected with a 110- or 220-volt lighting circuit will be lighted, and thus heat the box until the temperature is increased to 100 degrees. Then the circuit will be opened by means of the thermostat, but as soon as the temperature in the box has decreased to 98 degrees, the circuit is again closed; in this way the required temperature is maintained automatically within 2 degrees.

With the Leeds & Northrup potentiometer, two methods of compensating for cold-end temperature variations are employed. In one case the operator adjusts the scale of a small dial to correspond with the temperature of the cold end; in the other, the compensation is entirely automatic. With the automatic compensation, the cold ends of all thermo-couples are extended to the reading station and the potentiometer circuit is so arranged that temperature changes affect the indicator so as to offset corresponding

temperature changes of the cold end. This feature is especially desirable for permanent installations, as it eliminates all cold-junction accessory apparatus. The indicator having a manually operated cold-junction compensator should be used as a check instrument, and also in some cases where different kinds of thermo-couples are employed.

Changes of Circuit Resistance and their Effect on Accuracy of Reading

The accuracy of pyrometer readings may or may not be decidedly affected by appreciable changes in the resistance of the thermo-couple and in the wires leading to the indicating instrument. With some pyrometers the standard length of lead wires should not be changed, because the resulting increase or reduction of resistance would affect the accuracy of the meter readings. Other pyrometers are affected either slightly or not at all. If the indicating instrument has a resistance of only 5 or 10 ohms, it will be sensitive to changes of resistance in the circuit such as would be caused by adding considerably to the length of the lead wires, or even by atmospheric temperature changes. A variation in the resistance of the thermo-couple will also affect the accuracy of the reading. On the contrary, if the indicating instrument is of the high-resistance type, and has an internal resistance of, say, 500 ohms, the length of the leads might be increased from 20 or 30 feet to several hundred feet without causing appreciable errors; and atmospheric temperature variations and their effect on resistance would also be negligible. The Leeds & Northrup potentiometer type of pyrometer is not affected by resistance in the thermo-couple circuit.

The Brown "heatmeter" is another instrument which eliminates errors due to circuit resistance. This instrument is intended for even greater accuracy than is obtained with the high-resistance pyrometer. In addition to a standard high-resistance millivoltmeter or galvanometer there is a dry cell and rheostat to reduce the cell voltage. The voltage generated by the thermo-couple is opposed by part of the voltage of the dry cell; these voltages are equal when the pointer of the instrument is in the zero position, showing that no current flows through the galvanometer. When the thermo-couple voltage is cut out, the voltage of the dry-cell circuit directly indicates a voltage equal to that of the thermo-couple at the time when the two circuits were in balance. Since temperature changes which might occur in the thermo-couple after it is cut out of circuit will not be indicated, the thermo-couple is connected to the galvanometer and the dry-cell circuit is cut out to see if the readings are the same. If there is a variation, the rheostat is adjusted until the readings coincide, the switch being moved back and forth so that the circuits may readily be compared. When the deflections are equal, the switch is thrown so as to leave the thermo-couple in circuit. The instrument then shows the thermo-couple temperature, and readjustment is necessary only when a possible change in line resistance may have occurred, or a serious change in the temperature of the meter. After making the adjustments referred to, the heatmeter may be used for several hours or days under ordinary conditions, and it will directly indicate temperatures without hand manipulation being necessary.

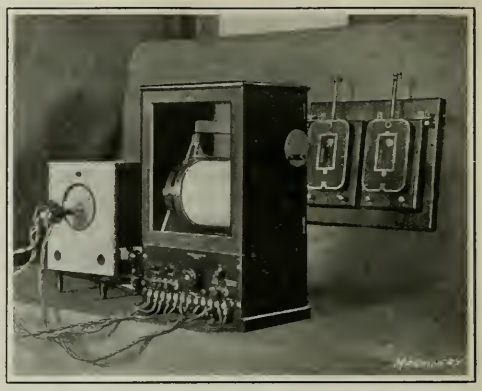


Fig. 37. Apparatus for determining Transformation or Critical Points in Steel

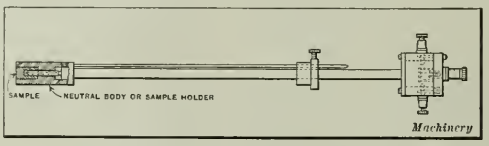


Fig. 38. Arrangement of Thermo-couples, Neutral Body, and Sample of Steel, the Transformation Points of which are to be determined

Determining Hardening and Annealing Temperatures

While the various forms of temperature indicating and controlling apparatus that were described in the preceding installments are indispensable in connection with the heat-treatment of steel, an instrument for indicating temperatures is of little use unless the temperatures necessary to produce good results are known. The best grades of steel may easily be injured or entirely spoiled by heating them beyond certain temperatures which vary for different kinds of steel, depending upon the elements in the steel and their relative proportions, as well as upon the kind of heat-treatment and its object. It is possible, by means of ordinary pyrometers or special apparatus, to determine when important changes in the structure of steel occur and the temperatures at which different steels should be heated for obtaining the best results in hardening or annealing. These changes which are revealed by the apparatus referred to are due to the simple fact that heat is absorbed during a certain period as the temperature of steel rises, and heat is given out during a certain part of the cooling period. For instance, if steel is placed in a furnace in which there is a uniform temperature, the temperature of the steel will continue to rise steadily until the point is reached where a greater number of heat units than was required before, is needed to raise the temperature one degree. This absorption of heat continues throughout a period or range which depends upon the chemical elements in the steel. Different points which mark this period of heat absorption are commonly known as decalescent points and they are designated by the symbol Ac to which may be affixed the number 1, 2, or 3 to indicate what part of the critical range the symbol represents. For example, Ac1 represents the beginning of the critical range or the decalescent point where the transformation or change in the structure of the heated steel begins, and the symbol Ac3 indicates the end of the critical period



Fig. 39. Method of using the Transformation Point Apparatus shown in Fig. 37

or the point where the change is complete. When steel which has been heated beyond the period of decalescence, is allowed to cool slowly, another period is reached where more heat is given out for a drop of one degree in temperature than at any other point in the cooling stage, which is the reverse of what occurred when heating the steel. This effect marks another critical period which is designated by the symbol Ar followed by the number 1, 2, or 3 to denote either the first, intermediate or final stages of the transformation which occurs in the steel. These are the recalescent points. This interesting and important relation between the temperature and the structural changes which occur at the decalescent and recalescent points has been fully explained in articles previously published in MACHINERY, and need not be considered further at this time.

Apparatus has been developed for determining at what temperatures these decalescent and recalescent, or transformation, points occur. It is essential to know these temperatures, because, to obtain good results, steel should be uniformly heated for hardening or annealing, slightly above the upper decalescent point (Ac3) as it will then have the finest grain and the best physical structure. The length of time that this temperature should be maintained depends upon the kind of steel and the size of the piece. If the temperature is not as high as that required for the decalescent period, the changes necessary to produce hardening when the steel is suddenly cooled, have not occurred. On the other hand, if steel is heated considerably beyond the Ac3 point, the grain will be coarsened and the steel injured. It is more important to determine the temperatures corresponding to the decalescent points than those of the recalescent points. The latter are always at lower temperatures than the decalescent points, and with some alloy steels the recalescent period occurs below normal temperatures as in the case or air-hardening steels. Most hardening and annealing operations require a complete change in the structure of the steel, and this can be obtained only by heating to a temperature above the decalescent range. This is true regardless of the position of the recalescent range, and if the steel were heated only to the temperature of recalescence, the complete structural changes would not be obtained. Therefore, determining the temperatures corresponding to the upper critical range, or decalescent point Ac3, is the most important.

Apparatus Used for Determining Transformation Points

The critical ranges or transformation points may be determined either by obtaining a direct record of temperatures and noting their relation to intervals of time, or by what

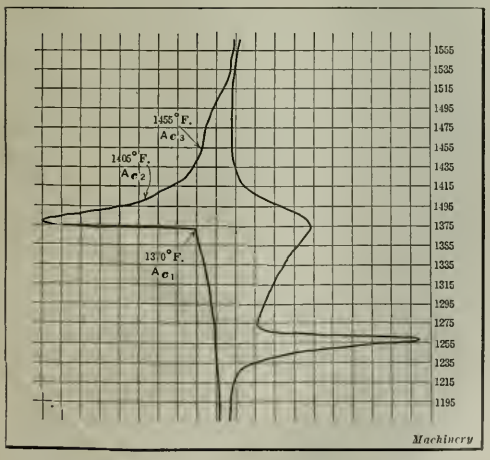


Fig. 40. Chart obtained from Transformation Point Apparatus showing Decalescent and Recalescent Points of Steel

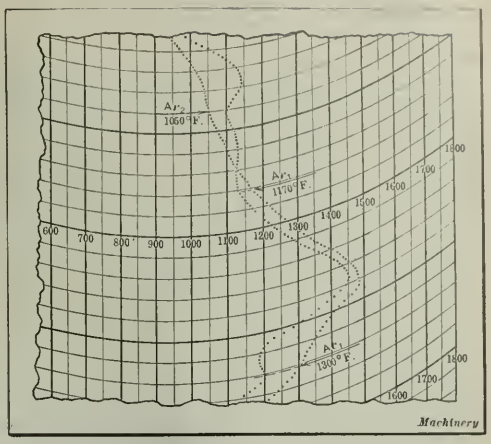


Fig. 41. Section of a Chart obtained from Transformation Point Pyrometer shown in Fig. 42

is known as a temperature temperature-difference or differential method. When the temperature-time method is employed, a sample piece of steel is heated, and by means of a pyrometer, temperature readings are taken at brief and uniform intervals, when approaching and passing the critical range, the location of which is usually between 1200 and 1400 degrees F. If these temperature readings are plotted with reference to the intervals of time, a curve will be obtained which shows where the absorption of heat occurred. This curve may show that, during a brief period, the temperature remains the same or even decreases slightly; this marks the point where some of the heat is consumed by the structural changes occurring in the steel. The time-temperature record may be plotted automatically by using a pyrometer of the recording type, although it may be difficult to determine just where the transformation begins or ends, the change being more pronounced with some steels than with others. In some cases the temperature may not be plotted, an indicating pyrometer simply being used to show when the steel is passing through the critical range. This point will be revealed by a lag in the movement of the pointer, extending over a period of one or two minutes. The specimen of steel used for the test should be small so that it will heat uniformly and without requiring too much time. A small cylindrical piece is sometimes used, in which case a hole is drilled part way through the center, and the hot end of the thermo-couple is inserted in this hole. Instead of using a cylindrical test piece, two small rectangular plates of the same size are sometimes clamped to the thermo-couple. When a commercial pyrometer or one intended for ordinary temperature measurements is used, the thermo-couple may be made more sensitive to temperature changes by reducing the size of the hot end.

Differential Method of Determining Critical Points

The differential or temperature temperature-difference method previously mentioned is employed in order to determine the critical points or ranges with greater accuracy than is obtained by simply noting the temperature changes in a test piece at successive intervals of time. The effect of the structural changes which occur at the critical points is much more pronounced in carbon tool steel than in high-speed or alloy steel. This is due to the fact that the extent to which heat is absorbed or liberated during these changes varies with the different kinds of steel mentioned. For instance, if a time-temperature curve were plotted for an alloy steel of low carbon content, the change in the direction of the curve at the critical points might be so small that temperatures corresponding to these points could not readily be determined; moreover, the temperatures might be affected

by a variation in the rate of heating either in the furnace itself, or in the test piece, thus causing changes that would be misleading.

The Leeds & Northrup apparatus for locating critical points is illustrated in Fig. 37. With this apparatus the differential method is employed. The principle governing the use of the apparatus is as follows: The sample to be tested and a neutral body which will heat uniformly without undergoing changes (such as occur in steel at the critical points) are heated together in the same furnace and while in close contact. Now, these two pieces would continue to heat at a uniform rate were it not for the fact that structural changes occur in the steel sample which cause an absorption of heat; the neutral body, however, is not similarly affected, so that there is a decided temperature difference between the steel test piece and this neutral body which makes it possible to locate the critical points readily. It is essential to so arrange the apparatus that even slight temperature differences may be detected easily, which is accomplished by a rheostat. Means must also be provided for determining accurately the temperatures at which the changes in the sample test piece occur, because this is the object of the test and these are the temperatures needed for the heat-treating process.

The sample to be tested is in the form of a cylinder ¾ inch long by ⅜ inch in diameter, and it has a small hole drilled in the center to a depth of ½ inch. When the steel to be tested is in the form of a sheet, it may be rolled up to a cylindrical shape. The sheet before being rolled may be cut to form a hole at the center, or this hole may be drilled as in the case of a solid sample. In any case, the hole in the sample is lined with a thin sheet of mica to prevent the couple from sticking to the sample. A special set of thermo-couples known as a "double couple" is used. One of the couples is known as the measuring couple and is composed of chemically pure platinum wire and a platinum 10 per cent rhodium wire. The other couple is known as a difference couple and is composed of two pieces of platinum joined by a short piece of iridium wire. The hot junction of the measuring couple and one junction of the difference couple are in contact with the sample and the other junction of the difference couple is in contact with the neutral body. A cross-section of this neutral body or sample holder, and the sample itself may be seen in Fig. 38. This neutral body is of cylindrical shape. It is counterbored at one end for receiving the sample and at the other end for receiving the nickel tubing of the thermo-couple stem. The thermo-couple itself passes through a hole in the center of the neutral body. A sensitive reflecting galvanometer is employed for indicating the changes in the electromotive force of the difference couple resulting from the differences in temperature between the sample and the neutral body. This galvanometer and the difference couple show when the sample is passing the transformation or critical points, and at the same time the temperature is measured by means of the measuring couple and a potentiometer.

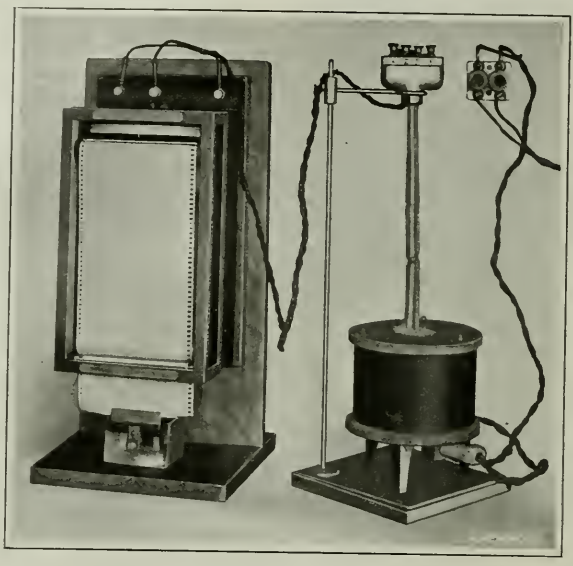


Fig. 42. Transformation Point Pyrometer and Small Electric Furnace used in making Tests

The instrument shown in Fig. 37 is arranged to plot the temperature-difference curves so that it is not necessary to take readings and then plot a curve. The curves are drawn upon a chart by means of a pen. This chart is mounted upon a drum which also carries the potentiometer slide wire. The pen automatically records corresponding electromotive forces or temperatures upon the paper as the drum is revolved to keep the potentiometer in balance. The reflecting galvanometers used in conjunction with this apparatus are attached to the wall. One galvanometer is for the potentiometer and the other measures the electromotive force of the differential couple. Light is reflected upon the mirrors of the two galvanometers by a small electric lamp attached to the indicator case. The beam of light reflected from the potentiometer galvanometer should fall upon a fixed target on a translucent scale at the top of the indicator case, and the beam of light from the temperature-difference galvanometer should fall upon a movable target attached to the pen carriage. This pen carriage may be traversed parallel to the axis of the chart drum by rotating a worm-shaft. When the apparatus is in use, as illustrated in Fig. 39, the operator moves the carriage so as to keep the spot-light from the galvanometer connected to the difference couple always on the semi-transparent target. As the result of this movement of the carriage, the pen is traversed in one direction or the other across the chart whenever the difference in the temperature of the sample and the neutral body changes. The sample or test piece is heated by means of the electric furnace located at the right of the galvanometers. When the temperature of the steel is approaching the critical period, the potentiometer is brought into balance so that it records the temperature of the sample upon the chart. At the same time, the movable target is aligned with the beam of light reflected from the difference galvanometer. Then as the temperature of the sample increases, the operator continually adjusts the potentiometer by turning a knurled wheel at the left, thus keeping the beam of light from the potentiometer galvanometer at the zero or "no deflection" point; simultaneously, by means of a knurled wheel at the right, the beam of light from the difference galvanometer is followed with the movable target. The operation of heating the sample test piece and cooling it to obtain the decalescent and recalescent points, ordinarily requires about three-quarters of an hour.

The chart obtained with this apparatus varies somewhat according to the kind of steel. The one reproduced in Fig. 40 shows the decalescent and recalescent points of steel having a carbon content of 0.3 per cent. The curve representing the heating period is shown at the left, and the cooling curve at the right. The temperatures of the steel sample are represented by vertical distances as indicated by the degrees Fahrenheit at the right of the chart, and the horizontal distances represent the difference between the temperature of the sample test piece and the temperature of the neutral body. With this particular steel, an abrupt temperature difference occurs at about 1370 degrees F., which marks the

beginning of the upper critical range or the Ac1 point. After the temperature difference reaches the maximum, it is gradually reduced as the test piece assumes its normal temperature relative to the neutral body, and finally the transformation in the structure of the steel is complete. Changes which are the reverse of those that occur during the heating period are indicated by the curve on the right-hand side.

The Brown transformation point pyrometer, shown in Fig. 42, is designed to operate on the differential principle. The sample of steel to be tested and a neutral body of pure nickel are each provided with a thermo-couple and are placed in the furnace together. When the temperatures of the test piece and of the neutral body increase at a uniform rate, there will be no differential effect, but when the steel sample is passing through the transformation period or critical range, this will be indicated by means of the two thermo-couples and the recording apparatus used. The differential recorder is automatic after it is once set in operation, and records all transformation points and temperature changes on the chart without adjustment or attendance. The instrument has two windings on one movable system, actuating a single pointer and producing a double record by means of an automatic switch. These records are normally parallel, and one of them shows the correct temperatures of the test piece. When the steel is passing through the transformation period, the changes, as indicated by the other record, are magnified considerably as compared with the temperature record line. This magnified record is secured by making one of the galvanometer windings about ten times as sensitive as the other. Fig. 41 shows part of a record sheet for 30 per cent nickel steel and illustrates how pronounced the transformation points are, although on the true temperature line these points are scarcely perceptible.

* * *

THE DUTCH EAST INDIES AS A MARKET FOR MACHINE TOOLS

By J. W. EVANS

An entirely new market for machine tools is developing in the Dutch East Indies as a result of the war. It is a market that will supply the needs of 50,000,000 predominantly agricultural people, 35,000,000 of whom inhabit the island of Java which has only one-third the area of California. When the war made it impossible for these people to replace parts of German-made machines, it became necessary for them to import machine tools, erect shops, and make the required repair parts themselves. In 1916 there were 4000 employes in the foundries of Java; there was a screw and nut factory, and the state railways and a large steamship company had repair shops; and there was a total of 150 machine shops, forge shops, etc., employing 7220 men. There were also 46 automobile and machine repair shops, employing 1114 men, and 13 railway and street car shops, employing 3025 men.

In 1917 the United States was forced to stop most of its machinery exportations, and the Dutch East Indies had to depend more than ever on their ability to make small machine parts. A final impetus has been given to this new industry by the appointment of a committee for developing domestic industry, whose work it is to foster the building of new factories and work-shops and to create a strong industrial tendency in the commercial life of the people. Mining, electrical, and oil mill machinery, railroad equipment, and the machinery used in 211 sugar factories, in 200 tea factories, on 250 coffee estates and in hundreds of rice factories are constantly in need of repair, and an opportunity is thus presented for the erection of repair shops.

The recent discovery of enormous iron and nickel deposits in Celebes and their projected development also opens the way for new industrial growth. The only adequate way to take advantage of this growing market is for the manufacturer of or dealer in machine tools to send a representative, as European machine tool dealers did before the war. The colonial government is directly interested in this matter.

THE MACHINE TOOL INDUSTRY IN JAPAN

At present there are about twenty-five plants in Japan manufacturing machine tools, and these machine tool builders are enjoying a prosperous business. A number of Japanese export merchants have sold fully a million dollars' worth of Japanese-built machines to Siberia during the past few months. The reason why this machine tool industry has sprung up in Japan during the war is that it became increasingly difficult to obtain machine tools either from Europe or from America. At the same time the demand for machine tools both in Japan and Siberia for munition factories and ordnance plants created a keen demand in Japan. When finally both America and the European nations placed a complete embargo on machine tools, it became necessary for Japan to build her own. Hence, while up to 1916 practically all machine tools were imported into Japan, largely from America, there is now a considerable machine tool industry in the country.

The Japanese Bureau of Commerce and Industry reports show that in 1916 there were 1857 shops in the mechanical industries, employing 149,000 people. It is not entirely clear what the report means by mechanical industries, but it is likely that the shops referred to are those building machinery and tools of all classes.

The future of the Japanese machine tool industry is difficult to foretell. Many of the machine tools built during the latter years of the war were decidedly inferior to the machines previously imported from America and Europe, but there are at least one or two firms that made very good machine tools. These firms, however, charged prices above the American price level; but it is likely that the war conditions made it possible for them to charge these prices, although such high prices were not necessary from a production point of view. During 1918 Japan exported over $30,000,000 worth of machine tools, while in 1917 the exports were not much more than one-half this amount.

Since the armistice was signed, American machine tools in large quantities have been exported to Japan, and American manufacturers should give the Japanese market close attention. It is not likely that the Japanese product will stand the competition with American machine tools except for purposes where less high-class types of machines are satisfactory. Japan has on hand large supplies of iron and steel purchased during the war period at high prices, and it is doubtful whether the Japanese machine tool builders will be able to produce at a satisfactory competitive price, using these high priced materials, for a long time to come.

The importance of the cheap labor of Japan should not be overestimated, because while the labor is cheap, it is also inefficient, and the shop equipment is inadequate. Engineers who have traveled in Japan believe that it will be difficult for this nation to compete successfully in the machinery lines for years to come. It should be remembered, however, that the Japanese are very able in their sales methods, and it is stated that this is a good time for American machine tool manufacturers of the ordinary standard types of lathes, planers, drilling machines, shapers and milling machines to make their best salesmanship effective in Japan and in the markets contributory to the Japanese market.

* * *

FORMING AND PIERCING DIES FOR PRONGED COLLETS

In the article entitled "Forming and Piercing Dies for Pronged Collets," published in the August number of MACHINERY, the statement referring to the production obtained with this equipment should read as follows: It formerly required the services of two machines and two operators to manufacture seventy-five gross of these collets per day, whereas with this forming and piercing punch and die four hundred gross of these collets per day per machine are now being produced, requiring but one operator.

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MACHINERY TWENTY-FIVE YEARS OLD

Twenty-five years ago this month MACHINERY started with sixteen reading and about eight advertising pages. The first number was dated September, 1894; the subscription price was fifty cents a year; the field—machine design, construction and operation, from which this journal has never departed. The growth of MACHINERY during the past twenty-five years corresponds roughly with the growth of America's mechanical industries, and especially the machine tool industry, which leads the world. During the quarter century of its existence MACHINERY has continued under the same ownership and management.

* * *

STANDARDIZATION OF TOLERANCES

In an editorial in the July number of MACHINERY entitled "A Task for the Bureau of Standards," attention was called to an important work for which the Bureau has the necessary facilities and prestige. It is gratifying to be able to announce that the Bureau has entered upon this work and is now collecting preliminary data with a view of establishing tolerances and manufacturing limits, and of determining the extent to which standardization along these lines may be practicable in the various machine-building industries.

The undertaking is of great importance and the work involved is enormous. No other agency but the Bureau of Standards could possibly undertake and complete it successfully. Manufacturers are earnestly requested to cooperate with the Bureau to the greatest extent in this work, by fully answering the questionnaires the Bureau will send out and by furnishing the valuable data and information they have as manufacturers of different classes of machinery. Only through this active cooperation can the work of the Bureau of Standards in the investigation of tolerances and in the establishment of standard limits of accuracy for different classes of work prove successful. Manufacturers interested in the success of the undertaking would do well to communicate with Dr. S. W. Stratton, Chief of the Bureau of Standards, Washington, D. C., who has repeatedly invited manufacturers to work in cooperation with the Bureau.

* * *

FACTORY TRANSPORTATION SYSTEMS

The importance of proper means for transporting materials and finished products within a factory is being more and more recognized. Engineers devoting themselves to the organizing of shops in order to obtain increased production agree that a great deal of the waste of time and effort—and the consequent increase in cost of the finished product—is due to lack of proper facilities or methods for transporting materials within plants. The leading article in this number of MACHINERY, which is the first of two on automobile factory transportation systems, describes an exceedingly well developed system of factory transportation.

While designed especially for a large automobile plant, the principles involved are equally applicable to manufacturing plants in general, no matter what their product may be. It is evident that in smaller plants there is no need of the elaborate devices described in some instances, but some of the ideas will suit practically every plant.

This subject becomes increasingly important as the wages of that class of labor which is generally employed for trucking and moving materials within a plant are being constantly increased. Mechanical means must be developed for transporting materials and products when human labor becomes too expensive. In fact, the fundamental reason why America has always excelled Europe in the employment of machinery and automatic devices of all kinds has simply been a question of wages. In Europe, where wages were low and labor therefore inexpensive, it was often cheaper to make use of human labor than to employ machinery. In America, where the condition was reversed, there was a great need of labor-saving machinery; there was also the great freedom of action and initiative characteristic of a new and rapidly developing industrial democracy. The result of all these favoring factors was a great development of automatic machinery and labor-saving apparatus.

* * *

REPEAL THE POSTAL ZONE SYSTEM

The Republican Party now holding the congressional reins at Washington has an important duty to perform in regard to the repeal of the inequitable zone system as applied to periodicals and newspapers. Many of the senators and representatives see the absurdity of the claim that cheap postage on magazines and newspapers is a subsidy to publishers. As stated by Senator Capper of Kansas, if anyone wants to use the term "subsidy," he should realize that it is a subsidy to the American public. Senator Capper regards the Post Office Department in much the same light as he does the public schools. He believes that cheap postage on periodicals and newspapers has made Americans a people of readers to a greater extent than is true of any other nation in the world. He points to the national benefit derived from widespread reading and believes that publishers, in order to make their business pay, must add the increased zone postage to the subscription price, which means that the reader pays the increased postage. This country had a postal zone system more than fifty years ago and it was abolished completely by President Lincoln in 1863 because it was regarded as an unsound postal policy.

There is no question whatever that the present zone system, according to which periodicals have to pay more for postage alone to some parts of the country than the whole subscription price, is utterly unjust and illogical, and is punitive in purpose. The zone postage rates are not even based upon the cost of the service rendered, for the actual cost of carrying periodicals has never been properly determined. Some of the zone rates now established by law justify an increase in the subscription rate of MACHINERY from $3.00 a year, the present rate, to $20.00 or more for the sections affected. There is no justice and no statesmanship in laws which produce such conditions. Readers of mechanical journals who believe in a "square deal" for themselves, should write their senators and representative in Congress about it.

British Machine Tool and Metal Industries

By ALEXANDER LUCHARS

Trade Commissioner, Department of Commerce, Bureau of Foreign and Domestic Commerce, Washington, D. C.

Early in the spring Secretary Redfield, of the Department of Commerce, appointed Alexander Luchars, publisher of MACHINERY, as U. S. Trade Commissioner to Great Britain and Continental Europe for the purpose of studying conditions affecting the sale and use of American machine tools and accessories in the European market. The present article is the first report of Mr. Luchars to the Department of Commerce, published by the Department last week. This report deals comprehensively with the conditions in the British machine-building and metal industries in general and with the machine tool field in particular. The report is dated London, July 23.

LABOR is the dominating factor in the British industrial situation. All industry is waiting to see what labor is going to do. With the signing of the armistice everyone felt that peace was a foregone conclusion, and during the period of readjustment which followed, progressive manufacturers were planning future developments and strengthening their selling organization, especially in foreign markets, and the work of preparation was well under way; but the element of uncertainty holds back the actual performance.

London, of course, is quite different from the darkened, harassed city in which I spent some time during the war; and there are many evidences, besides the lighted streets and buildings, that peace is here. One, which many business men have welcomed, is the ending of the postal censorship, even if it did involve dismissing 6000 young women employed in censoring London's foreign mail. Another is the official proclamations of peace and the discontinuance of various stringent regulations under the Defense of the Realm Act (popularly known as "Dora"), a voluminous document almost as intricate and exasperating as our income tax return. But it will be a long time yet before conditions settle so that the industrial future can be forecast accurately, and the unavoidable delay in my leaving America was therefore no disadvantage.

New Plants and Extensions

With the exception of plants formerly engaged in munition manufacture, activity is the rule among machine tool and metal manufacturing industries here, caused principally by the changes from war to peace production; and as considerable time will be required to complete such changes, this activity will probably continue unless the labor troubles result in a complete stoppage of manufacture. British manufacturers of all kinds have been carrying on for a period of nearly five years without being able to make changes or enlargements to their plants, except for war work, and many firms are now taking advantage of the removal of building restrictions, whenever material is obtainable and labor conditions permit, to carry out contemplated extensions which are necessary to enable them to handle the volume of work in hand and being offered.

The turnover from war to peace production is well illustrated in the case of Sir W. G. Armstrong, Whitworth & Co., Ltd., one of the largest armament makers in the country. Although provision has been made for the quick resumption of war work if future events demand it, the main works at Elswick, Scotswood and Openshaw are being rearranged for the manufacture on a large scale of machine tools, locomotives, marine engines and turbines, brass and other nonferrous alloys (including brass and bronze powders), castings, stampings, and pneumatic tools, as well as all classes of commercial shipbuilding. Motor car construction and the manufacture of electric power plant are also to be resumed. New shops and a large increase of plant are being provided for the machine tool and small tools department. The manufacture of tools will follow the best modern methods, and it is stated that "all standard types will be produced."

Other well-known machine tool firms making extensions are J. Butler & Co., Halifax, manufacturers of planers, shapers, and slotting machines, who are erecting new works; William Asquith Ltd., Halifax, manufacturer of boring and drilling machines, who is generally remodeling his plant and re-equipping a large works formerly used for shell production; Dean, Smith & Grace Ltd., Keighley, manufacturers of lathes, who will double the size of their existing works; Denham's Engineering Co. Ltd., Halifax, manufacturer of lathes and slotting machines, who is making enlargements and installing new plant; the Churchill Machine Tool Co., Broadheath, Manchester, manufacturer of grinding machinery, who is building works which will cover about fourteen acres; Smith & Coventry Ltd., Salford, Manchester, manufacturers of milling machines, who are also erecting new works; and H. B. Clay & Co., Birmingham, manufacturers of milling cutters and small tools, who are taking over a fair sized works.

The Demand for Machine Tools

All these firms and others not mentioned are full of orders; in some cases it is stated that they are sold up for eighteen months. The fact that large numbers of secondhand tools are being placed on the market does not materially affect orders in some lines, although there are still large quantities to be sold. Up to the present such tools have brought surprising figures, in some cases much more than their original price. The same conditions apply to new tools of certain kinds that are in great demand, due to the efforts of other industries to resume operations for which they must have tools of some kind, if only for temporary use, and also because hardly any machine tool maker is producing to capacity, principally on account of labor difficulties. Complaints of backward deliveries of new tools are frequent, one case being where a firm has been waiting over nine months for some presses not yet delivered. Until the extensive reorganization work mentioned is complete this condition will continue. Many of the machine tool builders would be enjoying a run of prosperity equal to that of the war if they could produce to capacity. The volume of business is very large and the excess profits tax has been reduced from 80 per cent to 40 per cent minimum, increasing the net profit in some cases. Most of the tools turned out on home account are being used to supplement existing equipment, but the new motor car industry requires a large proportion.

Changes in Manufacturing Methods

There is a greater tendency toward specialization, because British machine tool makers had plenty of object lessons of its value during the war, but many large machine tool makers are notable exceptions, still continuing their old methods practically without change. Some firms are building a larger number of sizes than their capacity warrants;

NOTE: The pound sterling is now selling for about £4.33; snd as it is difficult to trsnspose all the figures in this letter into Americsn currency, it is suggested to those who are not familiar with English currency that, roughly, a pound is equal to $5.00, a shilling to 25 cents, and a penny to 2 cents.

others, a larger number of lines than they can produce profitably; both methods result, as we know, in unnecessary increase in costs, the machines being produced in small lots, sometimes only two or three of a kind. One well-known concern makes no less than twelve different types of machines, including engine lathes, hand screw machines, milling machines, turret lathes, gear-cutting machines, drilling and tapping machinery, boring machines, planers, shapers, slotters, and grinding machines. A lot of "two dozen" standard tools, such as lathes or drilling machines, is here regarded as a large "batch." There are hundreds of small employers operating shops with a handful of work people, men, women, boys and girls, who will continue to operate in the same way to which they have been accustomed for a generation or more. They have practically no overhead to think about and are making a good living at present prices. They cannot afford the high-priced machinery, automatics, etc., with which they compete to some extent, and are troubled with no ambitions, satisfied to live from day to day as their fathers and grandfathers did. Why worry?

In America we are rapidly forgetting the lessons of self-denial and thrift learned during the war, and the same is very largely true of Great Britain also—especially as the English are more ready to return to old ideas than we.

Little is being done in designing new tools, perhaps on account of the various conditions referred to above, and as few changes have been made in design, not many new catalogues have been printed.

The plants of many of the machine tool manufacturers in Great Britain are full of orders; in some cases it is stated that they are sold up for eighteen months. The fact that large numbers of second-hand tools are being placed on the market does not materially affect orders in some lines, although there are still large quantities to be sold. Up to the present such tools have brought surprising figures, in some cases much more than their original price. The same conditions apply to new tools of certain kinds that are in great demand, due to the efforts of other industries to resume operations for which they must have machine tools, and also because hardly any machine tool maker is producing to capacity, principally on account of labor difficulties. Many of the machine tool builders would be enjoying a prosperity equal to that during the war if they could produce to capacity, especially as the excess profits tax has recently been reduced from 80 per cent to 40 per cent.

Some British Combinations

A tendency toward specialization and to a consolidation of their lines is noted in some cases, the principal one being that of the Associated British Machine Tool Makers, Ltd., consisting of eleven large concerns that have combined not only for marketing purposes, but for the purpose of improving designs and reducing manufacturing costs. Each works now concentrates on a limited number of types, so that large lots of similar machines are turned out on a repetition basis in the American way. Each firm retains its identity, ownership and control, neither capital nor other interests being pooled. The Associated British Machine Tool Makers, Ltd., comprise:

James Archdale & Co., Ltd., Birmingham, medium-sized drilling machines; milling machines, horizontal and vertical.

William Asquith, Ltd., Halifax, large radial drills.

J. Butler & Co., Halifax, planers, shapers and slotters.

Churchill Machine Tool Co., Manchester, grinding machinery.

Kendall & Gent, Ltd., Manchester, planer-millers, vertical millers, horizontal boring and milling machines.

John Lang & Sons, Ltd., Johnstone, Glasgow, lathes.

Thomas Shanks & Co., Johnstone, Glasgow, heavy machine tools for railways, shipbuilding, marine engine work, etc.

J. Parkinson & Son, Shipley, universal millers and gear planers.

George Richards & Co., Broadheath, Manchester, turning and boring mills; drilling, boring and milling machines; side planers; keyway milling machines.

Smith & Coventry, Ltd., Salford, Manchester, sensitive drills, relieving lathes, horizontal milling machines, and bevel-gear planers.

H. W. Ward & Co., Ltd., Birmingham, capstan lathes, hand screw machines and turret lathes.

A very wide range of tools is covered by the Association, and to enable them to quote for complete equipment they have taken up sole agencies for other non-competing manufacturers. To insure adequate representation abroad they have opened branch offices in Belgium, France, Holland, Italy, the Argentine, and India, with a competent engineer as manager, assisted by a staff of expert machine tool representatives in each office.

Besides the Associated British Machine Tool Makers, Ltd., associations of manufacturers of the following products have been formed:

Milling Cutter Manufacturers' Association.—Formed in 1918 "to deal with all matters interesting or affecting the makers of these tools"; membership believed to be large, but details not procurable. Secretary, P. M. Archer, Sir W. G. Armstrong, Whitworth & Co., Ltd., Openshaw, Manchester.

British Screwing Tackle[1] Manufacturers' Association.—Formed in 1918 "to look after the interests of the screwing tackle industry." Honorary Secretary, Mrs. F. Turrell, The Coventry Ordnance Works, Ltd., Coventry.

British Gage Manufacturers' Association, Ltd.—Formed in 1918 "with the object of encouraging, promoting and protecting the British gage manufacturers' industry and generally to watch over and protect the interests of the gage manufacturers of Great Britain." Secretary, A. L. Pailthorpe, 44 Caxton House, London, S.W. 1.

Association of British Driving Chain Manufacturers.—Formed to develop the use and application of chain driving, the value of which its manufacturers feel is not yet appreciated by power users, and to keep down the costs of chain driving. The policy projected includes the standardization of chains, wheels, and chain wheel cutters to insure interchangeability; elimination of unnecessary sizes of chains, which have been a source of confusion and difficulty to the user; increasing the output so as to secure a larger share of overseas business than at present. The members of the Association are the Alfred Appleby Chain Co., Ltd., Birmingham; Brampton Bros., Ltd., Birmingham; The Coventry Chain Co., Ltd., Coventry; and Hans Renold, Ltd., Didsbury, Manchester.

The last four associations mentioned are apparently not intended as selling organizations, so far as I have been able to learn.

New Lines Added

Some examples of permanent additions to lines since 1914 are furnished by:

Denham's Engineering Co., Ltd., Holmfield, Halifax; 13-inch tool-room lathes; 17-inch high-speed lathes.

Colchester Lathe Co., Colchester; all-geared-head lathes.

Clifton & Baird, Ltd., Johnstone, Glasgow; high-speed friction sawing machines.

James Bennie & Sons, Govan, Glasgow; punching and shearing machines, built-up, steel-plate type.

Stephen Stell & Co., Ltd., Keighley; 15- and 19-inch engine lathes.

C. Redman & Sons, Halifax; 43-inch swing surfacing and boring lathe.

The Power Plant Co., Ltd., West Drayton; Sykes gear generating machines.

Oldfield & Schofield, Ltd., Halifax; precision grinders and pillar shaping machines.

New Fortuna Machine Co., Ltd., Bristol; internal grinding spindles.

Morton & Weaver, Coventry; plain grinding machines.

[1]Taps, dies, wrenches and chasers.

Monometer Mfg. Co., Ltd., Birmingham; die-casting machines.

D. Mitchell & Co., Ltd., Keighley; 48-inch radial drilling machines.

John Lang & Sons, Ltd., Johnstone, Glasgow; light pattern lathes.

Jones & Shipman, Ltd., Leicester; plain and universal grinders; radial race grinders; heavy-duty drilling machines, to drill 3 inches from solid.

Humpage, Thompson & Hardy, Bristol; gear-hobbing machines.

G. & A. Harvey, Ltd., Govan, Glasgow; all-geared-head lathes, 18- to 36-inch centers.

Motor Car Manufacture

In this industry, which is protected by an import duty of 30 per cent, reorganization work is more in evidence than in any other. Motor car manufacturers, during the war, built up enormous works which were engaged principally on munitions and war material. These factories are being re-equipped to carry out comprehensive post war programs and require a large supplementary amount of equipment. In some cases entirely new machinery must be installed, the existing plant being practically useless for economical motor car production. It is unlikely that new cars will be produced in anything like quantity this year and the high prices of automobiles will therefore continue. Some firms have been more fortunate in respect to changing over than others; for example, Sunbeam motors, Rover motors, Claytons and Crossley motors were engaged on car production during the war, and can soon change to the new models.

Agricultural Machinery

The impetus given to domestic agriculture during the war has resulted in a marked increase in the output of farm tractors, the manufacture of which has been taken up not only by the east country agricultural machinery makers, but by motor car and other concerns, notably, the Austin Motor Co., Ltd., Birmingham; D. L. Motor Mfg. Co., Ltd., Motherwell; and Melchior, Armstrong & Dessau, Ltd., London. In the main, these tractors follow the American four-wheel type, with engines arranged to start on gasoline and run on a heavier oil fuel.

Other developments, in response to growing demand, are in connection with motor ploughs, steam tractors, and small gasoline and oil engines, coupled to pumps or electric generators for working in isolated locations.

Twist Drill Machinery

The extraordinary demand for twist drills has directed some attention to the production of twist drill machinery. Two concerns, Herbert Hunt & Sons, and Isaac Best, Ltd., both of Manchester, are specializing on a line of machines for twist drill turning, pointing and cutting off, grooving, clearance milling, and groove grinding.

Chucks and Small Tools

Strong competition has been started in the manufacture of American scroll chucks and in small tools such as center drills and counterbores, boring-bars, tool-holders, drill sleeves and sockets, etc. The manufacture of lathe chucks has been taken up by F. Pratt & Co., Ltd., of Halifax, who have changed over from the manufacture of machine tools and will specialize on chucks. Another large firm, Jones & Shipman, Ltd., of Leicester, is devoting several departments to the above product. One department is given over to the manufacture of scroll type self-centering chucks and another to the manufacture of Slocomb type center drills and countersinks, both of these departments being self-contained and under the charge of different works managers. It is said that the selling price will be considerably less than that for which the American product can be sold here; taking sleeves and sockets as an example, Jones & Shipman have reduced manufacturing costs to a figure that will allow them to undersell the cheapest German product offered here before the war.

Steel and Other Industries

The Sheffield steel manufacturers and kindred industries have also a large share in the reconstruction work. These firms generally have profited by their experience during the last four years, and in addition to modernizing their works, are reorganizing their selling departments, and changing over from large shell, gun and similar production. For example, Hadfields, Ltd., Sheffield, are turning their extensive shell shops into steel foundries and rolling mills; Cammell, Laird & Co., Ltd., Sheffield, are carrying out similar arrangements and modernizing their plants. At their Birkenhead works, large numbers of new tools are being installed, and their large Nottingham factory is being reorganized for peace production. These examples are typical of many others.

The manufacture of the new equipment required in such changes greatly stimulates not only machine tool making, but allied industries as well. Such concerns as Davey Bros., Sheffield, and Henry Berry & Co., Leeds, and other press and rolling mill makers are extremely busy. The Birmingham brass and associated trades, which have in many cases been practically closed down during the war, are now starting up, and the same general conditions apply.

Strong competition has been started in Great Britain in the manufacture of American scroll chucks and in small tools such as center drills and counterbores, boring bars, tool holders, drill sleeves and sockets, etc. It is said that the selling price will be considerably less than that for which the American product can be sold in England; taking sleeves and sockets as an example, one company has reduced manufacturing costs to a figure that will allow underselling even the cheapest German product offered before the war. Particular activity is shown in jig production, the demand for jigs and fixtures far exceeding the capacity of the tool-rooms of individual plants. A number of small concerns have entered the field to supply this demand, and some of the larger firms have created departments for the exclusive manufacture of jigs, fixtures, gages and special tools made to the customers' own designs. The brisk demand for small tools has led to an increase of about 60 per cent in the number of people engaged in this trade since 1914—an appreciable development.

Magnetos, Spark Plugs, etc.

An unusual development has taken place during the war in the manufacture of magnetos, spark plugs and other accessories such as were previously imported. Prior to the war the Bosch magneto, a German product, practically held the field by means of the highly specialized manufacturing methods used, resulting in an inexpensive article with which competition was difficult. The increased war demand and the cessation of German supplies brought a number of manufacturers into the field who have since combined under the title of "British Ignition Apparatus Association," with the result that foreign competition is likely to be rendered difficult in the future. There is no Sherman Law in Great Britain.

The names of the firms in the Association are: C. A. Vandervell & Co., Acton Vale, London; North & Sons, Ltd., Watford; the Thomson-Bennett Co., Coventry; P. N. L. Magneto Syndicate, Ltd., Coventry; Electrical Ignition Co., Ltd., Birmingham; British L. M. Ericsson Mfg. Co., Ltd., Beeston, Notts; British Thomson-Houston Co., Ltd., Coventry and Willesden; British Westinghouse Electric & Mfg. Co., Trafford Park, Manchester. Other concerns outside the Association, including Vickers, Ltd., London, are also manufacturing magnetos.

Jigs and Fixtures

Particular activity is shown in jig production, the demand for jigs and fixtures far exceeding the capacity of the tool-rooms of the individual plants. A number of small concerns have entered the field to supply this demand, and some of the larger firms, such as W. Beardmore & Co., Glasgow, and W. H. Allen & Co., Bedford, have built extensions or departments for the exclusive manufacture of jigs, fixtures, gages and special tools from customers' own designs.

The brisk demand for small tools has led to an increase of about 60 per cent in the number of persons engaged in this trade since 1914. Permanent additions to the lines of concerns since 1914 may be itemized as follows: Self-opening die-heads, screw gages, taps and dies, self-centering chucks, belt lacing tools, tool stands, twist drills, micrometers and slip gages, tool-holders, center drills and countersinks.

Die Casting and Extrusion

Die-casting and extrusion manufacturers were very busy during the war, but there is a need for improved machinery for die-casting, particularly in aluminum and brass, British machines for this work generally being said to be somewhat primitive.

Statistics of the Machine Tool Industry

It is difficult to arrive at anything more than an approximate estimate of the number of work people engaged in the British machine tool industry. The classification adopted in the statistical tables published in the Labor Gazette, which is the organ of the Ministry of Labor, is a broad one, all the engineering trades being aggregated and subdivided in respect to districts, but the machine tool industry is not given separately. The approximate number of shops is about 200, and figures which I have obtained and have had verified by authorities show a total of about 26,000 workmen in 1914 as against 32,000 in 1919. The above figures do not include concerns making forge and blacksmith shop, patternmaking and foundry tools, heat-treatment furnaces and small tools and accessories. This group will number 100 concerns at least, and approximately 6000 workmen were employed in 1914, which number has been increased in 1919 to at least 7500.

The approximate number of shops building machine tools in Great Britain is about 200, with a total of about 26,000 workmen in 1914 as against 32,000 in 1919. These figures do not include concerns making forge and blacksmith-shop tools, patternmaking machinery, and foundry tools, nor those making heat-treatment furnaces, small tools and accessories. This group numbers 100 concerns, at least, with approximately 6000 workmen employed in 1914, which number was increased to at least 7500 in 1919. The greatest increase is shown in the small tool industry.

Control of Imports

There is at present no restriction in, or governmental control of, the imports of machine tools and kindred products, nor is any license required to import them. The only limitation is the amount of shipping space available from America. Some Americans take an erroneous view of our favorable trade balance and the enormous sums due us from Europe; but a moment's thought will show that these favorable balances, adverse to Europe, are a handicap rather than a stimulus to our export trade, because the present demoralized exchange rate represents an increased cost to British importers of over 10 per cent on American products.

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Classes of Tools in Demand

Dealers report a steady and general demand for high-class tools, except automatics, which show a slight decrease owing to the disbanding of the Government fuse factories which set free a large number of these machines. A good demand should continue for small (12- to 14-inch) and medium (17-inch and upward) high-class engine lathes, turret lathes, grinding machines, broaching machines, heavy-duty and multiple drilling machines, milling machines, gear-cutters, automatic screw machines, die-casting machines, chucking machines, precision bench lathes, machinists' small tools, and particularly tools adapted to the economical production of such parts as automobile engine cylinders, gears, back axles, connecting-rods, etc.

Government Sales of Machine Tools

British government sales of machine tools are being conducted so as to disturb the markets as little as possible. Prices rule uniformly high in the case of standard tools, and the last sale produced about £150,000. A new method was adopted—that of overhauling each second-hand machine before it was offered and putting it in such a condition as to render it immediately available for work. In this way the Government obtained the benefit of what is known as the "immediate delivery premium," which more than repaid the money expended in overhauling the machines. The government policy on the tariff question is unknown, but an announcement is expected in September. Public opinion on the question is divided. One side, represented by users and merchants and certain makers, is that a duty on imported tools would be a great disadvantage to British industry and a check to progress; on the other side, makers ask why machine tools should come into their country free if they have to meet a duty against them in foreign countries, meaning America. Most of the old protection and anti-protection arguments which we are accustomed to in America are being made use of. The writer's opinion is that the question involves so many conflicting interests that no practical working policy can be decided on by September. British makers at present cannot begin to meet the demand for certain kinds of machines produced in the United States, such as automatics, broaching machines, multiple-spindle drilling machines, vertical surface grinders, and bench precision lathes, and they will continue to buy them there; while the demand for cylindrical and internal grindiug machines and high-class engine-lathes is considerable.

A national desire has developed in Great Britain to manufacture machine tools, as well as everything used or consumed in the country; and this feeling has been emphasized by the unfavorable exchange rate which prevails, the pound sterling selling almost as low as at any period of the war.

While there is the utmost good feeling on the part of the British toward America, the tendency is strong to place orders for all kinds of machinery at home, even at a somewhat higher price, if the machines are made here. Two large orders for railway equipment, one for India and the other for Canada, I am informed, have lately been placed in Great Britain at prices higher than American manufacturers offered, although all British locomotive works are

behind in their deliveries, one being said to be eighteen months behind. All the railroads here build their own locomotives, the independent manufacturers making principally for export.

Increase in Selling Price

The accompanying table exhibits roughly the average increase in the 1919 selling price of certain classes of British tools. The average increase is 97 per cent.

TABLE 1. PRICES OF BRITISH MACHINE TOOLS IN 1914 AND 1919

Class of machine	Price in 1914	Price in 1919
14-inch shaper	£70	£157
Horizontal boring, facing and milling machine	290	710
20-inch single tool grinder	22	39
Metal band-sawing machine	130	214
Hydraulic press	500	1000
Double-end punching and shearing machine	168	380
20-inch engine lathe, Lancashire built, good class	200	420
20-inch lathe	90	180
12-inch lathe, cheap line	26	52
16-inch engine lathe	120	235
17-inch lathe, Yorkshire type, manufacturing	56	92
17-inch lathe, Yorkshire type, manufacturing	65	140
19-inch lathe, Yorkshire type, manufacturing	60	130
Planing machine	180	240
13-inch turret lathe	140	230
8 by 3 by 3 ft. planing machine	245	590
30-inch boring mill	200	270
Hacksawing machine	21	31
9-inch slotter	100	196
10-inch slotting machine	80	160
Hand screw machine	58	100
Horizontal boring machine	360	576
Universal tool and cutter grinder	65	94
48-inch radial drilling machine	95	200
Combination turret lathe	300	480

Machinery

The increase of 6s per ton of coal that was announced to meet the increased costs consequent upon the payment of the higher wage rate, the forthcoming reduction of hours to seven per day shift, and the consequent lessened output has been deferred. The postponement is due largely to the prompt admission of the seriousness of the position by the miners themselves and to the realization that there exist other checks to output besides the cause above mentioned, such as the shortage of cars and materials. The whole situation is to be dealt with by the cooperative effort of the government, colliery owners and miners. The opinion is expressed that American coal will be offered in the London market. It is stated here that American coal is being offered f. o. b. at Atlantic ports at 20s per ton, but the lowest price for American coal in European ports is stated to be 130s per ton; that is, the freight and handling costs 110s a ton.

Remuneration of Work People

In 1914 the average wage of a turner (machinist) was from 34s to 39s per week according to district, as against from £3 12s 0d to £3 15s 0d per week in 1919; that is, about 100 per cent. In addition to this increase in wages, hours have been reduced from 53 or 54 to 47, and a further reduction to 44 is being considered. The current wage for men employed at time rates is made up as follows:

Basic wage (Midlands)	£2	6s	0d
War advance	1	1	6
Special bonus of 12½ per cent		8	4
	£3	15s	10d

For men employed on piece-work, a general minimum advance of 10 per cent on pre-war rates, plus 21s 6d per week, has been adopted in the federated machine shops throughout the country. The following table shows the average amount of increase (inclusive of the 12½ per cent bonus) granted up to the end of April 1919, on the district time rates for men in certain representative occupations in a number of the principal machine centers, and the equivalent percentage increases over pre-war rates:

Occupations	Amount of Increase per Week		Percentage Increase on Pre-war Rates, per Week
Machinists	37s	11d	98
Moldera	38	2	92
Laborers	35	5	156

For women in the machinery industry, 18 years and over, not engaged on men's work, the present minimum, including 16s war advance, is 38s per week. Higher rates are paid to women engaged on men's work, and to those employed on certain special classes of work.

Remuneration of workpeople in the machine tool industry is largely by piecerate, the operators being allowed to make a total as large as they can in a week's work. Although in general the attitude on the part of the men toward the premium and bonus system is not sympathetic, some machine tool concerns have adopted it successfully. In one plant all the work is done on that basis, a standard amount of time being allowed for each operation; the difference between the standard time allowed and the time taken is equally divided between the firm and the workman. Standard time allowances are determined by the departmental foremen, who actually do or watch each of the operations under working conditions. Once set, the standard time is never cut, no matter how much the operator may earn. The firm in question believes that rate cutting on piecework is not only unfair but demoralizing and that the best way, if a mistake has been made in the rate, is to stand by it.

TABLE 2. PRICES OF MATERIALS 1914 AND 1919

Material	July 1914 per Ton	June 1919 per Ton
Mild steel bars	£6 5s 0d	£19 0s 0d
Copper	61 2 6	84 10 0
Iron (crown bars) N. E. coast and Lancashire	6 12 6	20 10 0
Pig Iron, No. 1 foundry (Cleveland)	2 14 0	8 10 0
Steam coal—Best Hards	10 3	1 2 6
Seconds—Best Hards	9 6	1 1 6
Slacks—Best Hards	6 3	18 3

Machinery

Profit-sharing Plans

Profit sharing plans are attracting attention and one in particular, which has been adopted in several plants, is held by some to offer the promise of a solution of one of the most difficult industrial problems. It is based first on the provision of a standard wage plus a further interest based upon the selling price of the product. In the case of a lathe plant, where the system has been adopted, a careful investigation of the books for many years back has shown that the cost of material represents at least one-third of the selling price of the finished machine; another third, it is reckoned, should rank as wages; and the remaining third is for overhead charges, interest on capital, selling and any other miscellaneous expenses. This agreement starts with the declaration that the standard rate of wages is to be maintained and that each month any balance remaining from one-third of the total selling prices for the period is to be divided among the workers in proportion to the time worked and the standard wage of each workman and apprentice.

It is claimed that this system encourages the introduction of new machinery, for any increase in production is bound to benefit the worker, while any new machinery made by the firm for its own use is credited to the bonus fund on the basis of its market value. Attention to work and full time are encouraged by the substantial inducements held out, while laxity, if penalized, is not unfairly dealt with. Any workman absent more than 15 hours in one month, unless for a valid reason, forfeits 10 per cent of his accrued bonus. To check any tendency to rush out goods regardless of quality or finish, provision is made that, in the event of any legitimate complaint from a customer on account of defective workmanship in machines made by the firm, which defective workmanship has to be made good, the cost of wages for such substitution or repair is to be borne out of the current month's bonus fund, while any cost of material is borne by the firm. A committee of three has been appointed by the workmen to discuss any improvements in production and conditions of employment.

The question, often asked by American manufacturers as to the relative productive capacity of the British and

American workmen in the machine tool industries, is impossible to answer accurately without detailed comparisons of actual production. The observation of those who are familiar with the conditions in the two countries agree that the general comparison favors our workmen to quite a large extent.

Prices of Food and Other Commodities

The all-around increase in the price of food since 1914 is well over 100 per cent. For example, the price of flour and bread has doubled, bacon and imported mutton have trebled, and sugar and lard have quadrupled, in Great Britain. Clothing costs three times the 1914 price with a still rising tendency. Traveling costs are up 50 per cent. Good quality house coal, which was 28s per ton in 1914, is now 52s 6d. Gas and electric light have increased correspondingly. The rents of working men's dwellings have, by reason of the control, remained about where they were in 1914, but when the control is lifted, as it will be in a few months, rents will increase as is evidenced by the increased purchase price of house property.

Labor Conditions and Employment

A great deal of unemployment exists, particularly in the big munitions centers, such as Sheffield, Birmingham and Manchester. The men there are, however, largely unskilled, who have been drawn into the machinery industry by the war. Skilled men are scarce, and owing to this shortage and other causes referred to, the progress of reconstruction is retarded.

The total number of unemployed persons on May 2, according to the donation records, was 1,093,400 as compared with 1,060,245 on March 28, an increase of 33,155. The total of 1,093,400 was made up of 402,151 men and 1316 women demobilized from the army and navy service, and 689,933 civilians. Of the latter, 452,132 were women and girls. An analysis of 1,082,759 of the applications made up to May 2 revealed that 63,930 of the unemployed persons were in receipt of the reduced donation which is paid to civilians after the expiration of the first period of 13 weeks' unemployment; of this number nearly two-thirds were women. The number of men on the live registers of the employment exchanges on May 9 was 653,270, an increase of 87,902 over March 28; the number of women was 450,155, a decrease from March 28 of 113,035 on the total. The number of vacancies unfilled on May 9 was 44,211 for men and 62,369 for women, the corresponding figures for March 28 being 46,591 and 65,145. Trade unions with a net membership of 1,202,793, excluding those serving with the forces, reported 2.8 per cent of their members as unemployed at the end of April as compared with 2.9 per cent at the end of March, and 0.9 per cent a year ago. The unemployment pay for civilians is at present £1 a week for 13 weeks. No figures can be given for the time following this period, as the pay varies considerably according to the individual's responsibility. For soldiers who have been demobilized since November last the pay is £1 9s a week for 13 weeks; after that period the same amount is paid as to civilians.

Great apprehension exists in industrial circles over the attitude and requirements of labor, and the resulting uncertainty is paralyzing industrial development. There is no industry or occupation in which stable labor conditions exist.

When their labor troubles are settled, British manufacturers expect to see the greatest trade revival of this generation; but if they continue for any considerable period, it is felt that British markets will pass in a large measure to competing countries where such troubles do not exist.

There is a greater tendency toward specialization because British machine tool makers had plenty of object lessons of its value during the war, but many large machine tool builders are notable exceptions, still continuing their old methods practically without change. Some firms are building a larger number of sizes than their capacity warrants; others, a larger number of lines than they can produce profitably; both methods result in unnecessary increase in costs. Little is being done in the designing of new types of machine tools.

OXY-ACETYLENE PROCESSES IN THE NAVY YARDS

Oxy-acetylene processes are being used to a very large extent in the navy yards, but it may be news to many that in these yards oxy-acetylene cutting is used more than welding. This was especially the case during the war. At that time hundreds of ships had to be reconstructed from the pursuits of peace for the transport of troops and for the carrying of war cargo. Every time a passenger or cargo vessel had to be converted into a transport many changes were necessary. Bulkheads had to be cut out or removed, ventilation arrangements had to be installed, and fixtures of various kinds had to be put in place. During the war, time was the primary consideration and expense came secondary. The oxy-acetylene torch cut its way through all obstructions and provided a quick and easy transportable means for accomplishing the desired end. It thoroughly demonstrated its value for work of this kind.

In a paper read by Commander H. G. Knox of the United States Navy before the International Acetylene Association, attention was called to the fact that many of the repairs made on the broken cylinders of the German ships, damaged by their crews in American harbors in the early part of the war, were performed in our navy yards not only by electric arc welding, but by oxy-acetylene welding as well. At the Norfolk Navy Yard three German ships were delivered for repairs—*Rhein*, *Neckar*, and *Bulgaria*. The major portion of the welds on the damaged cylinders on these ships were made by oxy-acetylene, six out of eight cylinders on the *Rhein* and the *Neckar* being thus repaired, and all but one bad break on the *Bulgaria* being handled by the oxy-acetylene welding process. According to Commander Knox, one important point brought out by his experience in the repair of engine cylinders was that the character of the gas weld made it easier to machine than an electric arc weld. A gas-welded cylinder liner could be easily machined as there was no trace of hardness at the welding line between the original metal and the filler. This was seldom the case with the arc-welds that required machining. It is presumed that both types of welds were made with equal care.

During the war, the Government established three oxy-acetylene welding schools which were maintained for the duration of the war. Each of these schools accommodated a class of 100 welders, the course of training being from 6 to 8 weeks. The actual welding time averaged about 260 hours, and in addition to this there were 30 hours of lectures. A course of 60 standard problems was selected to cover the motor truck welding field. These problems included steel, cast iron, malleable iron, aluminum, brass, bronze and copper welding, as well as brazing and lead burning. Three and one-half weeks, on an average, were spent on steel welding, two weeks on cast-iron welding, one week on aluminum welding, and the remainder on the other metals. It was thoroughly demonstrated that by proper training any intelligent man could be developed into a fair oxy-acetylene welder.

* * *

It was estimated in 1915 that a total of 49,000,000 horsepower was in use in the United States. This was divided among the various industries as follows: Irrigation, 500,000; mining, 6,000,000; flour, grist, and saw mills, 1,250,000; factories, 25,000,000; central stations, 8,000,000; individual plants, 4,250,000; and electric railways, 4,000,000. Of this amount 61.2 per cent was steam power, 24.4 per cent water power, and 14.3 per cent combustion engines.



Fig. 10. Power Press equipped with Dial Feed and Separate Magazines for delivering Side Bars and Rivets to Dial Ready for assembling Two Rivets in Each Side Bar



Fig. 11. After Center Blocks are assembled to the Partial Assemblies from Machine shown in Fig. 10, the Final Work of assembling the Chain is completed on This Machine

Making Diamond Sprocket Chain

Second of Two Articles Describing Special Machines and Fixtures Developed for Making Chain

By EDWARD K. HAMMOND

THE work of making the side bars for Diamond bicycle sprocket chain is accomplished by a relatively simple series of power press operations. The rivets are made on automatic screw machines. After the side bars, center blocks, and rivets have been completed, we come to the process of assembling the chain.

First Step in the Process of Assembling

In assembling, the first step is to put together one side bar and two rivets, a rivet being pressed into the hole at each end of the side bar. In Fig. 10 is shown the machine equipped for doing this part of the work. It consists of a power press provided with a dial feed mechanism and means of automatically feeding side bars and rivets into place ready to have the rivets pushed into the holes in the side bars. Referring to the illustration, it will be seen that the side bars are carried on a U-shaped wire *A* to enable them to drop into position in notches of the dial feed mechanism on the press. The rivets are contained in hopper *B* and descend through two feed-chutes from this hopper to drop into notches in the feed dial which locates them directly over the holes in the side bar into which they are to be pressed. In hopper *B* there is an agitator operated by a link mechanism, of which *C* is a part, to facilitate the feeding of rivets through the chutes from hopper *B*.

The rivets drop into place in the V-shaped notches which will be seen in the dial, and the side bars are pushed into pockets located on the under side of the dial. For this reason it is necessary for the side bars, as they drop off U-wire *A*, to be pushed into successive pockets in the dial, and for this purpose there is provided a cross-slide *D* which is actuated from slotted crank *E* through a suitable arrangement of links and cams. A slide is also required to push the rivets forward, as they drop out of the feed-chutes from hopper *B*, into place in the notches in the dial. The end of this slide is shown at *F*, and the slide is actuated by an

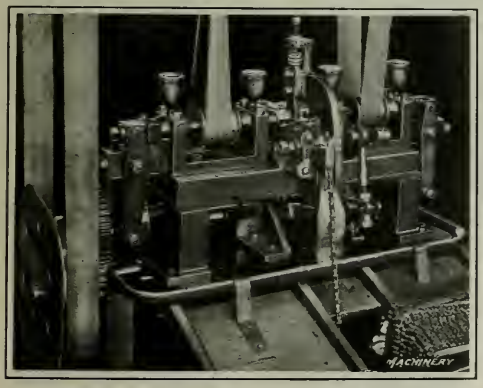


Fig. 12. Special Opposed Two-spindle Rivet-spinning Machine on which Riveting Operation is completed. A Special Mechanism provides for alternately indexing for the Long and Short Spaces between Adjacent Rivets



Fig. 13. Table arranged for applying a Load of 500 Pounds to Each Bicycle Chain. This Load is Great enough to insure an Adequate Factor of Safety for the Chain when in Operation under the most Severe Conditions

arrangement of links located under the table which supports the dial feed. In the case of slides *D* and *F*, a positive mechanism moves the slides back, and their forward movement is accomplished by means of tension springs. The two springs used for this purpose will be seen at *G* and *H*, respectively.

Second Step in the Process of Assembling

As the work leaves the machine shown in Fig. 10, it consists of a side bar with two rivets pressed into place in the holes. These partial assemblies are taken over and placed beside the table shown in Fig. 11, so that girls employed for the purpose may assemble center blocks on the rivets by hand, thus building up a chain of the form shown at the right-hand side of the machine, which is only lacking the final side bar needed to complete it. At the left-hand side of this machine there will be seen a U-wire feed mechanism *A*, similar to that used on the machine in the preceding illustration, and this arrangement is employed to feed down to the dial on the machine the remaining side bars that are required to complete the chain assembly. In the present instance, the feed mechanism for carrying the work under the plunger of the press is rather different from that on the preceding machine, as it consists of a sprocket over which the partially assembled chain runs. The means provided for pushing the side bars from the ends of the U-wire into the pockets on the under side of the feed dial, are also somewhat different. In this case it will be seen that the left-hand end of the crankshaft on the press has been continued outward to provide for mounting a disk *B*, which has an annular slot running around its periphery to provide for carrying a ring *C* to which yoke *D* is secured at either side. It will be apparent that disk *B* is mounted on this shaft in an angular position so that as the disk rotates, ring *C* which slides in the groove in this disk, will have an oscillating movement imparted to it. This oscillating movement is transmitted through the vertical shaft and lever *E* to a slide which provides for pushing the side bars through into the pockets beneath the feed dial. As the dial moves around, the ram of the press pushes the rivets down into the holes in the side bars carried at the under side of the dial, thus completing the work of assembling the chain.

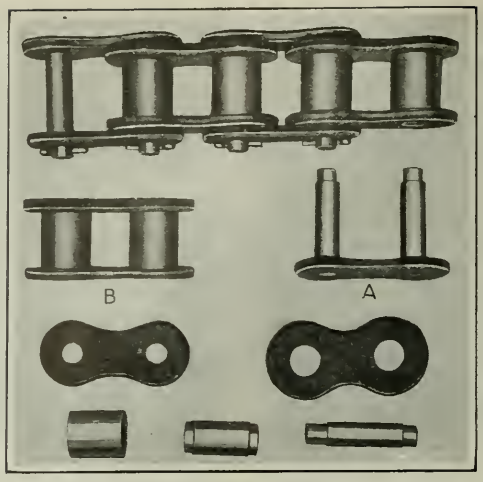


Fig. 14. Parts of the No. 8 "Manufacturers' Standard" Sprocket Chain used on Motor Truck Drives

Spinning Over the Ends of the Rivets

The sprocket chain is now practically completed with the exception of spinning over the ends of the rivets to avoid danger of their pulling out and to give the chain a good finished appearance. This operation is performed on a special two-spindle rivet-spinning machine of the form shown in Fig. 12, which has opposed horizontal spindles to provide for simultaneously spinning opposite ends of the same rivet. There is a sprocket wheel over which the chain runs in being fed to this machine, and it is obviously important to accurately index the work to bring the ends of the rivets exactly opposite the spinning tools. This would ordinarily be a very simple problem, but in the case of sprocket chains there is a slight difference in the spacing of the rivets. On the No. 9 bicycle chain, one pair of rivets is located at a distance of approximately 19/32 inch between centers, and the next pair is located at a distance of approximately 13/32 inch between centers, this spacing being uniform but changing with each alternate pair of rivets. In designing an index mechanism for locating the work in the desired positions for the performance of successive spinning operations, the expedient was adopted of using a ratchet and pawl mechanism, with alternate long and short ratchet teeth which provide for locating rivets which are alternately spaced 19/32 and 13/32 inch between centers in the required positions for spinning.

Testing Strength of Finished Chain

After the chain has been assembled, it is necessary to test each piece for strength, and this is done with the apparatus shown in Fig. 13. The table on which these tests are con-



Fig. 15. Five-spindle Semi-automatic Drilling Machine used for drilling Cotter-pin Holes in Rivets

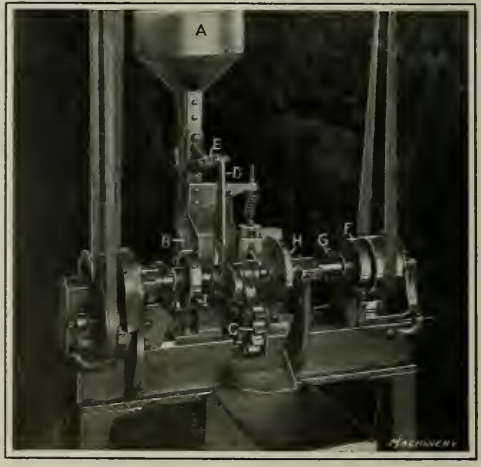


Fig. 16. Special Machine used for countersinking Both Ends of the Hole in Bushings and Rollers

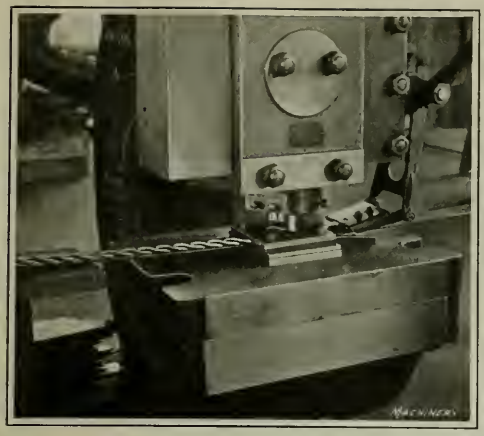


Fig. 17. Power Press equipped for blanking out the Inner and Outer Side Bars for "Manufacturers' Standard" No. 8 Sprocket Chain

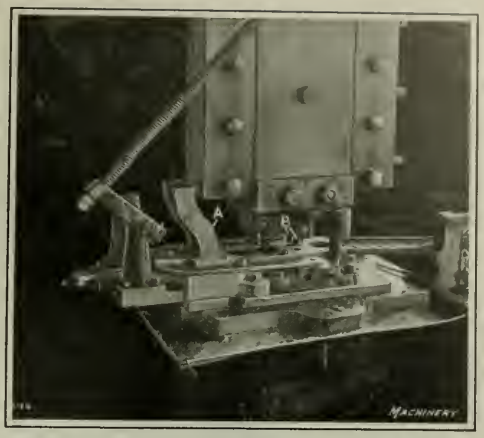


Fig. 18. Power Press equipped for piercing Holes in Opposite Ends of Side Bars produced on Machine equipped as shown in Fig. 17

ducted is covered with sheet metal to protect the surface from rapid wear, and at the right-hand end there will be seen a lever arrangement which has a clamp *A* on it in which one end of the chain is secured. At the left-hand end of the table there is a sprocket wheel over which runs a strand of chain *B*, which is connected to a weight *C* that normally rests on the floor. The end of the chain to be tested is placed over a smaller sprocket which will be seen at the front of the sprocket-carrying chain *B;* and the ratio of sizes of these two sprockets is such that this ratio multiplied by weight *C* gives an effective weight of 500 pounds which is applied to the chain to be tested when the lever is pulled over, causing the chain under test to lift weight *C* from the floor through its action in turning the sprocket wheels which carry the test chain and chain *B*, respectively. This load of 500 pounds is substantially more than a bicycle chain is ever likely to be called upon to carry in actual conditions of service, so that a liberal factor of safety is allowed on all chains which undergo this test successfully.

Making Motor Truck Chain

In starting to describe certain processes that are involved in the manufacture of the No. 8 "manufacturers' standard" sprocket chain, the reader's attention is first directed to Fig. 14 which shows a strand of this chain completely assembled, and also parts of the chain. From this illustration a comprehensive idea will be obtained of the construction of the chain and the nature of the parts which have to be manufactured. It will at once become apparent that this is a more complex form of chain than the No. 9 bicycle chain, in which there are only three different kinds of parts. It will be seen that the No. 8 chain consists of two different sizes of side bars, rivets for holding parts of the chain together, split pins placed through cross-holes in the ends of the rivets so that any portion of the chain may be disassembled at will, bushings which surround the rivets, and rollers which go over the bushings and come into engagement with the teeth on the sprocket wheels on which the chain runs. The following description concerns itself with a few of the more interesting methods and mechanisms which are employed in the manufacture of this size of chain.

Fig. 15 shows one of the five-spindle horizontal drilling machines, which is used for drilling the split pin-holes in the rivets, of which mention has already been made. It will be apparent from this illustration that the work *A* is held in a vertical position by means of suitable fixtures (two styles of work-holding fixtures are shown in place on this machine) which are designed in such a way that it is merely necessary to drop the work to be drilled into position between two V-blocks and then manipulate a hand-lever in order to tighten the clamp which is actuated by a suitable form of cam or eccentric. All of the five spindles on the machine rotate continuously and there is a horizontal camshaft which provides for feeding one spindle after another forward in sequence. Consequently, the operator goes from fixture to fixture on the machine, removing drilled pieces and substituting fresh blanks; and the feed is such that the operator can comfortably keep up with the rate at which holes are drilled in the work. The production is approximately 400 pins per hour on each machine.

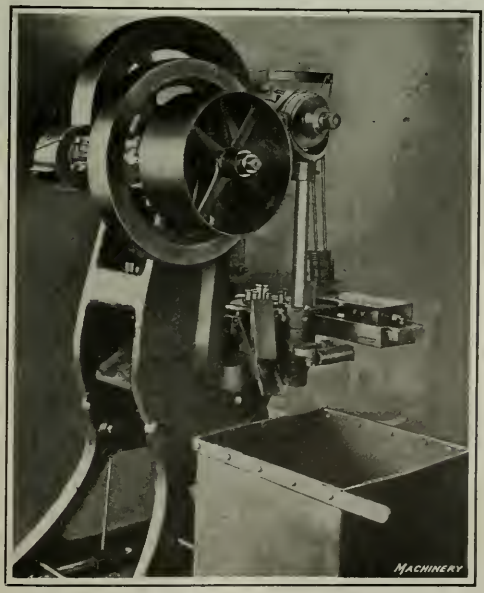


Fig. 19. Power Press equipped with Dial Feed and Magazine to provide for assembling together One Side Bar and Two Rivets

Countersinking Openings at Ends of Bushings

For performing the countersinking operation in the ends of the bushings, use is made of special machines of the type shown in Fig. 16, which are provided with a hopper *A* from which bushings are delivered through a curved feed-chute *B* that delivers the bushings into the notches of wheel *C* in which they are held while the operation is performed. As in the case of other machines of this type, an agitator is provided to facilitate the feeding of bushings from

hopper *A* into the feed-chute. This agitator is manipulated by means of a cam which imparts an oscillating movement to links *D* and *E*, thus causing the agitator to move up and down at the opening of the feed-chute and preventing the work from becoming jammed. The countersinking operation is performed by twist drills. The illustration does not show the machine as clearly as might be desired, but after reading the following description, its principle of operation will be readily understood. At opposite ends of the horizontal camshaft there are cams *F* which operate a link mechanism that can just be seen at *G* to provide for simultaneously feeding in the two opposed spindles which carry the drills toward or away from the work. Cam *H* tightens a binding jaw on the work to hold it ready for the countersinking operation, or releases the jaw after the work has been done. Cam *I* is provided for the purpose of actuating a ratchet and pawl mechanism for indexing notched wheel *C* around to bring successive pieces of work between the opposed spindles of the machine, so both ends are countersunk simultaneously.

Blanking out Side Bars Piercing Rivet Holes

Attention has already been directed to the fact that there are two sizes of side bars used in the No. 8 "manufacturers' standard" sprocket chain. While these bars are of somewhat different size, they are of essentially the same shape and form so that similar methods of manufacture can be employed in making both sizes. Referring to the illustration Fig. 17, it will be apparent that ribbon stock is used in making these bars under a power press. This illustration also very clearly shows the method of laying out the work in order to reduce to a minimum the amount of scrap which is produced, thus effecting a saving in the stock required.

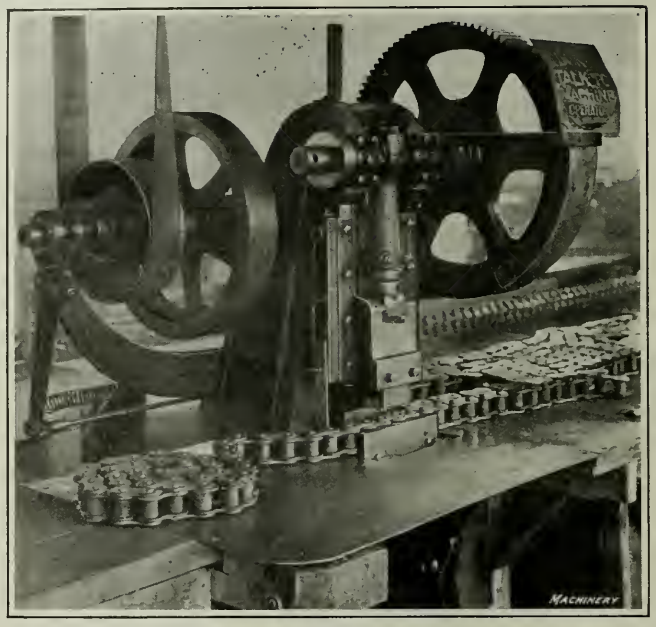


Fig. 20. Power Press on which the Riveting Operation is performed after the Final Work of assembling the Chain by Hand has been completed

After the side bars have been blanked out, the next step in the process of manufacture is to bevel the edges, and after this has been done the work is transferred to a power press which is equipped as shown in Fig. 18 to provide for piercing the rivet holes. This press is provided with a feed-chute *A* in which the blanks are placed ready to be fed into the die. Underneath this feed-chute there is a slide mechanism which takes the blanks as they descend from the chute and feeds them through the die so that piercing punches *B* may cut the desired holes. As the side bars pass under the piercing die, they are engaged by a V-block mechanism which grips each successive side bar at its opposite ends to provide for accurately locating it ready for the performance of the piercing operation. After the piercing operation has been completed, the work is taken to a machine equipped in the same way as the one shown in Fig. 18, but provided with shaving punches which are larger than those provided to pierce the holes. The object of this second operation is to shave the holes in order to remove the burrs which were left on the metal at the points where the holes were pierced, and produce a better finish around the holes.

Assembling Operations

In starting to assemble No. 8 "manufacturers' standard" sprocket chain, the method of procedure is quite similar to that described for the bicycle chain. The machine used for this purpose is shown in Fig. 19, and its equipment represents a combination of the mechanisms provided on the machines shown in Figs. 10 and 11, which were described in connection with the explanation of methods used in assembling bicycle chain. The purpose of this operation is to assemble together one outer side bar and two rivets, making partial assemblies of the form shown at *A* in Fig. 14. The next step is to make a partial assembly of two bushings, two rollers over the bushings, and two inner side bars, as shown at *B*. Having proceeded to this point, we now have virtually the same situation as that which existed in the case of the bicycle chains where a side bar and two rivets had been assembled together, after which it will be recalled that center blocks were assembled over the rivets by hand and then the remaining side bar was pressed into place. In the case of the No. 8 "manufacturers' standard" chain, however, the method of procedure in assembling is slightly different, the machine used for this purpose being shown in Fig. 20. The partial assembly *B*. Fig. 14, consisting of two bushings, two rollers, and two inner side bars, is slipped over the corresponding partial assembly *A* consisting of two rivets and an outer side bar after which the remaining outer side bar is placed in position on top of the rivets and struck a sharp blow with a lead hammer. The chain is assembled together in this way by a helper, after which it is passed to the power press operator who runs the chain under the press to provide for pushing down successive side bars and setting the heads of the rivets. The chain then goes to a spinning machine to have the heads of the rivets spun down, which completes the assembling operation.

* * *

CONTROLLING THE COOLING OF CASTINGS

A method of cooling castings which eliminates the difficulties and defects that arise from the uneven contraction of irregular masses of the metal after casting, has recently been patented. The method involves the application of electrical heat to the thinner and less dense parts of the castings, with the object of keeping the temperatures of these parts the same as those of the thicker and denser parts. This is accomplished by casting runners or ribs on the thinnest sections, and applying heat electrically by dropping electrodes into the molten metal.

MANUFACTURER'S LIABILITY FOR DEFECTIVE PRODUCTS

By CHESLA C. SHERLOCK

Liability of a manufacturer for defects in his product, whether it be machinery, appliances or other material, is an important question in the industrial world. When a manufacturer sells his product to a jobber or dealer, the relation between the two concerning the manufactured product is said to be contractual; that is, the contract of sale expresses the whole agreement between them and outlines the basis of liability of the manufacturer. It is worth while to note that the liability of a manufacturer for his product as to quality and durability is founded on the old common law and not upon statute law, as a general rule.

Under the common law it is a recognized principle that a person cannot be liable to third parties for defects in his manufactured products unless such a liability rests in a contractual relation. If a man made a defective product and some one with whom he had no contractual relations was injured, the law says that the manufacturer could not be held for such injury. While this is the general rule of the law, it is subject to certain exceptions and restrictions which do not often operate to protect the manufacturer.

How Courts have Construed the Law

A consideration of a few of the cases upon the subject will serve to illustrate the general rule and the exceptions as applied to specific cases by the courts. In an Indiana case, it was held that the manufacturer of an engine was not liable for injuries to the employe of the second-hand buyer (which injuries were caused by an explosion of the boiler due to rusted seams) in the absence of knowledge of the fact or of fraud in selling it. This decision was based upon the ground that an engine is not imminently dangerous, and therefore it should not be the duty of a manufacturer to protect all who might come in contact with it.

In a Kentucky case, it was held that a wholesale dealer who buys a standard paint dryer in open market and without knowledge that it is inflammable or explosive when used with ordinary care, is not bound to ascertain its qualities or warn customers of possible danger arising from its use; neither is he liable to an employe of another dealer for an injury caused by an explosion when the employe attempts to transfer the dryer from one receptacle to another, using a candle for illumination.

In another case, the facts involved a stitching machine which the manufacturer had agreed to keep in a state of repair. The employe of the purchaser was injured because the machine was not in good repair, and the employe sought to recover damages from the manufacturer. The court held that the manufacturer owes no duty to the employe of a licensee of a machine to keep it in repair. In the same case, even though the manufacturer had repeated to the employe his promise to keep the machine in repair and had represented that such repairs had been made, the manufacturer was not held liable, because the promise was wholly without consideration and not enforceable by law.

In a Michigan case it was pointed out that when a manufacturer is in possession of and is testing his own machinery, he owes everyone who may be in danger from it, the duty of proper care; and if he exposes anyone to danger arising from his carelessness, whether it be in the handling or in the construction of the machine, he is responsible for the consequences. It was also held that the duty of care under such circumstances is not a contract duty, but a common law duty; also that the contract is important only as it evidences the degree of care which the defendant is bound to observe.

Liability to Third Party

The most important exception to the general rule that a manufacturer owes no duty as to care in the manufactured product, unless it arise from a contractual relation, is where the manufactured product is of itself inherently dangerous to the public. In cases of inherently dangerous products, the manufacturer may become liable to persons having no contractual relations with him, for negligent construction thereof, which when added to the inherent character of the appliance, makes it imminently dangerous and causes, or contributes to, a resulting injury not necessarily incident to the use of such an article if properly constructed, but resulting from a defective construction. In a New York case, it was held that the manufacturer of a boiler which contained steam pipes, knowing the purpose for which it was to be used when he put it upon the market, was chargeable with knowledge of defective and unsafe construction, and therefore was liable to one with whom he had no contractual relations, for injuries sustained by the explosion of the boiler.

It has been specifically held that an automobile is an inherently dangerous machine, and in New York, Kentucky and federal cases, it was held that the manufacturer of automobiles, or parts going into them, was liable to third parties for the defective construction thereof, even when no contractual relations existed. In Kentucky, a manufacturer sold a hand-car of defective construction, the imperfection in which he covered up with paint. The court held that the manufacturer was liable for injuries caused by this defective article. This exception to the general rule deals with a very common situation. If a manufacturer knows that his product is defective but takes steps to conceal it, there is nothing that can be said in justification of his act. He has attempted fraud and in case of injury to the user of the machine, whether under contractual relation or not, he must stand liable.

Representing the Article to be Free from Defects

The second exception to the general rule has to do with instances where the manufacturer makes an express representation that the manufactured article is sound, thereby directly inviting or inducing the party to use it, with the result that the injury arises. It is not actually necessary that the manufacturer personally make such representation or issue such invitation. It may be done by his salesmen or agents or other accredited representatives. The effect, of course, of this situation is that since a direct representation as to quality has been made, such representation amounts to nothing less than a warranty between the parties, and since such representation was a material factor in inducing the injured party to use the defective product, then the manufacturer must stand responsible for such injury as his representation has caused.

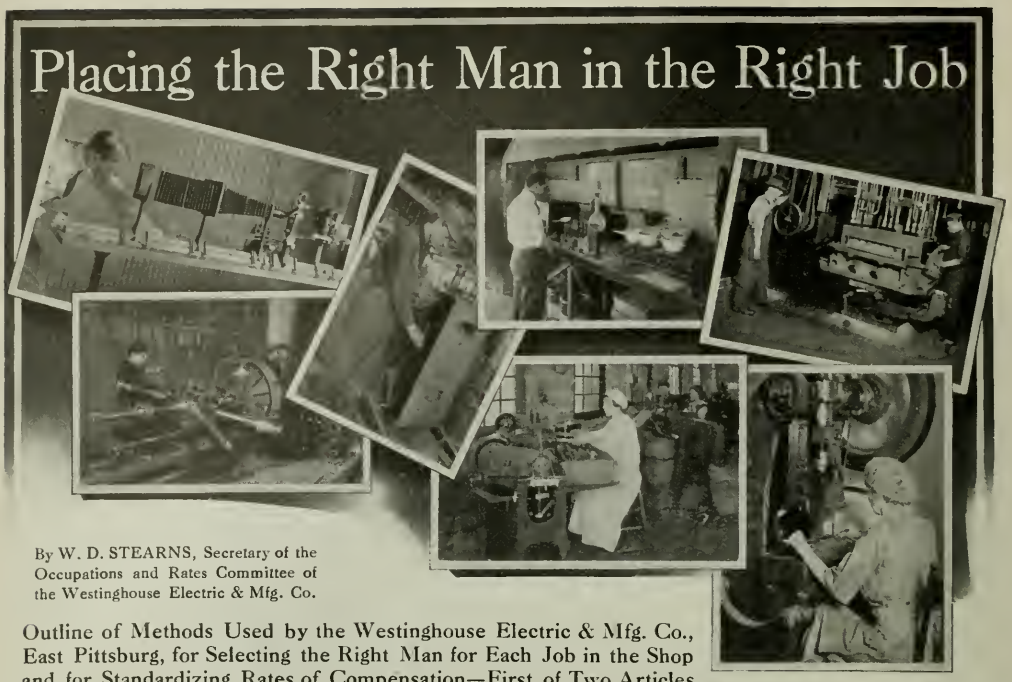
A manufacturer has a legal right to sell a defective machine. That principle is well recognized, but he must not sell it as a good machine, or take steps to conceal its true condition. If the machine has two defects and the manufacturer mentions only one of them, he has not absolved himself from blame if an injury arises. If a machine is not inherently dangerous, the manufacturer will not be liable to third parties for injuries caused, in the absence of knowledge of defects in it. The law is such that a manufacturer can protect his own interests only by the exercise of the utmost care in the inspection of every machine placed upon the market.

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MINNESOTA MINIMUM WAGE FOR WOMEN

The Minnesota Wage Commission has issued an order that beginning August 4 the minimum wage for women employed in the industries in Minnesota shall be $11 per week for a 48-hour week. It is further stipulated that women apprentices under eighteen years of age, in cities with over five thousand population, shall receive $8.65 as a beginner's wage and after three months, $10 per week; in cities under five thousand population, women apprentices under eighteen shall receive a minimum of $6.50 per week, and those over the age of eighteen, a minimum of $7.75 per week.

Placing the Right Man in the Right Job



By W. D. STEARNS, Secretary of the Occupations and Rates Committee of the Westinghouse Electric & Mfg. Co.

Outline of Methods Used by the Westinghouse Electric & Mfg. Co., East Pittsburg, for Selecting the Right Man for Each Job in the Shop and for Standardizing Rates of Compensation—First of Two Articles

THE work connected with the hiring of the right man for each job in the plant and of determining the proper rate of pay for each job includes "job analysis," the standardization of occupations, and the classification of jobs and rates of pay. Briefly, the object of the whole system is to make sure that the employment manager may select the job for which an applicant is best fitted, and at the same time promise the man a compensation that will be just, and that will be in proportion to the pay of other men working in the plant. To accomplish this result, there are five specific steps necessary in organizing the system.

1. The determining of standard occupations in the plant, and the choice of proper names and descriptions for these occupations. An "occupation," as used in this sense, differs from an "operation" and a "job." "Occupation" is used in the broad sense of the word, and designates the general nature of the work to be done; "operation" is used to indicate the specific process to be performed; and "job" is the specific process applied to certain parts in a given department. As an example, the occupation might be termed "milling machine," while the operation would be "gear cutting," and the job would be "cutting small bevel gears." The object of determining standard occupations is to make it possible to establish a norm, or standard, for the hiring of all the labor that is required in the plant.

2. The making of a complete job analysis of all the jobs in each occupation. This analysis includes a statement of physical and mental requirements for each job, the education and experience necessary, and a description of the nature of the work. The job analysis makes it possible to select the right kind of work for an applicant, or the right applicant for certain work.

Haphazard methods in hiring men and in determining their compensation have probably led to more dissatisfaction on the part of labor and greater losses of production to manufacturers than any other one cause. Recently some manufacturers have taken steps to establish systematic means whereby men may be hired for the work for which they are especially fitted, their compensation being determined in an equitable manner, with regard to the skill and qualifications required for the work. This plan has been worked out in an unusually complete and satisfactory manner at the Westinghouse Electric & Mfg. Co.'s plant in East Pittsburg, Pa., and the methods used there should prove helpful to other manufacturers who are planning to follow a similar procedure.

3. The classification of jobs in accordance with their relative value to the industry. In order to determine a just and equitable wage scale, it is necessary to have each job properly graded as to its value, so that it may be possible to give uniform pay for uniform service. Such a classification also provides a chance for rational methods of promotion. The basis for the classification should be the relative value of the job to the industry, and should have no connection with any specific hourly rate. In other words, when classifying the jobs with a view to uniformity of compensation, and dividing the jobs into various groups, the rates paid per hour should not be considered.

4. The establishing of a wage rate. After the jobs in the plant have been properly divided into broad classes according to their relative value to the industry, a wage rate is assigned to each of these classes, and this wage rate should be adhered to without deviation.

5. The establishing of satisfactory methods of compensation. Having established a wage rate, the next step is to determine satisfactory methods of paying for the work performed, and of creating, by means of bonus or premium rates, an additional incentive for extra effort.

When a system such as this has been adopted, much has been done to obtain, throughout the plant, uniform compensation for uniform service. This prevents the discontent that arises from jealousy due to lack of uniformity in wages. Furthermore, wages may be maintained at a predetermined rate, having a given range for each job. When an employe reaches the limit of that range of pay, he should be promoted to an occupation that has a higher rating, if his ability and qualifications make such promotion advisable.

Reasons which Led to the Adoption of Plan Described

The Westinghouse company recognized that the men making up the organization were as important to its success as the buildings, machinery, and equipment. It was also recognized that the necessary skill and training required for performing work well and efficiently was not enough, but that the right attitude on the part of the men toward their work and toward their fellow-workers was of equal importance. The right mental attitude is more important in making efficient workers than shop rules, penalties, or premiums; hence, to create the proper mental attitude was one of the objects of this plan.

Another object was to reduce the labor turnover because of the great financial loss caused by frequent changes in personnel. It has been estimated that it costs from $8 to $25 to train an unskilled workman for a new job; from $35 to $70 to train a semi-skilled workman; from $100 to $200 to train a skilled workman; and from $500 to $1000 to make a change in foremen. Hence, it is equally as important to hold a man after he has been hired as it is to hire the right man in the first place. To do this effectively, the man must be given work that is congenial, and must be paid a wage that is fair. A thorough study of the occupations in the shop and an analysis of the requirements for each job are the only means toward obtaining this result. Furthermore, an increase in pay when brought about by giving the man a better job, for which he has proved his fitness, is less likely to cause dissatisfaction among the other workers than when an increase is given without apparent reason.

Need for Standardization of Occupations

In a former article in MACHINERY, on the duties of the employment manager, it was pointed out that the man who hires labor may be likened to a purchasing agent. A purchasing agent buys materials, while an employment manager buys labor. To facilitate his work, the purchasing agent has standardized the requirements for the materials necessary in production. The employment manager may also standardize the requirements for the help he has to hire and thereby make certain that he will obtain what he needs. The first step toward getting the right man for the right job, therefore, is a standardization of the occupations within the plant.

How Occupations are Standardized

In preparing a list of standard occupations, care should be taken to include every occupation in the plant. At the same time, the occupations listed should be kept to a minimum by grouping together as many processes and jobs as can properly be included under one heading. The method by which such a list was obtained at the Westinghouse plant was as follows: The names of occupations such as he thought necessary was obtained from the foreman of each department. After all these data had been collected, the foremen were again consulted for further information and explanations. When all the occupations in each department were listed, it became evident that there were many duplications, and, in some instances, occupations that were practically the same had been given different names. In many cases, also, occupations were found to be so nearly alike that they could be combined under one name.

Names for Standardized Occupations

It is very important that standard names should be used for the occupations, and that these names, when once chosen, should not be changed. If the same name is used through-

TABLE 1. CLASSIFICATION OF OCCUPATIONS IN USE AT THE PLANT OF THE WESTINGHOUSE ELECTRIC & MFG. CO.

No.	Occupation	Class
16	Assembler	D
3	Babbitter	C, E
4	Balancer, Running	B
5	Balancer, Static	A, B, C
7	Bander, Rotor	B, C
84	Battery repairman	B
8	Beltman	C
9	Blacksmith, General	A, B, C
10	Blacksmith, Helper	D
182	Blacksmiths, Machine; Tool-dresser	A
12	Boiler cleaner	C
15	Bolt threader	C, D, E
13	Boring mill, Horizontal	A, B, C
14	Boring mill, Vertical	A, B, C, D
20	Box-maker	D
21	Box-marker	C
26	Brazier	C
22	Bricklayer	A
165	Bull-block man	D
27	Cabinet-maker	B
28	Carpenter	A, B, C
30	Centering machine	D
32	Chauffeur	C
29	Checker, Car	D
31	Checker, Materials	C, D, E
23	Chipper	D, E
33	Coil assembler	C, D
41	Coil presser	C, D
40	Coiling and bending	C
35	Coils, Form and Pull	D
39	Coppersmith	B, C
36	Core-builder	B, C, D, E
37	Coremaker	B
42	Coslettizer	D
43	Craneman	C
44	Cutting-off machine	C, D, E
46	Die-casting maker	D
47	Diemaker	A
163	Draw-bench	D
49	Drilling machine	B, C, D, E
164	Edging machine	C
50	Electrode-maker	D
52	Elevator man	D, E
53	Emery-wheel dresser	D
55	Engineman, Stationary	B
59	File-cutter	B
60	File-sharpener	C
58	Filer	C, D
64	Fitter	A, B, C, D
71	Forger, Drop	A
72	Forger hammersmith	A
17	Forging machine	B
62	Formerman	C
63	Furnaceman	B, C, D
65	Galvanizer	C
66	Gear-cutter	C
67	Grinder	A, B, C, D
73	Hammer operator	D
68	Handyman	D, E
172	Heaterman	C, D, E
74	Helper, Machine	D, E
75	Holp rolling machine	B
57	Hostler locomotive	D
1	Industrial autotruck driver	D
82	Industrial locomotive	C, D
79	Inspector, Equipment	B, C, D
80	Inspector, Production	A, B
86	Instructor	B
81	Instrument-maker	A
61	Insulator	C, D
87	Lamp trimmer	D
88	Lathe, Engine	A, B, C, D
89	Lathe, Turret	A, B, C, D
90	Layer-out	A, B, C
94	Machine tool setter	A, B, C, D
174	Machinist, Journeyman	A, B
92	Marble driller	D
93	Marble enameler	D
91	Marble worker	C, D
95	Material cutter	C, D
97	Mica and composition worker	B, C, D
70	Mica builder machine	D
98	Micarta finisher	D
38	Micarta former	C
45	Micarta roller	C
96	Milling machine	A, B, C, D
99	Millwright	B, C
102	Motor tender	C, D
104	Molder, Bench	C
105	Molder, Floor	B
103	Molder, Machine	D
101	Moveman	C, D
107	Oiler	D, E
108	Packer	D
111	Painter	C, D, E
110	Patternmaker, Metal	A
109	Patternmaker, Wood	A
112	Pipe-fitter	B, C
113	Planer	A, B, C
114	Plater	D
115	Plumber	B
116	Pollsher	C, D
77	Press, Hydraulic or Pneumatic	B, C, D
78	Pumpman	B, C
118	Punch press	C
161	Repairman	A, B, C
119	Rigger	C, D
120	Riveter	D
167	Roller, Cold	C
166	Roller, Hot	B
168	Rougher	B
6	Saw, Band or Circular	C, D, E
122	Saw filer, Machine	C
121	Saw filer, Hand	B
124	Screw machine, Automatic	C
123	Screw machine, Hand	C
125	Set-up for test	C
126	Shaper	B, C, D, E
127	Shearman	C, D
128	Sheet-metal worker	B
54	Sheet-steel painting machine	E
171	Shipper	C, D, E
129	Sign-writer	A, B, C, D
130	Slater	A
2	Sleeve machine	C, D
170	Slitting machine	C
131	Slotter	A, B, C, D, E
173	Solderer, Hand	D
132	Solderer, Pot	C
133	Spring-maker	A, C
135	Stockman	D
137	Stoker	C
136	Store-room attendant	E
169	Straightener	D
138	Structural iron worker	C
106	Switchboard mounter	D
139	Switchboard operator	B
83	Switchman, Industrial	D
175	Tester, Electrical	A, B
140	Tester, Mechanical	D
141	Tinner	D, E
142	Tinsmith	B, C
146	Tool-dresser, Wood	B, C
145	Toolmaker	A, B
144	Tool temperer and hardener	A, B
148	Trackman, Railroad	D
149	Transformer, Mounter	B, C
147	Treat, Dip and Insulate	C, D, E
150	Under-cut commutator	C, D, E
85	Unskilled workman	E
151	Water tender	C
155	Weigher	C, D
152	Welder, Arc	A, B, C
153	Welder, Spot or Butt	C, D
154	Welder, Oxy-acetylene	B
159	Winder, Coil, Field, and Transformer	D, E
117	Winder, Coil, Rotor, and Stator	D, E
162	Winder, Rotor	A, B, C
176	Winder, Stator	A, B, C
100	Winding mold setter	E
158	Wireman apparatus	B, C, D
157	Wireman, Shop	A, B
156	Woodworking machine	B, C

Machinery

out the organization, the office, the foremen, and the men in the shop will all speak a "common language" when they refer to the work in the shop, and frequent misunderstandings will thereby be avoided. In a large plant, a great many records are necessary. By having standard names for every occupation, these records can be so filed and arranged as to be of real value.

Whenever possible, words were chosen that described the occupation, but, at the same time, care was taken to make the name as brief as possible. When the occupation was generally known to the trade by a certain name, this name was adopted. If there was more than one word in the name, the principal word was used first; for example, "grinding machine, universal," not "universal grinding machine," and

TABLE 2. A SUGGESTED LIST OF STANDARD OCCUPATIONS FOR A SMALL METAL-TRADE INDUSTRY

1. Blacksmith	22. Helper, Machine	42. Production clerk
2. Boiler cleaner	23. Industrial auto truck	43. Repairman
3. Boring mill, Horizontal	24. Inspector, Equipment	44. Riveter
4. Boring mill, Vertical	25. Inspector, Production	45. Saw
5. Carpenter	26. Lathe, Engine	46. Screw machine
6. Chauffeur	27. Lathe, Turret	47. Shaper
7. Checker	28. Ledgerman	48. Shear
8. Clerk, General	29. Machinist, Journeyman	49. Sheet-metal worker
9. Chipper	30. Milling Machine	50. Slotter
10. Coremaker	31. Millwright	51. Stenographer
11. Correspondent	32. Molder	52. Stockman
12. Cost clerk	33. Moveman	53. Structural iron worker
13. Craneman	34. Office boy or girl	54. Time clerk
14. Drilling machine	35. Oiler	55. Tinsmith
15. Elevator man	36. Packer	56. Toolmaker
16. Engineman, Stationary	37. Painter	57. Typist
17. Filer	38. Pipe-fitter	58. Unskilled workman
18. Fitter	39. Planer	59. Weigher
19. Furnaceman	40. Polisher	60. Welder
20. Grinder	41. Press	61. Woodworking machine
21. Handyman		

Machinery

"boring mill, vertical," not "vertical boring mill." This aids in finding the occupation in alphabetically arranged lists. No hard-and-fast rule was made. When an occupation consisted of running a machine, the name of the machine was generally used alone; otherwise, the general name for the man performing the work was employed. For example: Lathe, engine; milling machine; screw machine; inspector; babbitter; filer; craneman.

Standard Occupations Adopted by the Westinghouse Electric & Mfg. Co.

After the standard names had been determined, they were arranged in alphabetical order and numbers were assigned to each. Numbers were used to provide a convenient means for identification and reference, so that, in cases where it was more convenient numbers could be used instead of having to write out the whole name of the occupation.

Table 1 gives the standard occupations as adopted by the Westinghouse Electric & Mfg. Co., together with their classification, which will be described later. It will be seen that the numbers of the occupations do not follow consecutively. This is partly due to changes in manufacturing conditions, and partly to defects that became evident as more experience was obtained in standardizing occupations, so that later, when the occupations were arranged in alphabetical order, they no longer appeared in numerical order. Some occupations have been cancelled, some have been added, and the names of some have been changed to meet new requirements. All of this indicates how important it is to choose the right names at first. The list adopted by the Westinghouse company includes practically all the occupations found in the metal trades and a large number found only in the electrical industry. Office and clerical occupations are also included. In a small metal-working industry, probably not much more than sixty occupations would be required. Table 2 gives suggestions for a list for such a factory.

Description of Occupations

When the standard occupations have been determined and names given to them, the next step is to make a brief description of each. This is necessary in order that there may be a proper understanding of the requirements of each occupation, so that anyone may determine immediately what the qualifications are for a man fitted for that particular work. In preparing these descriptions, or the "occupational dictionary," the Westinghouse company aimed at concise descriptions stated in universally used terms. The description of each occupation includes the duties and the qualifications necessary. It should be understood that the description must be broad enough to cover the occupation in every department in the plant. The job analysis, which will be described later, defines the work as applied to specific jobs, is more detailed, and applies to a single department or a single job in one department only.

Method of Preparing Standard Descriptions of Occupations

In preparing the standard descriptions of occupations, a list was first made of all the departments in which the occupation was used. The foremen of these departments were then required to give their ideas as to the qualifications of a man suitable for that work, and the duties he would have to perform. Generally, this information was obtained by personally interviewing the foremen. The individual descriptions as obtained from the various foremen were then merged together into a general description, sufficiently broad to cover that occupation throughout the plant.

Examples of Standard Descriptions of Occupations

A few examples are given of the descriptions of occupations as adopted by the Westinghouse company. In many cases it was found that the "Trade Specifications" as adopted by the United States Army, could not be improved upon. In such instances these were used. The examples are selected with a view to being of direct interest in the machine-building trades.

Boring Mill, Horizontal—Duties—Operation of universal precision types of horizontal boring mills on any class of work. *Qualifications*—Must be thoroughly skilled and able to work to drawings, making calculations necessary to lay out any kind of boring mill product. Must be competent to set up, bolt, and clamp all kinds of work—heavy, light, and springy parts—and perform intricate boring operations, such as surfacing, under-cutting, threading, turning taper fits, and working to close center measurements. Must be capable of very accurate machining on all kinds of work, and must be skilled in use of large calipers, micrometers, surface plate, scribers, snap, plug, and limit gages. Should have had thorough practical experience in ship, railway, or machine shop, or machine tool plant.

Diemaker—Duties—Making or sinking any kind of forging or press die for any purpose. *Qualifications*—Must be experienced and thoroughly expert in the making or sinking of all kinds of drop-forge, swaging, and forming dies. Must be able to read drawings and sketches, figure dimensions, reproduce samples, or lay out from general instructions, and make complete trimming and shearing dies of all sorts of die steel or cast iron, and must be acquainted with the best drop-forge die practice. Should be able to set dies for testing. Should have a thorough knowledge of shrinkages and allowances, of all grades of die steels, methods of annealing and hardening, and the materials from which forgings are made. Must be expert in the operation of profilers, milling machines, grinders, and die-sinking and engraving machines, skilled in the use of chipping and engraving tools, and be able to use the necessary measuring instruments for accurate work. *Similar Occupations*: Die-sinker for drop-forge plant, toolmaker, expert machinist, engraver.

Draftsman, Mechanical—Duties—General mechanical designing and mechanical engineering drafting. *Qualifications*—Must be a technical engineer and a thorough general mechanical draftsman, experienced in lay-out of power plants, factories, buildings and machinery, and capable of making all kinds of detailed or assembly drawings from sketches. Should have a knowledge of construction materials, machinery, mechanical apparatus, and manufacturing methods.

Gear-cutter—Duties—Operation of gear shapers or gear milling machines of standard types of all kinds of gears. *Qualifications*—Must be able to work to drawings and make calculations for the lay-out of blanks and the correct shaping and milling of teeth. Must thoroughly understand the making of all kinds of spur, bevel, helical or spiral, and eccentric gears of any material. Should be skilled in the use of calipers, micrometers, tooth and other gages, and be able to work to very close dimensions on all classes of work. Must be experienced in the setting, adjustment, and operation of Gould & Eberhardt type of gear-cutters, and Gleason single- and double-tool type of gear shapers.

Grinder—Duties—Operation of various standard types of precision grinding machines, such as surface, plain, cylindrical, and universal, on general work. *Qualifications*—Must understand drawings and be able to select proper wheels for different classes of work and materials. Must understand the operation of the principal types of grinders, be able to set up work and make operating adjustments for cylindrical, spherical, and taper or internal and external work, and be able to grind eccentric pieces. Should be familiar with cutter, tap, and reamer sharpening, skilled in the use of micrometers, and plug, snap, and limit gages, and capable of doing accurate work. *Similar Occupations*—Toolmaker, tool-room machinist, machinist, or operator on any type of precision grinder.

Milling Machine—Duties—Operation of milling and profiling machines of various kinds and sizes on general work. *Qualifications*—Must be able to work to drawings and sketches, figure dimensions, and make simple calculations for laying out milling or profiling work. Must understand setting up and clamping single or gang work, fairly heavy or light springy pieces. Should be able to cut racks and use index head for spur gears and angle work. Must understand the use of calipers, micrometers, and gages, and be able to produce accurate work. For profiling, should thoroughly understand setting forms and patterns, setting cutters, and be able to perform any kind of profiling for machining of parts to close limits. *Similar Occupations*—Tool-room machinist, general machinist, or plain miller operator.

Planer—Duties—Operation of planers and planing machines of all kinds or sizes on any class of work. *Qualifications*—Must be able to work to drawings and sketches, figure necessary dimensions, and lay out work. Must be familiar with placing, blocking, bolting, setting, and clamping large or small, heavy or light, springy parts, on single or gang work. Must be experienced in setting tools and skilled in planing methods, such as squaring, under-cutting, facing, and fitting, and in the use of calipers, micrometers, and snap or limit gages, and on general roughing or accurate work. Should have had thorough practical experience as planer hand in large general ship, railway, or manufacturing machine shop, or machine tool plant. *Similar Occupations*—Shaper operator, slotting machine operator, general machinist.

Time-study Engineer—Duties—Making thorough analytical time studies of operations of any kind with the object of standardizing all methods of operation and determining and selecting the proper time required for various operations. *Qualifications*—Must be a thoroughly experienced, educated, and practical technical engineer, with a broad knowledge of manufacturing details in any industrial line. Must have a thorough knowledge of wage systems. Capable of making an analysis and time study of every detail of an operation with a view to eliminating any lost motion, and setting a standard time. Must be a mathematician capable of preparing graphical curves and charts, and determining formulas and laws governing any class of operations. Must be tactful and capable of handling men and dealing with labor problems without causing antagonism.

Toolmaker—Duties—Construction and upkeep of all kinds of special tools, gages, and manufacturing fixtures for any class of work where closest accuracy is necessary. *Qualifications*—Must be thoroughly experienced in making tools, gages, and fixtures of all kinds. Must be familiar with interpreting intricate drawings and sketches, able to figure dimensions, and work from samples or general instructions in laying out and making completely intricate and difficult matter, or making jigs, templets, fixtures, sizing taps, dies, and reamers for interchangeable work. Must possess a thorough knowledge of clearances, tolerances, and temperature allowances, and be able to work to the highest degree of accuracy, using micrometers, and vernier surface plug, thread, slip ring, and limit gages of all sorts. Must be skilled in the use of Johansson gage-blocks, screw gages, surface and test plates, and all the apparatus involved in the making of the finest classes of testing tool work, and able to test or check any class of work. Must be familiar with materials, the annealing, machining, and hardening of tool and die steel, and casehardening of machine steels. Must be thoroughly skilled operator of tool-room lathe, milling machine, profiler, shaper, drill press and planer, surface and universal grinders, and must be expert on filing, scraping, and general bench and hand work, including the use of gravers. Must have had extensive experience as expert tool-room machinist in tool-room of thoroughly modern shop or machine manufacturing plant.

The examples given are intended to suggest to others, who may want to install a similar system, how this work was carried out by the Westinghouse company. The next installment of this article will deal with the actual job analysis, and will show in detail how this work is carried through.

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A PREDICTION OF PRICES

The chart shown in the accompanying illustration was originated by the Laclede-Christy Clay Products Co., St. Louis, Mo. It shows graphically the increases in prices that took place during the war period, and predicts the price conditions for the next five years. It will be seen that present prices are not going to decrease for some time, and when the decrease comes, it will be so gradual that it is likely that business conditions will be stimulated rather than depressed by the process. It will be interesting to note

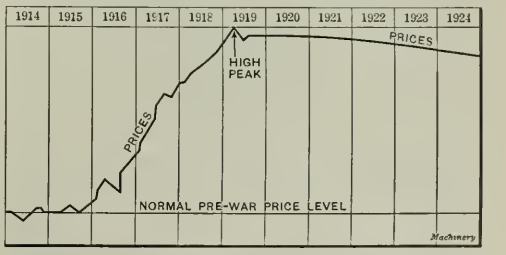


Chart showing Increase in Prices during War and indicating Price Conditions for the Next Five Years

five years hence to what extent this prediction will agree with the actual facts, but present indications point to the accuracy of the prediction, and most of the authorities on prices and industrial economics are agreed that the general principle indicated by the chart is correct. When prices begin to decline it is difficult to say just how far they will drop, but the originators of the chart shown state that in their belief prices will finally stop at a permanent level somewhere between the present level and the low level before the war. They will, however, come down so gradually, it is believed, that even if wages decline with them there will be no decline in purchasing power.

* * *

According to the *Evening Post*, New York, forty of the large employers of Chicago have cooperated in the formation of a commission for the purpose of promoting more cordial feeling between workers and employers. The plans include organizations which will engage in activities designed to promote a spirit of cooperation between employes.

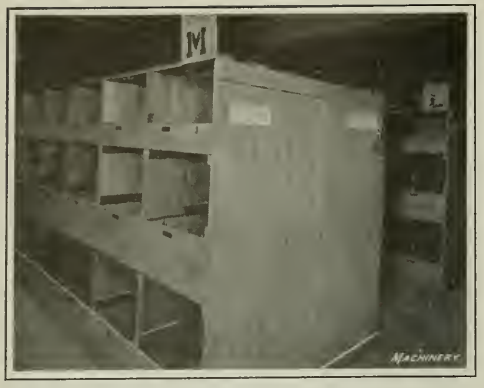


Fig. 1. Bank of Sections of Stock Bins showing Standard Type of Cleated Division Boards and Index Letters placed at the Ends of the Aisles



Fig. 2. Drawers that are used for the Storage of Small Parts. These Drawers fit into the Standard Sized Units into which the Bins are subdivided

Sectional Stock-room Bins

EVERY progressive business man is familiar with the advantageous features of sectional furniture for use in offices. Not only do filing cabinets, bookcases, and similar pieces of furniture that are constructed on the sectional principle enable the user to make an initial purchase of equipment which is adequate for his existing requirements, and then add to these facilities as occasion demands, but the flexibility of such systems also allows him to have sections containing letter files, card files, bookcases, etc., assembled together in units of standard width and height. These facts are matters of general knowledge, but they are mentioned in order to emphasize the possibility of securing similar advantages through the application of the sectional principle in constructing stock bins, storage shelves, etc., for use in industrial plants.

One such application of bins and shelving which are constructed on the sectional principle, has recently been made in the stock-room of S. F. Bowser & Co., Inc., Fort Wayne, Ind. This firm is engaged in the manufacturing of various types of automatic gasoline measuring pumps for garages, and a variety of different types of tanks and other apparatus for storing and handling lubricating oil. In the manufacture of a diversified product of this kind, it is necessary to keep large quantities of parts on hand, so that they are ready to be drawn out on requisitions issued by the assembling department. As this company's business grew, the need for additional storage space steadily increased, and to provide such facilities the stock-room was built on a piecemeal basis, which gave it a very haphazard arrangement.

Sherwood Hinds, factory engineer of S. F. Bowser & Co., undertook the work of correcting the unsatisfactory stock-room conditions and the inefficiency of this department of the plant in making deliveries of materials and parts for which requisitions were issued. It is not within the province of this short article to enter into a discussion of the system that is now used for recording the receipt of finished parts from manufacturing departments of the plant, and their subsequent delivery to the assembling department. We are at present chiefly concerned with the application of the sectional principle of constructing the stock-room equipment. In the study of conditions in the old stock-room, it was found that the shelves, bins, drawers, etc., which had been provided for the storage of parts, were of a great many different shapes and sizes, and that whenever it became necessary to change the arrangement of equipment in some part of the stock-room, an alteration of this kind could not be accomplished without causing a lot of trouble.

The stock-room is located in the basement of the factory, and the columns which support the first floor are uniformly spaced on centers of ten feet, both lengthwise and crosswise of the building. This spacing of the columns was made the basis of construction for the new sectional system of shelv-



Fig. 3. Type of Racks on which Bar Stock is stored. These Racks occupy the Same Amount of Space as a Bank of Standard Sized Bins

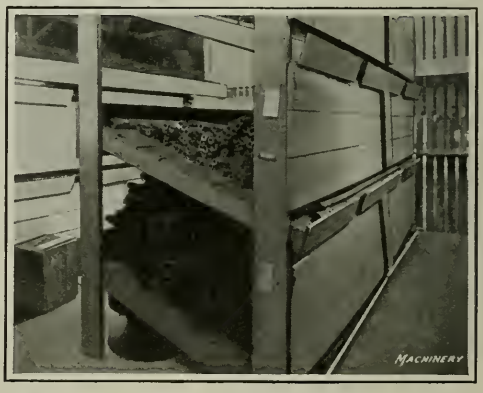


Fig. 4. Bins for the Storage of Rubber Hose, which assure using first the Hose which has been in Storage in the Bins the Longest Time

ing, bins, and drawers that was installed. There is a great variety of different parts to be handled in this stock-room, ranging in size from fairly large castings down to small screws and nuts. This diversity of the parts makes it necessary to provide equipment of various forms for holding these pieces of different sizes. Large bins must be furnished to hold the castings, while other parts will be most conveniently placed on shelves; and it is necessary to have close-fitting drawers to hold the screws and nuts to prevent them from getting lost.

It must be emphasized at this point, however, that the variety of facilities that are required for storing parts of the Bowser product did not make it necessary to depart in any way from a standard sectional system of constructing the stock-room equipment. Mention has just been made of the fact that the columns are spaced on 10-foot centers, and the scheme of construction finally adopted was to run banks of shelves, bins, or drawers, back to back along the center line of each row of columns. Standardization was carried a step further by making all banks of equipment of uniform size; namely, bins 33 inches in depth, with a 4-foot 6-inch aisle running between them.

In each bank of bins, division boards are placed on either 12-, 24-, 36- or 48-inch centers, making the bins virtually 1, 2, 3 or 4 feet in width. The number and spacing of the cleats on these division boards are the same for all the division boards in the stock-room, even though all the cleats are not used to support shelves, the width and height of any bin depending on the nature of material to be stored. This construction is a starting point from which the various forms of bins, drawers, and shelves are constructed. In designing the equipment, the fact has constantly been borne in mind that there is always likely to be a necessity for making changes, so that the division boards are not permanently nailed in place. Each of these division boards is made from 1- by 12-inch stock lumber, dressed and sized down to ¾ inch by 11 inches; and cleats are nailed onto these boards at specified intervals, in order to lay shelves or runways for drawers across the cleats. The shelf boards are also made from 1- by 12-inch lumber sized down to ¾ inch by 11 inches and cut into lengths for one of the four spacings for the division boards previously enumerated. With this arrangement, it is a very simple matter to make changes when the occasion for so doing arises, because the drawer runways or shelves may be lifted off the cleats, after which the division boards may be removed and replaced at proper intervals to provide for complete new units of a different size. It never becomes necessary to tear part of this equipment to pieces or to break up a lot of material in the process.

In addition to the provision that has been made for storing finished parts of the product, the stock-room must be provided with equipment for holding such raw materials as bar stock, rubber hose, etc. It was desired to adhere in all cases to the standard system of construction for the stock-room equipment; and with this idea in mind, racks were built for holding bar stock, as shown in Fig. 3, and bins for rubber tubing, as shown in Fig. 4. Each of the equipments of this type is placed in a space between two or more columns, with the racks placed back to back on the center line of a row of columns, in order that aisles of standard width may run between them. It will, of course, be apparent that in order to make provision for taking long pieces of bar stock around a corner into a given aisle, there must be a clearance space of sufficient size at the end of the aisle, so that the bars can be brought into an endwise position ready to be carried down the aisle. This makes it necessary to leave vacant spaces at the end of those aisles which are furnished with racks for carrying long bar stock, so that such stock may be swung around to enter the aisle.

So far as the stock-room system is concerned, it is not proposed to enter into a discussion of this subject, but merely to state that each aisle of the stock-room is designated by a letter, as indicated in Fig. 1, and that the bins, drawers, etc., in each aisle are designated by numbers. The stock-keeper maintains card files that afford a record of the bin in which each part of the product or each class of raw material is stored. Each bin is designated by a letter indicating the aisle in which it is located, followed by a number which marks the position of the bin in that aisle. E. K. H.

* * *

WEIGHT OF METAL REMOVED FROM MACHINE MEMBERS BY DRILLING

By WILLIAM THOMPSON

The illustration shows a chart that has been prepared for determining the weight of metal removed by drilling holes in a machine member in order to attain dynamic and static balance. By referring to the chart it is an easy matter to ascertain the approximate weight in ounces of metal

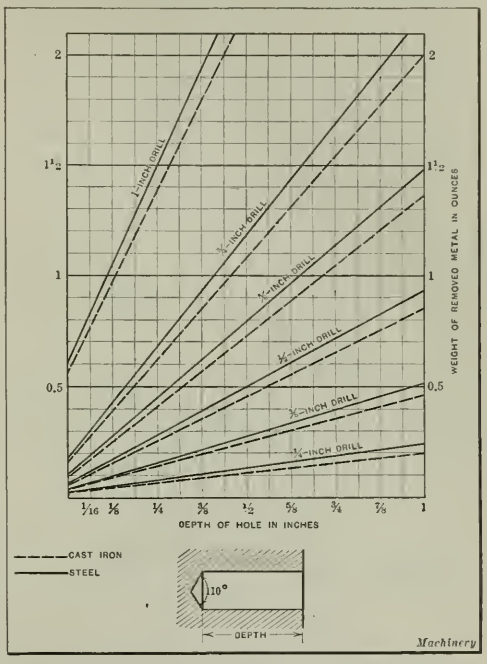


Chart showing Weight of Metal removed by drilling to obtain Static or Dynamic Balance

removed. The horizontal lines indicate the weight of the metal that is removed by the drill, the space between each successive line representing 0.10 ounce. The vertical lines indicate the depth in inches to which the hole is drilled, the space between the lines representing a depth of 1/16 inch; thus the second and third lines from the left-hand side represent 1/16 and 1/8 inch, respectively, and so on. The diagonal lines represent the diameter of the drill in inches. The solid diagonal lines are used when determining the weight of the removed metal if the part is made of steel, and the dotted lines are used if the part is made of cast iron. When this chart is used, the diagonal line corresponding to the diameter of the drill that is being employed is followed to the intersection with the horizontal line that represents the weight of the metal to be removed from the machine member, and by following that point downward to the bottom line of the chart the depth to which the hole should be drilled may readily be seen. The weight of the metal removed by the drill point is included in the values.

* * *

The public debt of the United States on May 31, 1919, was $25,921,151,270. The annual interest on this amount is greater than the total revenues received a few years ago.

Identification of Bar Steel

CONSIDERABLE attention has been given to the marking of bar steel for identification, by E. K. Morgan, general superintendent of the Rockford Drilling Machine Co., Rockford, Ill. In this plant the steel is marked, when it arrives from the steel mills, so that the grade of steel of any piece of a bar is readily identified. The correct method would be for the steel to be marked at the mills, because the customer usually has no means of identifying the different kinds of steel when he receives them. Distinct advantages would result if the mills could be prevailed upon to adopt some such system, so that the kind of steel could be readily identified. A standard method of marking should also be determined upon, so that no confusion would result, as would be the case if each of the mills had its own system.

The method employed by the Rockford Drilling Machine Co. is to paint streaks of different colors laterally and transversely on one side of the bars. The exact information giving the colors of paint that are used for the various kinds of steel is here presented in tabular form. In Table 1 the colors are given for marking carbon and high-speed tool steels, these steels being classified according to their trade names. In Table 2 open-hearth carbon and alloy steels are classified according to the specifications of the Society of Automotive Engineers. The markings and compositions of the kinds and grades of steel are given, together with the names of the different classes and the symbols of the heat-treatments used for each class.

The heat-treatments, the symbols of which have been given in the table, resemble very closely the heat-treatments that are specified for various kinds of steel by the Society of Automotive Engineers. The treatments correspond with the treatments of this society having the same symbols, and some are entirely the same. They are as follows:

HEAT-TREATMENT A

After Forging or Machining

1. Carburize at a temperature between 1600 and 1750 degrees F. (1650 to 1750 degrees F. desired).
2. Cool slowly or quench.
3. Reheat to 1450 to 1500 degrees F. and quench.

HEAT-TREATMENT B

After Forging or Machining

1. Carburize at a temperature between 1600 and 1750 degrees F. (1650 to 1700 degrees F. desired).
2. Cool slowly in the carburizing mixture.
3. Reheat to 1550 to 1625 degrees F.
4. Quench.
5. Reheat to 1400 to 1450 degrees F.
6. Quench.
7. Draw in hot oil at 300 to 450 degrees F., depending upon the degree of hardness desired.

HEAT-TREATMENT B-1

After Forging or Machining

1. Carburize at a temperature between 1600 and 1650 degrees F.
2. Cool slowly.
3. Reheat to 1525 to 1550 degrees F.
4. Quench.
5. Reheat to 1400 to 1425 degrees F.
6. Quench.
7. Reheat to 400 degrees F.
8. Cool slowly.

HEAT-TREATMENT B-2

Before Machining

1. Heat to 1450 to 1475 degrees F.
2. Quench.
3. Draw at 1100 to 1200 degrees F.
4. Machine.
5. Reheat to 1450 to 1475 degrees F.
6. Quench.
7. Draw at 600 to 700 degrees F.

HEAT-TREATMENT D

After Forging or Machining

1. Heat to 1500 to 1600 degrees F.
2. Quench.
3. Reheat to 1450 to 1500 degrees F.
4. Quench.
5. Reheat to 600 to 1200 degrees F. and cool slowly.

HEAT-TREATMENT E

After Forging or Machining

1. Heat to 1500 to 1550 degrees F.
2. Cool slowly.
3. Reheat to 1450 to 1550 degrees F.
4. Quench.
5. Reheat to 600 to 1200 degrees F. and cool slowly.

HEAT-TREATMENT E-1

1. Heat to 1415 degrees F.
2. Quench in oil.
3. Reheat to 1410 degrees F.
4. Quench in oil.
5. Reheat to 500 degrees F. and cool slowly.

HEAT-TREATMENT F

After Shaping or Coiling

1. Heat to 1425 to 1475 degrees F.
2. Quench in oil.
3. Reheat to 400 to 900 degrees F., in accordance with temper desired, and cool slowly.

TABLE 1. MARKINGS OF CARBON AND HIGH-SPEED TOOL STEELS

Name	Kind	Long Streak	Short Streak
"Firth-Sterling Special"	Tool steel	Green	Blue
"Columbia"	Tool steel	Green	Yellow
"Ketos"	Tool steel	Green and White	Blue
Not specified	Tool steel	Green	White
"Blue Chip"	High-speed steel	Red	Blue
"Red Cut"	High-speed steel	Red	Red
Not specified	High-speed steel	Red	Yellow
Not specified	High-speed steel	Red	Green

Machinery

HEAT-TREATMENT G

After Forging or Machining

1. Carburize at a temperature between 1600 and 1750 degrees F. (1650 to 1700 degrees F. desired).
2. Cool slowly in the carburizing mixture.
3. Reheat to 1500 to 1550 degrees F.
4. Quench.
5. Reheat to 1300 to 1400 degrees F.
6. Quench.
7. Reheat to 250 to 500 degrees F. (in accordance with the necessities of the case) and cool slowly.

HEAT-TREATMENT H

After Forging or Machining

1. Heat to 1500 to 1600 degrees F.
2. Quench.
3. Reheat to 600 to 1200 degrees F. and cool slowly.

HEAT-TREATMENT K

After Forging or Machining

1. Heat to 1500 to 1550 degrees F.
2. Quench.
3. Reheat to 1300 to 1400 degrees F.
4. Quench.
5. Reheat to 600 to 1200 degrees F. and cool slowly.

TABLE 2. OPEN-HEARTH CARBON AND ALLOY STEEL MARKINGS AND HEAT-TREATMENTS

S.A.E. Specification Number	Carbon, Per Cent		Manganese, Per Cent		Phosphorus, Per Cent	Sulphur, Per Cent	Nickel, Per Cent		Chromium, Per Cent		Vanadium, Per Cent		Kind of Steel	Mark		Heat-treatment
	Max.	Min.	Max.	Min.	Max.	Max.	Max.	Min.	Max.	Min.	Max.	Min.		Long Streak	Cross-bar	
1114	0.20	0.08	0.80	0.30	0.12	0.120							Bessemer Screw Steel			
1010	0.15	0.05	0.60	0.30	0.045	0.050							Open-hearth Carbon Steel	Yellow	Yellow	Quench at 1500 Degrees F.
1020	0.25	0.15	0.60	0.30	0.045	0.050							Open-hearth Carbon Steel	Yellow	Blue	A or B
1025	0.30	0.20	0.60	0.50	0.045	0.050							Open-hearth Carbon Steel	Yellow	White	H
1035	0.40	0.30	0.60	0.50	0.045	0.050							Open-hearth Carbon Steel	Yellow	Yellow	H, D, or E
1045	0.50	0.40	0.60	0.50	0.045	0.050							Open-hearth Carbon Steel	Yellow	Green	H, D, or E
1095	1.05	0.90	0.50	0.25	0.04	0.050							Open-hearth Carbon Steel	Yellow	Red	H, D, or E
1030	0.35	0.25	0.60	0.50	0.045	0.050							Open-hearth Carbon Steel	Yellow	Red	F
2315	0.20	0.10	0.80	0.50	0.04	0.045	3.75	3.25					3.5 Per cent Nickel	White	Red	H, D, or E
2320	0.25	0.15	0.80	0.50	0.04	0.045	3.75	3.25					3.5 Per cent Nickel	White	Blue	G, H, or K
2330	0.35	0.25	0.80	0.50	0.04	0.045	3.75	3.25					3.5 Per cent Nickel	White	White	G, H, or K
2335	0.40	0.30	0.80	0.50	0.04	0.045	3.75	3.25					3.5 Per cent Nickel	White	Yellow	H or K
2340	0.45	0.35	0.80	0.50	0.04	0.045	3.75	3.25					3.5 Per cent Nickel	White	Green	H or K
2345	0.50	0.40	0.80	0.50	0.04	0.045	3.75	3.25					3.5 Per cent Nickel	White	Black	H or K
3120	0.25	0.15	0.80	0.50	0.04	0.045	1.50	1.00	0.75	0.45			Low Nickel Chromium	Black	Red	
3125	0.30	0.20	0.80	0.50	0.04	0.045	1.50	1.00	0.75	0.45			Low Nickel Chromium	Black	White	G, H, or D
3130	0.35	0.25	0.80	0.50	0.04	0.045	1.50	1.00	0.75	0.45			Low Nickel Chromium	Black	Yellow	H, D, or E
3135	0.40	0.30	0.80	0.50	0.04	0.045	1.50	1.00	0.75	0.45			Low Nickel Chromium	Black	Yellow	H, D, or E
3140	0.45	0.35	0.80	0.50	0.04	0.045	1.50	1.00	0.75	0.45			Low Nickel Chromium	Black	Green	H, D, or E
3220	0.25	0.15	0.60	0.30	0.04	0.040	2.00	1.50	1.25	0.90			Medium Nickel Chromium	Black	Black	H, D, or E
3230	0.35	0.25	0.60	0.30	0.04	0.040	2.00	1.50	1.25	0.90			Medium Nickel Chromium	Black White	White	G, H, or D
3240	0.45	0.35	0.60	0.30	0.04	0.040	2.00	1.50	1.25	0.90			Medium Nickel Chromium	Black White	Yellow	H or D
3250	0.55	0.45	0.60	0.30	0.04	0.040	2.00	1.50	1.25	0.90			Medium Nickel Chromium	Black White	Black	H or D
x3315	0.20	0.10	0.75	0.45	0.04	0.040	3.25	2.75	0.95	0.60			Med. High Nickel Chrome	Black White	Red Yellow	M or Q
x3335	0.40	0.30	0.75	0.45	0.04	0.040	3.25	2.75	0.95	0.60			Med. High Nickel Chrome	Black Yellow	Blue	G
x3350	0.55	0.45	0.75	0.45	0.04	0.040	3.25	2.75	0.95	0.60			Med. High Nickel Chrome	Black Yellow	Green	P or R
3320	0.25	0.15	0.60	0.30	0.04	0.040	3.75	3.25	1.75	1.25			High Nickel Chromium	Black Yellow	Red Yellow	P or R
3330	0.35	0.25	0.60	0.30	0.04	0.040	3.75	3.25	1.75	1.25			High Nickel Chromium	Black Green	White	L
3340	0.45	0.35	0.60	0.30	0.04	0.040	3.75	3.25	1.75	1.25			High Nickel Chromium	Black Green	Yellow	P or R
6120	0.25	0.15	0.80	0.50	0.04	0.040			1.10	0.80	0.18	0.15	Chromium Vanadium	Black Green	Black	P or R
6125	0.30	0.20	0.80	0.50	0.04	0.040			1.10	0.80	0.18	0.15	Chromium Vanadium	Blue	White	S
6130	0.35	0.25	0.80	0.50	0.04	0.040			1.10	0.80	0.18	0.15	Chromium Vanadium	Blue	Yellow	S or T
6135	0.40	0.30	0.80	0.50	0.04	0.040			1.10	0.80	0.18	0.15	Chromium Vanadium	Blue	Green	T or U
6140	0.45	0.35	0.80	0.50	0.04	0.040			1.10	0.80	0.18	0.15	Chromium Vanadium	Blue	Black	T or U
6145	0.50	0.40	0.80	0.50	0.04	0.040			1.10	0.80	0.18	0.15	Chromium Vanadium	Blue	Red	T or U
6150	0.55	0.45	0.80	0.50	0.04	0.040			1.10	0.80	0.18	0.15	Chromium Vanadium	Blue	Red	U
6195	1.05	0.90	0.45	0.20	0.03	0.030			1.10	0.80	0.18	0.15	Chromium Vanadium	Blue	Yellow Red Red	U

Machinery

HEAT-TREATMENT K-1

After Forging or Machining

1. Heat to 1500 to 1550 degrees F.
2. Quench.
3. Reheat to 1450 to 1475 degrees F.
4. Cool slowly.
5. Reheat to 1370 to 1410 degrees F.
6. Quench.
7. Reheat to 375 to 400 degrees F. and cool slowly.

HEAT-TREATMENT L

After Forging or Machining

1. Carburize between 1600 and 1750 degrees F. (1650 to 1700 degrees F. desired).
2. Cool slowly in the carburizing mixture.
3. Reheat to 1400 to 1500 degrees F.
4. Quench.
5. Reheat to 1300 to 1400 degrees F.
6. Quench.
7. Reheat to 250 to 500 degrees F. and cool slowly.

HEAT-TREATMENT M

After Forging or Machining

1. Heat to 1450 to 1500 degrees F.
2. Quench.
3. Reheat to 500 to 1250 degrees F. and cool slowly.

HEAT-TREATMENT P

After Forging or Machining

1. Heat to 1450 to 1500 degrees F.
2. Quench.
3. Reheat to 1375 to 1450 degrees F.
4. Quench.
5. Reheat to 500 to 1250 degrees F. and cool slowly.

HEAT-TREATMENT Q

After Forging

1. Heat to 1475 to 1525 degrees F. (Hold at this temperature for one-half hour to insure thorough heating).
2. Cool slowly.
3. Machine.
4. Reheat to 1375 to 1425 degrees F.
5. Quench.
6. Reheat to 250 to 550 degrees F. and cool slowly.

HEAT-TREATMENT R
After Forging

1. Heat to 1500 to 1550 degrees F.
2. Quench in oil.
3. Reheat to 1200 to 1300 degrees F. (Hold at this temperature for three hours).
4. Cool slowly.
5. Machine.
6. Reheat to 1350 to 1450 degrees F.
7. Quench in oil.
8. Reheat to 250 to 500 degrees F. and cool slowly.

HEAT-TREATMENT S
After Forging or Machining

1. Carburize at a temperature between 1600 and 1750 degrees F. (1650 to 1700 degrees F. desired).
2. Cool slowly in the carburizing mixture.
3. Reheat to 1650 to 1750 degrees F.
4. Quench.
5. Reheat to 1475 to 1550 degrees F.
6. Quench.
7. Reheat to 250 to 550 degrees F. and cool slowly.

HEAT-TREATMENT T
After Forging or Machining

1. Heat to 1650 to 1750 degrees F.
2. Quench.
3. Reheat to 500 to 1300 degrees F. and cool slowly.

HEAT-TREATMENT U
After Forging

1. Heat to 1525 to 1600 degrees F. (Hold for about one-half hour).
2. Cool slowly.
3. Machine.
4. Reheat to 1650 to 1700 degrees F.
5. Quench.
6. Reheat to 350 to 550 degrees F. and cool slowly.

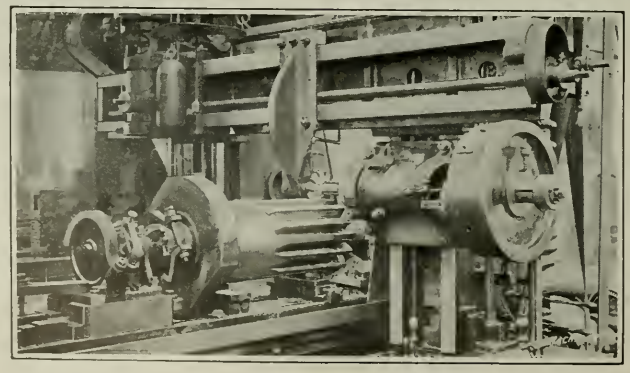
HEAT-TREATMENT V
After Forging or Machining

1. Heat to 1650 to 1750 degrees F.
2. Quench.
3. Reheat to 400 to 1200 degrees F. and cool slowly.

* * *

CUTTING A LARGE PINION

If an order came to your shop to cut a 40-point carbon steel pinion having fourteen teeth of one pitch, 19 inches in length, with a flange at one end of the pinion that is 31 inches in diameter by 4½ inches wide, how would you proceed to do the work? At the Bement-Miles Works of the Niles-Bement-Pond Co., in Philadelphia, Pa., it was recently necessary to cut a pinion of these dimensions, and the accompanying illustration shows the way in which the job was handled. A set of planer index centers was mounted on a Bement multiple-spindle milling machine, and a rotary gear-cutter was set up on an arbor mounted in the spindle of one of the side-heads. Of course this was no ordinary job of gear-cutting, because not only were the teeth of rather exceptional size, but the weight of the blank was so great that it could not be mounted on anything but a machine having ample strength and power. The actual operation of cutting the teeth was done in accordance with ordinary shop practice, it being merely a question of employing the power feed to pass the work under the cutter to produce a tooth space of the required length. Then the cross-rail was raised to lift the cutter clear of the work, after which the blank was indexed to locate it in position for cutting the next tooth space, and the table was returned to the starting point. When this work had been finished, it was merely necessary to lower the cross-rail to a locating stop which brought the cutter into the proper position for producing the next tooth space in the work. Fourteen successive cuts of this kind completed the job.



Cutting the Teeth of a Large Pinion on a Planer Milling Machine

* * *

DIE-CASTING BEARING METALS IN PLACE

Some interesting work in connection with the casting of bearing metals in place is done by the Victor Die Casting Machine Co., Ypsilanti, Mich., which company also builds machines especially adapted for making die-cast bearings. The casting of the bearing metal in place in connecting-rod bearings for Ford automobiles, for example, is a business in itself. The dies used are simple. In the case of a bearing cap, the cap itself, of course, forms part of the die, and the inside of the bearing is formed by a die having projections that form the oil-grooves in the bearing metal. Sectional parts of the die are also provided at the ends for the flanges at the end of the bearing. After having been cast, the bearing need only be reamed, and is then ready for service. Connecting-rod bearings 5 inches in diameter by 4 inches long have been die-cast by this method with the oil-grooves in place, and other bearings up to 8 inches long by 3¼ inches in diameter have also been cast in the same manner.

Practically all the metals that are suitable for bearings can be conveniently die-cast in place. The best metals for the bearings, and those that also can he die-cast most readily, are the genuine babbitts containing about 85 per cent tin with the remainder copper and antimony. These metals should not contain over 9 per cent copper. The copper constitutes the hardening element in the bearing. A recommended composition for a high-class bearing metal is 85 per cent tin, 10 per cent antimony, and 5 per cent copper. The antimony may vary from 7 to 10 per cent and the copper from 5 to 8 per cent.

Bearing metals with so high a percentage of tin, however, are expensive on account of the high cost of this metal. Recently a number of bearing metals have been developed containing a high percentage of lead, and these give very good results in bearings. One of these metals contains from 95 to 98 per cent lead which has been treated in the electric furnace. After die-casting, the metal becomes harder upon seasoning a few days. The bearing metals recommended by the Society of Automotive Engineers also contain some lead, although automobile manufacturers generally are said to use no lead in bearings for automobiles.

In die-casting bearings, the work is located from the bolt holes which are always drilled in the work previous to die-casting. It is important, however, that the bolt holes be accurately drilled with relation to the remainder of the machined surfaces so that the work may be located correctly and the bearing metal properly cast in place. The bearing metal is secured to the bearing in various ways, most commonly by drilling four holes in the bearing or by grooves filed at such an angle that when the bearing metal has solidified, it will be firmly gripped.

Directing Your Employes' Latent Abilities Into Right Channels

By WILLIAM A. ROCKENFIELD, Assistant General Manager, Baldwin Chain & Mfg. Co., Worcester, Mass.

IN the article entitled "Securing the Cooperation of Your Employes" published in the August number of MACHINERY, attention was called to some of the principal factors in selecting and dealing with employes so as to develop a feeling of loyalty, without which no concern can be truly successful. Sometimes, of course, difficulties are met with, and some men present problems that are not easily solved. It should be remembered, however, that if a man is a disturber he is a man with force, and generally a leader of other men. In that case, the main problem is to direct that force into right channels for the benefit of both the man himself and the concern for which he works.

The disturber and agitator has a surplus of energy for which he requires an outlet. Suppose the energy and ability that he employs in persuading other men that the conditions under which they work are unjust or unsatisfactory, were devoted to explaining and convincing his fellow-workers of the true conditions in the industry; in that case the man could become a force for good and for peace and cooperation, instead of for disturbance and dissatisfaction. As a rule, it is merely a question of convincing such a man as to the fairness and justice of certain measures that he may not have properly understood. If the attitude of the concern is not fair or just, it is, of course, impossible to expect that he can be convinced or that his ability and energy to convince others can be made use of; but in any case where the management aims to deal fairly with its employes, the surplus energy of the agitator within the plant can very often, by proper handling, be made to count for good instead of for evil.

In order to bring this about, it is important that the manager should know his men. This, of course, is possible only in small and medium-sized plants. He cannot place the energy of the disturber into the right channel until he thoroughly knows him. Furthermore, the foremen must be completely imbued with the ideas of the manager so that they will properly reflect his ideals throughout the whole organization.

How to Handle the Man who has Ideas for Improvement

When a man has an idea for an improvement in a process or method, care should be taken not to dismiss the idea hastily even though it may be at once apparent that it is impracticable. Every man who is interested enough in his work to propose a new idea to the management should be made to understand that his idea is given careful consideration. It may be that the experience and knowledge of the manager makes it possible for him to decide in a few seconds that the idea is impracticable, but the employe may have given a great deal of his time to it, and with his more limited experience would not understand this and would believe that his idea had been turned down without the slightest consideration. Accept every new idea with the statement that it will be given due consideration. Give it the consideration that it really deserves, and then, if it is found necessary to turn down the suggestion, explain clearly to the man who proposed the improvement why it would not be likely to be successful. If he is not convinced and if it would not involve too much expense to try out his idea so as to convince him of its impracticability, it might be well to let him try it out.

If a new idea is handled in this manner, the originator will not be discouraged; he will come forth with new suggestions in the future, but they are likely to be more carefully thought out. Some day an idea may evolve that will be of considerable value and that would never have been proposed had the first idea been turned down with no apparent consideration.

Snobbishness One of the Most Prolific Causes of Labor Discontent

The attitude of many employers toward their employes causes more labor troubles than do disputes about hours and wages. The manager who deals with the men in his shop as if they were both on a plane, except that he happens to have authority because of his greater experience and training, can govern by respect, and gets along with his men without much trouble. To create loyalty, the manager must show loyalty and be well disposed toward his men; in fact, that is what he gives in exchange for the loyalty that he requests for the concern, but this friendliness must not be pretended simply for its effect; it must be sincere on his part, and can easily be established, as it simply requires that he really look for virtues and good qualities as well as faults in his men. In these days when so many new ideas and "isms" are in the air, any unnecessary show of wealth and affluence is bound to cause resentment and ought not to be apparent around the plant, where the manager should be in evidence merely as a worker of superior ability. One manager has gained the loyalty of his men to a very large extent by speaking and extending the same friendliness and courtesy to them when he meets them on the street or any other place as in the shop. The men appreciate this recognition and realize that it is not only in the shop, but also outside the shop that he maintains the principle that they are co-workers.

Make Your Employes Feel that They Work with You and Not for You

The shop that has no signs, no "don'ts," no "musts," and especially no signs accompanied by "under the penalty of dismissal," is generally the shop in which there is the greatest amount of cooperation. One manager makes it a rule never to make an order of any kind in the form of a command, but always in the form of a suggestion or request. The men in the shop recognize his authority sufficiently to know that the suggestion is expected to be carried out, but the form in which the request is made makes a great deal of difference.

The best way in which to avoid any difficulties in regard to the breaking of such rules as must be enforced is to anticipate any conditions that may arise by creating other conditions which do not precipitate trouble. For a first offence, no man ought to be discharged, except in the case of stealing, or intoxication while on the job. These offences, however, should be understood to be unpardonable, and when a man is an offender he should be made an example of immediately, and the rest of the working force should know the reason for the discharge.

On the other hand, when a man has performed his work unusually well, or otherwise has made himself deserving of praise, do not spare commendations or forget to reward it, and it will soon become known among the other men that qualities such as his are appreciated. Set up a standard

toward which those who wish to work for the best interest of the company may gravitate, and let it be plainly known that certain conduct is being appreciated which aids in promoting a man, while other conduct, just as closely watched, carries with it a negative result.

Handling Complaints

Every shop should provide a recognized channel for adjusting complaints regarding shop conditions, so that every man may feel that he can obtain justice in case he thinks that he has been dealt with unfairly. Whenever a man asks for a hearing and wants to lay a complaint before the management, he believes that he is right, or otherwise he would not request to be heard. Hence, to refuse him a hearing would be an injustice, even though it may be known beforehand that his complaint is unreasonable. His viewpoint should be respected to the extent of paying attention to his complaint, and then, if he is evidently in error, care should be taken to explain to him all the conditions in the case, so that he will go away convinced that no injustice has been done to him. It is worth while spending a great deal of time in preventing any man in the plant from thinking that he has been unfairly treated, and these conferences should always be attended by his immediate superior if it is a subject in which he is interested.

How to Deal with Men who Leave for More Money

When men leave the employ of a company because of being able to obtain a more remunerative position elsewhere, they should not be criticized for so doing, but the manufacturer should recognize that they are acting exactly upon the same impulse as he does himself when he charges for his product the highest market rate that he can obtain consistent with his business policies. Sometimes men leave, not because they have obtained a better offer, but because they want to broaden their experience. These men are sometimes also criticized, but when we remember that the manufacturer himself generally selects men with the broadest experience for the most important positions within his plant, we will recognize that the young man who leaves in order to broaden his experience is acting upon a perfectly commendable and justified impulse, and in many instances the proper attitude at this time may bring the man back later as a much more valuable asset.

Some of the Aspects of Welfare Work

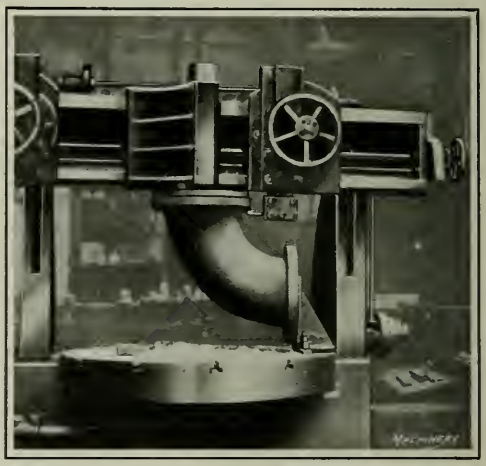
Generally speaking, the welfare-work idea is overdone. Men resent too much interference with their private life, and when the welfare work is so conducted that it takes away from rather than adds to a man's individuality and initiative, nothing is gained by it. Welfare work of any nature should never be commercialized and used as an advertising asset. On the other hand, by carefully handling welfare work on a purely humane plane, a great deal can be done that will add to the efficiency of the plant as well as to the happiness of the employes. Domestic troubles may be settled to the satisfaction of all concerned if the company has a man or a woman who can, in a friendly way, interest themselves in the domestic happiness of the employes. A great many instances have been recorded of the falling off of efficiency of men in the shop, and upon investigation the cause has been found to be domestic difficulties or sickness in the home. If a visiting nurse is employed by the company, it is a good idea to have her visit the home of every employe who is either sick himself or who has sickness in the family; but it is well not to have it understood that she makes such a visit as a representative of the company but rather as a visiting nurse employed by the community, or as a friend. The object is not to impress upon the employe that he is under any obligation to the company, but simply to see that normal health conditions are restored as soon as possible, so that he may regain his full efficiency for the benefit both of himself and of the company.

FLANGE FACING OPERATION ON A VERTICAL BORING MILL

By JOHN A. McMONAGLE

The operation shown in the accompanying illustration consists of facing the bolt-head side of the flanges on 15-inch cast-steel pipe ells. A large quantity of ells were to be machined, and as each flange contained twenty holes, forty in each ell, the operation of spot-facing them would ordinarily consume much time and be expensive and tedious as well. The job was therefore done in the following manner: The ells were first clamped and blocked to the machine table in the usual way and the gasket sides of the flanges faced. The work was then removed to the drilling machine where the bolt holes were drilled, three of these holes being tapped to provide a means of clamping the ells to the attachment on the boring mill when facing for the bolt heads.

The boring mill attachment, showing the work in readiness to be faced, is shown in the illustration. It consists of a saddle, mounted on the cross-rail of the machine and carrying a 5-inch vertical shaft to which a 23-inch faceplate is attached. This faceplate is drilled to match the three



Set-up for Facing Operation on Bolt-head Side of Large Cast-steel Ells

tapped holes in the ell by means of which the ell is fastened in position with tap-bolts. The saddle is adjusted on the cross-rail so that its shaft is concentric with the table of the machine, after which it is gibbed and clamped in position. The other flange is secured to the table by means of an angle-plate, so that the revolving of the table drives the saddle shaft and turns the work, thus presenting the upper flange to the tool in such a way as to face its under side. The ells are then reversed and the same method is employed in facing the flange at the opposite end. The work is thus held rigidly, which makes it possible to complete the operation in one cut.

* * *

A paper recently presented before the American Society for Testing Materials outlined the results of tests made to determine the effect of small amounts of copper in steel upon the rate of corrosion. Two heats of basic open-hearth steel were copperized in varying amounts from about 0.01 per cent up to 0.25 per cent. Sheets from different ingots were made and exposed to the weather for various lengths of time. The tests proved that very low amounts of copper in steel tend to lower the corrosion rate. Copper, to the extent of 0.12 per cent, is said to be sufficient to neutralize the influence of sulphur amounting to 0.055 per cent. Copper amounting to 0.15 per cent is sufficient to protect steels even if the sulphur content is much higher than normal.

Combined Bending and Twisting Moments

By VICTOR M. SUMMA, Examining Engineer, American Brake Co., St. Louis, Mo.

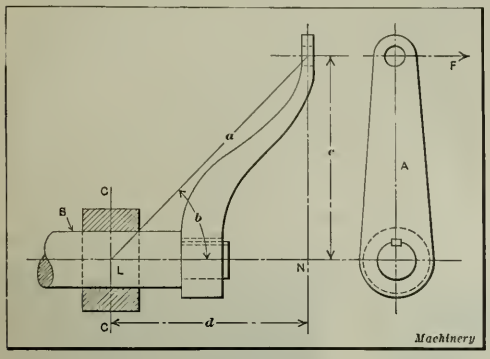


Fig. 1. Simple Lever transmitting Bending and Torsional Moments to Shaft

THE present article contains some new transformations of Rankine's fundamental formulas which may be used in obtaining the maximum tensile or compressive stress and the maximum shearing stress produced in round shafts when acted upon by combined bending and twisting moments. The examples under consideration refer to the use of different types of levers or cranks which are keyed or otherwise attached to the shafts.

In Fig. 1 is shown a lever A keyed to shaft B and transmitting to it a torsional moment equivalent to $F \times c$. On account of the eccentricity of force F, the cross-section of shaft B at CC is subjected also to a bending moment equal to $F \times d$. These two moments produce in the cross-section CC shearing stresses S_s and tension or compression stresses S acting simultaneously and normally to each other. Hence their maximum combined effect can be found by means of Rankine's original and fundamental equations:

$$P_1 = 1/2\ (S + \sqrt{S^2 + 4S_s^2}) \qquad (1)$$

$$P_2 = 1/2\ \sqrt{S^2 + 4S_s^2} \qquad (2)$$

But, since in the case of circular cross-sections the work of finding P_1 and P_2 is considerably shortened if these formulas are in terms of the moment of force F instead of stresses S and S_s, we give hereafter two more transformations of Rankine's equations and examples illustrating their use.

As the polar modulus of section of round bars is twice

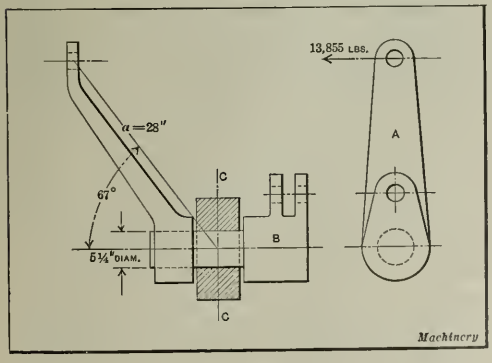


Fig. 2. Lever and Crankshaft ordinarily employed to operate Driver-brakes of Locomotive

that of bars of rectangular section, the following equations may be used:

$$S = \frac{Fd}{Z} \text{ and } S_s = \frac{Fc}{2Z}$$

which substituted in (1) and (2) give:

$$P_1 = 1/2 \left(\frac{Fd}{Z} + \sqrt{\frac{F^2d^2}{Z^2} + \frac{4F^2c^2}{4Z^2}} \right) = \frac{F}{2Z}(d + \sqrt{d^2 + c^2})$$

$$= \frac{F}{2Z}(d + a)$$

Or, letting $M = Fa$ and $a \cos b = d$ we have:

$$P_1 = \frac{M \cos b + M}{2Z} = \frac{M(1 + \cos b)}{2Z} = \frac{M \cos^2 (b \div 2)}{Z} \qquad (3)$$

$$P_2 = \frac{Fa}{2Z} = \frac{M}{2Z} \qquad (4)$$

Thus we obtain Formulas (3) and (4) which, on account of their compactness and simplicity of form, should find extended use among designers, care, of course, being taken not to apply them to bars of non-circular cross-section.

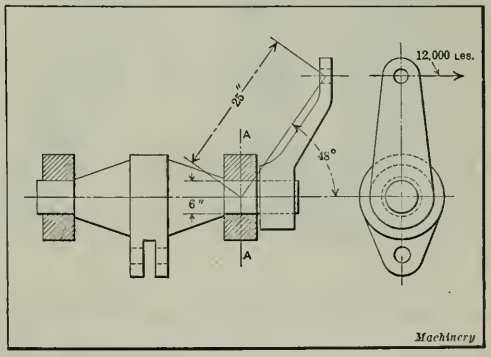


Fig. 3. Crankshaft used in Connection with the Operation of Driver-brakes

Example 1—Fig. 2 represents a cylinder lever A and crankshaft B such as are ordinarily employed on railway driver-brakes. It is required to find the maximum resultant stresses of the shaft at bearing CC. Using the data given in the illustration, Formula (3) by substitution becomes:

$$P_1 = \frac{13{,}855 \times 28\ (1 + 0.39)\ 5.1}{5.25^3} = 19{,}000 \text{ pounds per square inch as maximum tensile or compressive stress;}$$

and Formula (4) becomes:

$$P_2 = \frac{13{,}855 \times 28 \times 5.1}{5.25^3} = 13{,}700 \text{ pounds per square inch as maximum shearing stress.}$$

Example 2—Fig. 3 illustrates another case of crankshafts used in connection with driver-brakes. Assuming the data as shown in the illustration, find the maximum stresses at cross-section AA. Using Formulas (3) and (4), we have as before:

$$P_1 = \frac{12{,}000 \times 25\ (1 + 0.67)\ 5.1}{6^3} = 11{,}850 \text{ pounds per square inch in tension or compression and}$$

$$P_2 = \frac{12{,}000 \times 25 \times 5.1}{6^3} = 7100 \text{ pounds per square inch in shear.}$$

Example 3—The handle of the winch shown in Fig. 4 bears the relation to shaft E given by the dimensions indicated. If a man exerts a force of 150 pounds at A, find the stresses at CC, assuming that at this place the diameter of the rod is 1⅜ inch. In this case the maximum tension or compression is:

$$P_1 = \frac{150 \times 24\ (1 + 0.42)\ 5.1}{1.375^3} = 10{,}000 \text{ pounds per square inch}$$

and the maximum shear is:

$$P_2 = \frac{150 \times 24 \times 5.1}{1.375^3} = 7100 \text{ pounds per square inch}$$

Example 4—The axle of a grindstone is 1¼ inch in diameter, and is bent as shown in Fig. 5 in order to be used as a handle. If the force applied at A is 100 pounds, find the stresses at section CC of the rod, assuming that distance AO is 26 inches and its angle with the horizontal axis is 36 degrees.

As before:

$$P_1 = \frac{100 \times 26\ (1 + 0.809)\ 5.1}{1.25^3} = 12{,}800 \text{ pounds per square inch as tensile or compression stress; and}$$

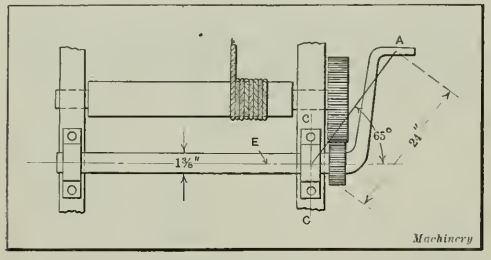


Fig. 4. Diagram illustrating Stresses produced in a Round Shaft of a Hand-operated Winch

$$P_2 = \frac{100 \times 26 \times 5.1}{1.25^3} = 6800 \text{ pounds per square inch as shearing stress.}$$

This example completes the discussion on members subjected to bending and twisting moments. The principal fact to remember is the generality and fundamentality of formulas $P_1 = \frac{1}{2}\ (S + \sqrt{S^2 + 4S_s^2})$ and $P_2 = \frac{1}{2}\ \sqrt{S^2 + 4S_s^2}$. These two formulas may be transformed to meet the conditions required by designers in any mechanical trade. In many cases, simpler expressions than those given in this article are possible. In the application of the preceding formulas, it is necessary to remember their limitations and that they should be used only as indicated.

* * *

The Grand Central Palace, which was taken over by the Government for the period of the war, is to be converted into a permanent show place for all kinds of manufactured products by the Merchants and Manufacturers Exchange, upon its release by the Government on September 30. The industries will be grouped, and permanent exhibits will be made on eight floors of the building, the four lower floors being used for short-term exhibits of various sorts. The International Material Handling Machinery and Factory Appliance Exchange will be one of the eight permanent industrial expositions. Permanent exhibits of the products of the more important industries will be opened October 15. The Merchants and Manufacturers Exchange has established foreign connections for export business in every important city of the world, the purpose being to bring about an extension of American commerce in foreign countries, as well as to increase the importation of foreign goods to America.

MAINTENANCE OF TRUCK TIRES

By A. F. MASURY
Chief Engineer of the International Motor Co., New York City

Motor trucks are now used so generally by machine tool builders and by other manufacturers for transmitting raw materials and finished products that means of reducing their operating costs should be of interest to the executives in these plants as well as to those directly responsible for truck maintenance. Economy in the operation of motor trucks is often thought of simply as some means of saving gasoline, but the saving of tire cost is equally important. On a heavy truck, tire cost and fuel cost are about equal. On lighter vehicles, tire cost is slightly less than fuel cost unless pneumatic tires are used, when the tire cost will slightly exceed the fuel cost. Why, then, should we hear so much about means of saving gasoline and so little about economizing on tires? While the two items of cost are normally of equal magnitude, abuse of tires can raise their cost out of all proportion to their normal costs and can swell this item far beyond the utmost extravagance in fuel.

It is a fortunate circumstance that gasoline waste inevitably limits the ability of the vehicle to perform and that unless the carburetor adjustment is set for reasonable economy the truck will hardly operate at all; consequently it cannot consume an excessive amount of gasoline. On the

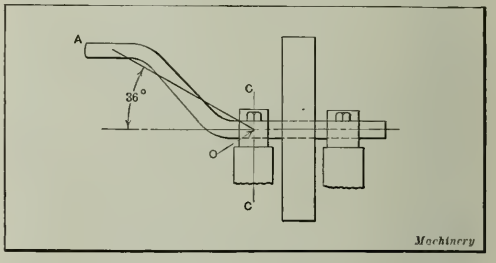


Fig. 5. Example of Stresses produced in Grindstone Axle when Force is applied to the Handle

contrary, tire abuse, unfortunately, limits the performance of the vehicle but little, and it gives rise to increased chassis maintenance cost and even increased fuel cost. It is no uncommon sight to encounter a truck-owner who is extremely particular about his carburetor adjustment, who employs the latest air-warming devices and insists that the engine be shut off at each stop, but who ignores the fact that the tires are cut and slivered, the wheels are out of line and the truck is running on car tracks. A truck will actually consume less gasoline without a governor than with one, but removal of the governor and consequent overspeeding of the chassis imposes a heavy toll on tires.

Common Tire Abuses

Commonest among tire abuses are overloading, overspeeding, running on car tracks, neglecting cuts and tears, spinning, skidding and sliding the wheels, and wheel misalignment. Overloading stresses the tires beyond their elastic limit, utterly destroying the life of the rubber and the durability and cushioning effect of the tires. Overspeeding, even with a light load, has the same effect, since the increased speed causes the impact of the tire on road bumps to be magnified. Running over a bump at twice normal speed pounds the tire eight times as hard and consequently may overload it at one spot 400 per cent. Running on car tracks simply cuts the tires by centering the pressure at one point instead of evenly over the tread, as is proper. The edges of the rails—particularly of the guard flanges of street-car tracks—become sharpened by the friction of the car wheels, and running tires over them is much like running them over the edges of steel knives. When solid tires are cut or torn by glass or sharp stones, the rubber slivers. Slivers on solid tires should be promptly cut off entirely as

soon as they appear. Care should be taken to see that a clean notch just below the end of the tear is made. If the sliver is left on, it will contribute nothing to the strength of the tire, but will continue to flap, and the tear will extend until half the tread width is torn loose. Spinning and sliding the tires in starting and stopping, and skidding in rounding curves also have a serious destructive effect. Upon loss of traction, most drivers will speed up their engines under the erroneous impression that this will increase traction. It actually does the exact reverse. The slower a wheel turns, the better traction it has. The more gently it is started turning, the less likely it is to slip. When a wheel begins to lose traction, the driver should throttle down his engine rather than speed it up, retarding his spark and being ready to release the clutch to prevent stalling. In engaging the clutch, it is also well to let it in gently. Low gear should be used, as this will permit the wheels to be turned very slowly, and there will not be so much danger of stalling the engine.

In applying the brakes, the wheels should not slide. Not only does sliding the wheels injure the tires, but it also reduces the braking effect. The quickest stop is made when the wheels are just turning and the abrasion on the tires is least. Skidding on rounding curves is unnecessary and dangerous. It is due to turning at excessive speed. In some of our cities, such as New York, it is illegal. All of these abuses do untold harm to the tires. A tire is made to roll over the ground, not to slide. Sliding the wheels of railroad cars causes flat wheels. If sliding a hardened steel tire over a smooth steel rail for a few seconds can so abrade the wheel that its pounding will crack 150-pound rails, consider the damage to a rubber tire in skidding or sliding over a road of stone or concrete.

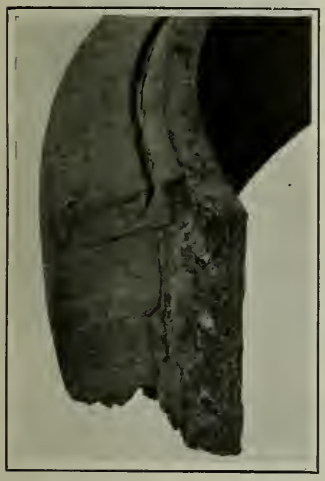


Fig. 1. Overloading as effectually destroys Tires as it does all Other Portions of the Chassis. Note the Peripheral Crack near the Base and Separation of Tire at Base



Fig. 2. Time is Money, but when a Truck turns a Corner so Fast that it skids or is stopped by sliding Wheels, the Slight Saving in Time is not worth the Ruin of a Tire



Fig. 3. The Effect of Overspeeding on Solid Tires. For High Speed, Pneumatic Tires should be applied. They cost more, but are cheaper than Solid Tires in the End

Effects of Lack of Alignment

Besides these more obvious causes of excessive tire wear, there is an insidious cause which often is overlooked. This is faulty alignment. When the wheels are properly located, the tire rolls smoothly and with the minimum of wear, but if out of alignment, it has a combination rolling and sliding movement over the road, which causes rapid wear and consumes power. There are two forms of faulty alignment, namely, that in which the wheel itself is out of true, so that it wabbles, and that in which the wheel-spindle is at an improper angle so that the wheel is constrained to a position out of parallel with the direction of vehicle motion.

Wheel wabbling is caused by strains and warping of the wood. Some of the strains which cause wheels to get out of true can be avoided. When a truck is driven diagonally into the curb, when a corner is rounded too sharply or a boulder is struck a glancing blow, the severe lateral strain at one point of the circumference of the wheel is likely to warp it. Sometimes carelessness in applying or removing pressed-on tires warps the wheel and in some cases a careless operator will press the tire on crooked, so that the effect on the tire is the same as a warped wheel. The remedy is to have the tire pressed off and the wheel trued by a wheelwright.

Misalignment of the wheel-spindles is caused by excessive shocks, such as running into curbs, and overspeeding on rough roads, which tends to bend the axles or the steering arms of the front steering knuckles. The destructive effect of a slight misalignment can readily be appreciated when one realizes that if a wheel is only out of line 1 degree horizontally, it must slip 92½ feet sidewise in a mile of travel. The destructive effect upon the tire is the same as though the truck were pulled sidewise this distance by a winch. And 1 degree is only equal to about 9/32 inch on the periphery of the tire.

Checking Wheel Alignment

Alignment of the wheels can only be checked by accurately measuring the distance between the wheel felloes. There are several good ways of doing this and a number of methods that are not so good. Most motor trucks have their rear wheels dead parallel. To check their alignment, the simplest method requires two men and a tape. The end of the tape is held against the front side of the inside face on one rear wheel and the tape is stretched across the corresponding point on the opposite wheel, care being taken to have the tape level and stretched tight. The bottom points of the felloes are then checked, and then the rear points. All three of these measurements should be the same. The most common misalignment of the rear wheels is what is called a spraddle, which means that the bottoms of the wheels are further apart than the tops. If this condition is found, the wheel bearings should be inspected for looseness first. If these are properly adjusted, then the axle should be straightened.

Front wheels should not be parallel. For greater strength and easier steering they are cambered. By this is meant that the wheels are further apart at their tops than at their bottoms. To correct the resulting tendency for them to roll



Fig. 4. Spinning the Wheels or permitting them to run oot of Line is like running the Engine without Oil. It will destroy the Tires rapidly, as shown in the Illustration



Fig. 5. Car Tracks are bad for Motor Trucks. The Wreck of a Tire here shown is an Advertisement of an Incompetent Driver and an Owner who is wasting Money



Fig. 6. Tire Slivers need not ultimately tear Great Chunks from the Tire and bring it to the Untimely End pictured here. This Tire could have been saved by Simple Surgery

incorrectly, they are correspondingly gathered at the front, their fronts being drawn in or "toed-in" usually about 3/8 inch. Measuring as before, correctly aligned wheels will have their bottoms and their fronts about the same distance apart. The bottoms may be 1/8 inch closer together than the fronts, but should not be farther apart than the fronts.

If these measurements do not check, the "gather" at the front may be adjusted by means of the tie-rod, which is threaded for adjustment. Before adjusting the tie-rod, however, it would be well to assure oneself that the steering arms have not been bent. This can be determined by measuring the distance from the ball or pin, as the case may be, to the wheel felloes. The two arms should be the same distance from their respective wheels. If they are unequal, the one that is bent should be straightened until it is the same distance from the wheel felloe as its mate and the final adjustment made on the tie-rod.

Testing Alignment of Axles with Frame

So far, the methods of checking apply only to the relation of the wheels with each other. Another important check must be made on the alignment of the axles with the frame. Naturally the axles should be perpendicular to the chassis center line. This can best be checked by selecting a fixed point at the center of the frame, such as the front universal and checking the measurement from it to the nearest unobstructed point on each rear wheel. The two should be equal. If unequal, be sure that the truck is on level ground and that the two rear springs are deflected equally. This may be checked by measuring the distance from the bottom of each frame side rail to the axle. If unequal, a jack may be used to raise the low side of the axle to the same height as the other side. The measurement to the universal can then be repeated. If it is found to be still unequal, the cause will be found either in unequal radius-rod adjustment, or if no radius-rods are fitted, in loose axle spring clips which have permitted the springs to shift. At the front a similar check may be made from some central point on the crankcase to opposite points on the wheels.

Too many motor truck users neglect to check their wheel alignments until the occurrence of an accident or other cause that necessitates an extensive repair. Misalignment is likely to result from minor causes in daily service, and unless frequently checked may go unnoticed, bringing about excessive tire destruction without any readily apparent cause.

* * *

PRACTICAL APPLICATIONS OF THE COMBINED STRESS THEORY—CORRECTION

Formula (11), on page 1171 in the article "Practical Applications of the Combined Stress Theory," published in the August number of MACHINERY, should read as follows:

$$S_c = \frac{\frac{P}{A}\left[1 + C\left(\frac{L}{r_g}\right)^2\right]}{3} + \frac{4}{3} \times \sqrt{\left(\frac{16M_t}{\pi D^3}\right)^2 + \left(\frac{\frac{P}{A}\left[1 + C\left(\frac{L}{r_g}\right)^2\right]}{2}\right)^2}$$

On page 1172, this formula, with the values substituted, should read as follows:

$$S_c = \frac{\frac{27{,}250}{7.07}\left[1 + \frac{1.95}{25{,}000}\left(\frac{120}{0.75}\right)^2\right]}{3} + \frac{4}{3} \times \sqrt{\left(\frac{16 \times 10{,}000}{27\pi}\right)^2 + \left(\frac{\frac{27{,}250}{7.07}\left[1 + \frac{1.95}{25{,}000}\left(\frac{120}{0.75}\right)^2\right]}{2}\right)^2}$$

$S_c = 11{,}960$ pounds.

* * *

A British shipwrecking company recently purchased twenty-five German submarines which will be broken up and the scrap metal disposed of. It is estimated that the breaking-up value of each vessel will be $12,166. The scrap metal thus obtained will be sold to various tin plate and steel mills.

Cutting Lubricants for Machine Tools

Functions of Cutting Lubricants and Their Requirements—Use of Lard Oil, Lard Oil Compounds, Soda Waters and Soluble Oils

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THE study of the art of cutting metals, the development of high-speed steel and the design of remarkably efficient automatic machine tools have been life works of some of our most eminent engineers, the aim being to increase machine production and to reduce costs. The improvements in these fields mark a wonderful record in the history of machine shop practice, but it is to be regretted that many manufacturers have failed to take full advantage of the opportunities afforded them to increase production and, nine times out of ten, to reduce costs at the same time. This has been due, in no small measure, to ultra-conservatism and ignorance of the fundamental physical and chemical laws governing the use of machine tool lubricants and coolants. The production, however, in practically every machining operation, can be increased by the proper use of an effective lubricant, and it is fair to assume that the necessity of a cutting lubricant is appreciated by the majority, at least, of our metal-working industries.

Undoubtedly there is one most effective cutting lubricant for each type of metal-cutting operation, but the search for this correct lubricant seems to have been along as many diverse lines as there have been shops making the investigations. The result has been that, even today, a canvass of prominent machine shops discloses the fact that several different so-called "cutting lubricants"—in many instances half a dozen or even a dozen—are quite extensively employed for the same service. Even in the same shop, several cutting lubricants may be used for the same kind of work.

Obviously, this lack of agreement must have considerable effect upon the output of the respective shops, for neither can the different lubricants be similarly effective nor can the benefits of the discoveries made in machine shop practice be as well realized in each case. Before these days of intensive shop methods, such lack of standardization was less of a handicap than it is today when all the difference between a profitable business and one conducted at a loss may depend upon the completion of an operation or two within a certain time limit. Also, in the days when the question of cutting lubricants for machine tools was considered less important, it was natural to depend almost wholly upon the results of more or less haphazard experiments. Without belittling the value of empirical deductions, experiments of such nature today can only be made when based upon sound technical foundations, for results can be realized most effectively only when approached from a scientific angle. This necessitates a clear understanding of the functions of a cutting lubricant and its essential properties—knowledge which can be acquired best by an analytical investigation coupled with broad experience.

Functions of a Cutting Lubricant

The removal of metal by shearing action—the act common to all machining operations—generates heat in direct proportion to the energy expended in performing the work. That is, the amount of heat developed is dependent upon the weight of the chip removed, the cutting speed, and the physical properties of the machined metal. The generation of this heat cannot be avoided; it is cumulative, and is the chief cause of tool deterioration, as it is conducive to more rapid abrasive action. Heat, then, is the governing limitation to the practical speed at which the machining can be conducted. In addition, there is a second source of heat which is also cumulative and deterrent to high-speed work. This is the frictional heat developed as the chip or ribbon of metal cut from the work follows up the tool; that is, the frictional heat generated by the removed material sliding over the tool and the work.

Just as there are two sources of heat when machining metals, there are two distinct functions for the cutting lubricant to perform, of which lubrication is not necessarily, or even customarily, the more important. First, there is the unavoidable heat generated by the cutting or tearing apart of the metal fibers during the actual operation of cutting. This heat has to be conducted away from the place where it is generated (the cutting area of the tool) in order to prevent its undue accumulation. Then there is the effective lubrication of the surfaces over which the chip or ribbon removed from the work will pass. The first requirement calls for a medium of high heat-absorbing capacity in order to discharge the service rapidly and without an unnecessarily lavish supply of lubricant; the second, a medium possessing good lubricating properties and, at the same time, a fair capacity of heat absorption in order to prevent accumulation of such frictional heat as may not have been prevented by effective lubrication.

The functions of a cutting lubricant are, then, first, cooling service, and second, lubricating service. This classification is fundamental, and it is failure to appreciate the respective importance of these two distinct primary requirements

that is the cause of so much difference in opinion regarding what constitutes the correct cutting lubricant for any particular operation. A true appreciation of the basic functions of a cutting lubricant is absolutely necessary if such a vital aid to production is to be standardized.

Standardization of cutting lubricants with the limited facilities to be found even in the most progressive and well equipped machine shop is well nigh impossible, but with the facilities afforded the lubricating experts who have specialized in the production of cutting lubricants true standardization of cutting lubricants becomes practicable.

Requirements of Cutting Lubricants

Though there are but two primary functions of a cutting lubricant, there are additional services which it should discharge to be truly effective. Briefly summarized, the duties which should be performed by an efficient cutting lubricant are:

1. To carry off the heat developed in separating the chip from the work, and thereby prevent a dangerous rise in temperature through the accumulation of such heat.
2. To lubricate the chip as it slides over the tool or the work, and thereby reduce the generation of frictional heat.
3. To improve the finish of the work and guard against rusting.
4. To increase tool maintenance.
5. To flush out the "cutting area" and wash out the small chips.

Lubricating Properties of Oils

Notwithstanding the fact that the cooling service of a cutting lubricant is usually its more important function in realizing high-speed operation, it is the lubricating capacity of the cutting lubricant which requires first consideration, as, obviously, any liquid can discharge the cooling service satisfactorily if used in sufficiently large quantities, irrespective of the heat-absorbing capacity (specific heat) of the liquid.

Even before the days of modern high-speed machining operations, it was discovered that lard oil possessed a peculiar unctuous property which made it especially suitable for machine tool lubrication. No other oil, sufficiently common for its use to be practical, possesses the same characteristic to an equal degree. However, there are decided objections to its use undiluted in modern machine shop practice, which are as follows:

1. The free fatty acid developed, particularly in the presence of heat.
2. The deterioration if used repeatedly as a cutting lubricant.
3. The high cost.
4. The loss in the cooling capacity after repeated use.

Notwithstanding these objections to lard oil when used alone, its peculiar unctuous property makes it the most valuable lubricant about which to compound a scientific blend possessing the necessary qualities to render effective cutting tool lubrication for almost any machining operation. That is, lard oil is the most suitable lubricant to serve as a base upon which to compound the cutting lubricants demanded for that great group of machining operations which require a good lubricating medium in only such quantities as will permit the economic use of lard oil compounds and for those operations where the importance of the lubricating service outweighs the economic consideration which often makes the use of a less expensive cutting lubricant desirable, as in most automatic screw machine work.

Lard Oil Compounds

Lard oil compounds compose the group of cutting lubricants best suited to perform these more exacting requirements, and should be stable blends of lard oil with other oils which will give to the compound the properties undiluted lard oil lacks. That is to say, the diluents should add to the compound properties that counteract the serious objections developed when lard oil is used alone. Obviously, then, the diluent must be a liquid (rather, an oil) which can be added to the lard oil in any proportion that experience shows to be the most effective for the particular work the compound is to perform, and which also can be obtained with certain characteristics more or less marked, as may be required to combat the failings of the lard oil.

The logical source of such diversified diluents is the petroleums, the mineral oil distillates of which can be obtained in numerous varieties possessing an almost endless number of both accentuated and less pronounced characteristics. With so many kinds of diluents to choose from, a lard oil compound consisting of an intimate blend of lard oil and a proper proportion of some mineral oil can be evolved to discharge the functions of an effective cutting lubricant for any machine tool cutting operation, no matter how severe or exacting. The proportions of mineral and lard oils vary, of course, as does also the viscosity of the mineral oil constituent, depending upon the nature and the severity of the work to be done. The mineral oil may be one of the pale amber mineral oils of medium viscosity, as used in the lard oil compounds suitable for Cleveland automatics and for other high-speed operations, where a constant and abundant stream of cutting oil is required, or it may be a heavy-bodied viscous oil which is compounded with the lard oil for use in heavy, coarse work where the chips are long and follow up the work.

Classification of lard oil compounds has been carried out by certain leading producers of cutting lubricants. For instance, there are lard oil compounds designated by number, the number indicating the percentage of lard oil contained in the compound. With such an index as a guide, and the nature of the work to be performed known, a lard oil compound may be selected for any particular operation, embodying the qualities that the experience of lubrication experts has shown to be required. Such classification also affords the individual shop an opportunity to make such logical modifications in subsequent specifications as its special work may indicate to be advisable.

Soda Waters

In addition to the group of machining operations for which lard oil compounds are the most effective cutting lubricants, and in many instances where such lubricants could be advantageously used except for economic considerations, there is that other great group in which the cooling service of the lubricant is of chief importance, or where a more lavish use of cutting lubricant is called for than the relatively high cost of oil compounds would warrant, that is, that group of machining operations best conducted with flooded lubrication.

In this field, practically every cheap liquid has been experimented with, and many of them are still in quite general use as so-called "cutting lubricants." Here, obviously, is an opportunity to use the cheapest of all liquids and the one with the greatest capacity of heat absorption—water. Water itself has little lubricating value, and will rust any but the non-corroding metals. Neither has it sufficient body for lubricating service, so its use has decided disadvantages. Soda water lubricants were developed, therefore, to avoid some of the objections to the use of plain water. These were at first mixtures of sal-soda and soft soap, combined with water in various proportions, the soft soap being added to give the required body to the mixture rather than for its lubricating qualities. As machine speeds increased, it was discovered that lubrication was required as well as cooling service, so it has become quite general practice to add some lard oil to the soda water.

Soluble Oils

The addition of lard oil improved the lubricating capacity of the soda water cutting lubricants, but neither the sal-soda nor the soft soap has any marked effect in overcoming the objections to the use of lard oil as a cutting lubricant

CUTTING LUBRICANTS FOR DIFFERENT MACHINING OPERATIONS AND METALS

Machining Operation	Kind of Metal Machined									
	Hard Steel	Soft Steel	Cast Iron	Wrought Iron	Malleable Iron	Brass	Bronze	Copper	Aluminum	Monel Metal
Turning	Lard oil comp. Soluble oils	Lard oil comp. Paraffin oils Soluble oils		Lard oil comp. Mineral oils Soluble oils	Soluble oils	Soluble oils	Soluble oils	Lard oil comp. Lard oils Kerosene	Lard oil comp. Kerosene	Soluble oils
Boring	Lard oil comp. Lard oils Paraffin oils	Lard oil comp. Mineral oils Soluble oils				Soluble oils	Soluble oils	Lard oil comp. Lard oils Kerosene	Lard oil comp. Kerosene	
Forming	Lard oil comp. Lard oils Paraffin	Lard oil comp. Mineral oils Soluble oils		Lard oil comp. Mineral oils Soluble oils	Soluble oils	Soluble oils		Lard oil comp. Lard oils Kerosene	Lard oil comp. Kerosene	
Milling	Lard oil comp. Soluble oils Mineral oils	Soluble oils Lard oil comp. Mineral oils		Lard oil comp. Soluble oils Mineral oils	Soluble oils	Soluble oils	Soluble oils	Lard oil comp. Lard oils Kerosene	Lard oil comp. Kerosene	Soluble oils
Drilling	Lard oil comp. Lard oils	Lard oil comp. Soluble oils	Lard oil comp.	Lard oil comp. Mineral oils Soluble oils	Soluble oils	Soluble oils	Soluble oils	Lard oil comp. Lard oils Kerosene	Lard oil comp. Kerosene Beeswax	Soluble oils
Reaming	Lard oil comp. Lard oils Sperm oil	Lard oil comp. Lard oils Soluble oils		Lard oil comp. Lard oils	Soluble oils	Soluble oils		Lard oil comp. Lard oils Kerosene	Lard oil comp. Lard oils Kerosene	
Tapping	Lard oil comp. Lard oils Tallow	Lard oil comp. Lard oils Tallow	Lard oil comp. Lard oils Soluble oils	Lard oil comp. Lard oils Soluble oils	Lard oil comp. Soluble oils	Lard oil comp. Lard oils Soluble oils	Lard oil comp. Lard oils	Lard oil comp. Lard oils	Lard oil comp. Kerosene	Lard oil comp. Lard oil and white lead
Thread cutting	Lard oil comp. Lard oils Cottonseed oil	Lard oil comp. Turpentine and white lead		Lard oil comp. Soluble oils	Soluble oils	Soluble oils	Lard oil comp.	Lard oil comp.		
Thread milling	Lard oil comp. Paraffin oils	Lard oil comp. Lard oils Paraffin oils			Soluble oils	Lard oil comp. Soluble oils	Lard oil comp.		Lard oil comp. Kerosene	
Broaching	Lard oil comp. Neatsfoot oil Soluble oils	Lard oil comp. Neatsfoot oil Soluble oils			Lard oil comp. Neatsfoot oil Soluble oils		Lard oil comp. Neatsfoot oil Soluble oils		Lard oil comp. Soluble oils	
Automatic screw machine	Lard oil comp. Lard oils	Lard oil comp. Mineral oils		Lard oil comp. Mineral oils		Lard oil comp. Paraffin	Lard oil comp. Mineral oils	Lard oil comp.		
Grinding	Soluble oils	Soluble oils	Soluble oils	Soluble oils	Soluble oils	Soluble oils	Soluble oils			
Cold saw	Lard oil comp. Kerosene and paraffin oils	Lard oil comp. Mineral oils Soluble oils		Lard oil comp. Mineral oils Soluble oils	Soluble oils		Soluble oils	Soluble oils		
Gear cutting	Lard oil comp. Lard oils	Lard oil comp. Mineral oils	Soluble oils		Soluble oils		Lard oil comp. Soluble oils			
Gear planing	Lard oil comp. Lard oils	Lard oil comp.			Soluble oils Lard oil comp.		Lard oil comp.			
Gear hobbing	Lard oil comp. Lard oils	Lard oil comp.	Soluble oils		Soluble oils	Soluble oils	Lard oil comp. Soluble oils			
Gear shaping	Lard oil comp. Lard oils	Lard oil comp. Soluble oils	Soluble oils			Soluble oils	Soluble oils			

Machinery

that are briefly enumerated under "Lubricating Properties of Oils." Furthermore, the unctuous characteristic of lard oil is not of particular value on account of the marked dilution with the soda water. Soda water has little more lubricating value than has plain water; hence, the lubricating qualities of various other oils would be as efficacious if the oils were simply emulsified with water. In fact, better results are obtained by compounding various oils which blend (that is, form stable emulsions) immediately with cold water. These soluble cutting oils have now been effectively developed and standardized by the leading producers of cutting lubricants for machine tools, and are today the standard lubricant for that group of machining operations where the cooling service of the cutting lubricant is more important than that of lubrication and the cost of the cutting lubricant is given added importance by its necessarily lavish use—that is, in flooded lubrication of cutting tools.

Cutting Lubricants for Various Machining Operations

The machine shop carrying a suitable line of scientifically compounded lard oil compounds and soluble oils has the most effective cutting lubricants for any machining operations encountered in machine shop practice. Even in the case of operations on aluminum, the use of kerosenes or compounds to which kerosene has been added is not to be recommended, for kerosene evaporates rapidly, promoting gumming and thickening of the cutting compound, and unnecessarily increases the fire risk. A light mineral oil of about 300-degree fire test will reduce the viscosity of the lard oil compound as well as kerosene, and, at the same time, will maintain considerably higher flash and fire points for the compound.

Should a special machining operation be encountered for which a strong solution of soluble cutting oil does not render suitable lubrication, and the lightest lard oil compound in stock lacks the necessary cooling capacity, a lard oil compound can be converted into a so-called "soluble compound" by the addition of an alkali (preferably borax, or soda ash) and a special lubricant evolved from standard cutting oils to effectively care for the special service.

The recommendation of the particular cutting lubricant for a given machining operation cannot very well be made without knowing the nature of the work to be done, kind of metal to be machined, cutting speeds, etc., but general recommendations can be made as to whether a lard oil compound or a soluble oil is best suited for the operation. This is done in the accompanying cutting lubricant chart. It should be mentioned that much of the information and data contained in this article and in the chart was secured by the writer in his capacity as consulting engineer of the Swan & Finch Co. By referring to the chart, it will be seen that no attempt has been made to differentiate between the different grades of lard oil compounds, or the degree of solution for the soluble oils, for such selection is dependent on special operating conditions such as cutting speed, weight of chip, etc.—and the manufacturer. It will be noticed that both lard oil compounds and soluble oils are recommended for the same operation on similar material. Selection between the two groups of cutting lubricants, in such cases, is also dependent upon special operating conditions and machine shop policy in the matter of cutting lubricants.

* * *

Arrangements have been made by the American Manufacturers' Export Association whereby introduction cards will be placed in the hands of foreign buyers about to visit this country. These cards, properly signed by representatives of the United States Government abroad, banks, chambers of commerce and the representatives of the association in foreign lands, will serve to accredit visiting buyers to the New York office of the association.

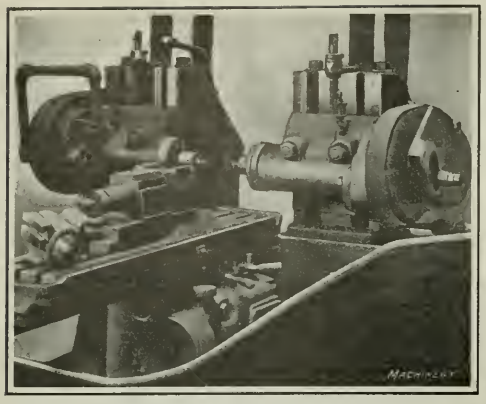


Fig. 1. Milling Two T-slots in the Work-head Spindle Carrier for a No. 1½ Grinding Machine at the Plant of the Cincinnati Milling Machine Co.

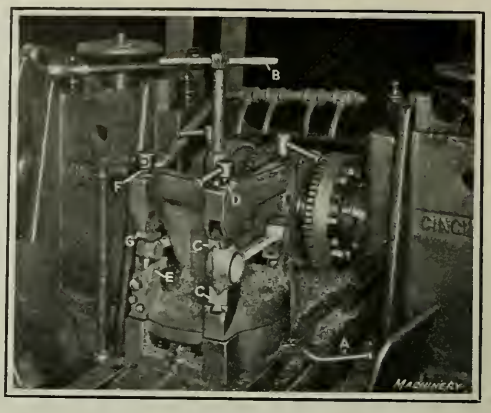


Fig. 2. Simultaneously straddle-milling Crankpin and Wrist-pin Bearings on Connecting-rods at the Plant of the Continental Motors Corporation

Production Milling on Automatic Machines

First of Two Articles Describing Advanced Practice in the Milling of Duplicate Parts

By EDWARD K. HAMMOND

INDUSTRIAL plants engaged in the manufacture of products on which there are large numbers of small or medium-sized parts to be milled find that these repetition milling operations can be advantageously performed on automatic milling machines. There are several millers of this general type built for the market, all of which are furnished with automatic control for the feed movement, in order to make it unnecessary for the operator to give his time to this part of the work. As a result, it is possible for one man to look after two or more machines, thus effecting a substantial reduction in the labor cost which must be charged against a job; but it is of interest to note that this cutting down of the cost of labor is by no means the only reduction of manufacturing costs which is made possible by the use of automatic milling machines under the most advantageous conditions of operation.

Owing to the variety of arrangements of control which have been devised by the designers of different types of automatic millers, definite information as to the way in which savings in manufacturing costs are effected, cannot be presented except in those sections of this article which deal with features of the different types of machines. At this time, however, a general statement can be made that the automatic control of the feed movement on milling machines of this type is the means of reducing idle time of the machine, both in traversing across the space from one piece of work to the next in cases where a number of parts are set up in a string fixture, in returning the table to the starting point at high speed after the cut has been completed, and through the application of similar time-saving methods of operation. The term "automatic millers" is generally applied to machines of this type, but they would be more properly designated as "semi-automatic millers," because, although the feed movements of the table are mechanically controlled, the operator is required to set up the work and remove the milled parts. A machine cannot be properly described as "automatic" unless both of these functions are performed by mechanism, as in the case of automatic screw machines.

Cincinnati Automatic Plain Milling Machine

In these articles dealing with the latest practice in tooling and operating automatic milling machines, it is proposed to first present a brief description of the essential features of each type of machine which is taken up for discussion, and then illustrate and describe some good examples of practice in the performance of milling operations on such a machine. The Cincinnati Milling Machine Co., of Cincinnati, Ohio, builds an automatic plain miller in three different sizes, which have a table traverse of 12, 18, and 24 inches, respectively. Machines of each of these sizes are made in single and duplex styles, according to the requirements of the work on which the machine is to be used. Aside from differences in size, whether the machine is equipped with one or two spindles, the features of all of these machines are the same, so that the following description will suffice for all cases.

Bearing in mind that these tools are to be used on production work, the design has

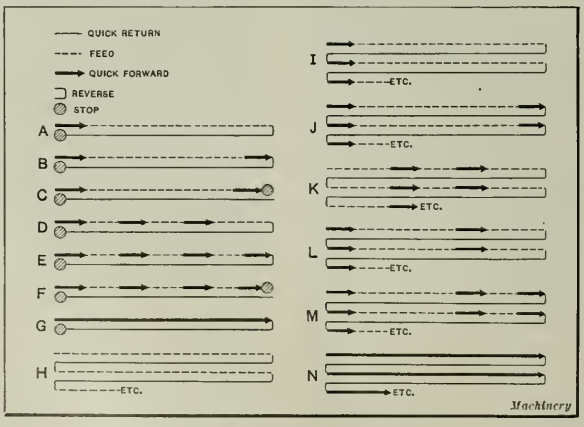


Fig. 3. Diagram showing Typical Cycles of Table Movements obtainable with the Intermittent Feed Mechanism on Cincinnati Automatic Milling Machines

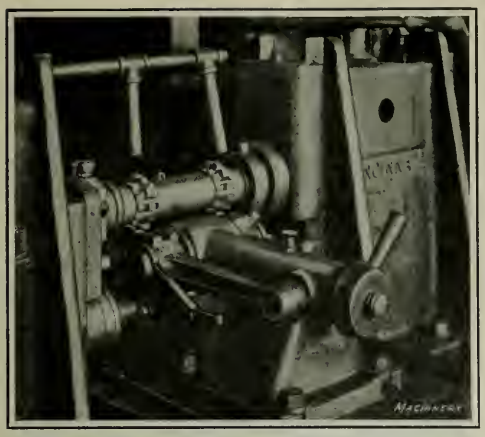


Fig. 4. Simultaneously milling Clearance Spaces between Bolt Bosses at Both Sides of Connecting-rods at Plant of Studebaker Corporation

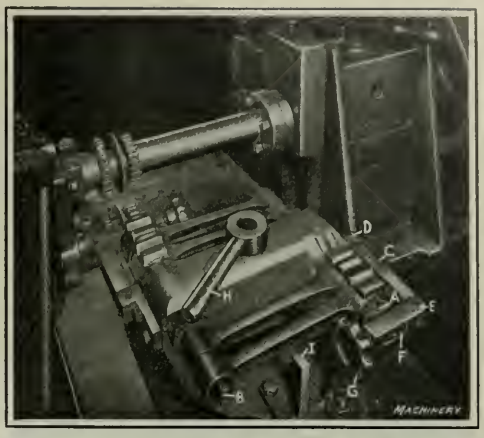


Fig. 5. Simultaneously straddle-milling Bolt Bosses at Both Sides of Studebaker Connecting-rods and cutting off Crankpin Bearing Caps

been made as simple and rigid as possible. All unnecessary slides have been eliminated, and there is no saddle, the table resting directly upon the bed. A stream lubrication system forms a part of the regular equipment of each machine, in order that the cutters and work may be thoroughly cooled when the machine is taking the heaviest cut of which it is capable. On a machine that is to be used continuously on the same job, provision for obtaining any of a number of different speeds is not a matter of importance; it is merely necessary to provide for driving the spindle at that speed which is suitable for the work on which the machine is engaged. This fact was responsible for these millers being designed in such a way that the purchaser may specify any one of twenty-four spindle speeds, covering a range of from 31 to 603 revolutions per minute. It is important to note, however, that the gears which furnish this one speed may be reversed to provide an additional speed; and should it happen that at some later date the machine is to be used on another job requiring a different speed, it is an easy matter to order suitable gears to adapt the miller for this new job.

Arrangement of the Automatic Feed Mechanism

These milling machines are so arranged that at the end of the table's feed movement a dog will automatically disengage the spindle clutch and apply a brake to stop the spindle at the time that the direction of table travel is automatically reversed, so that the table returns to its starting position with the cutter stationary. Two advantages are obtained from this condition of operation, namely, provision is made for the safety of the operator, and the quality of the finished work is improved. When the nature of the work does not require the use of this feature, the automatic spindle stop may be easily disengaged. The feed mechanism is so arranged that any of twelve rates of feed may be selected, according to the requirements of the work. As in the case of provision made for selecting a suitable spindle speed, the continuous operation of these machines on a single class of work makes it unnecessary to provide means for obtaining any of a number of feed changes. Attention is called to the fact, however, that the arrangement of feed gears is similar to those that provide for driving the spindle; namely, that where any one rate of feed is specified, reversing the feed gears enables an additional rate of feed to be obtained. The twelve feeds from which a selection can be made cover a range from 1.09 inch to 18.3 inches per minute.

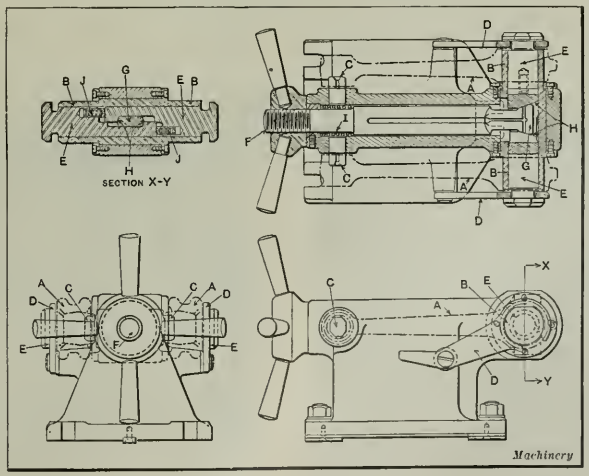


Fig. 6. Design of Work-holding Fixture shown in Operation on the Machine illustrated in Fig. 4

Combinations of Table Feed and Rapid Traverse Movements

There are a number of different combinations of intermittent table feed and rapid traverse movements which may be used on a machine of this type. The machine table is provided with two dog slots, one controlling the rapid traverse, and one the feed traverse; thus by setting dogs in these two slots, it is possible to shift from the feed used while cutting to the rapid traverse as often as may be desirable, and also to reverse by rapid traverse. The fast power traverse is at the rate of 100 inches per minute, and is used for returning the table to its starting position after completing the forward movement; the fast traverse is also utilized in cases where a string of parts is set up on the table and it is required to move the table rapidly across the spaces between adjacent parts which are to be milled. The use of a fast power traverse for moving rapidly across the gaps between successive pieces of work and for quickly returning the table to the starting point is the means of effecting a substantial reduction in the non-productive time of the machine.

Cycles of Feed Movements that are Frequently Used

Fig. 3 shows in diagrammatic form several of the most useful cycles of feed and rapid traverse movements which are made available by providing suitably placed dogs on the table of one of these



Fig. 7. Milling Seat for Crankpin Bearing Caps on Studebaker Connecting-rods

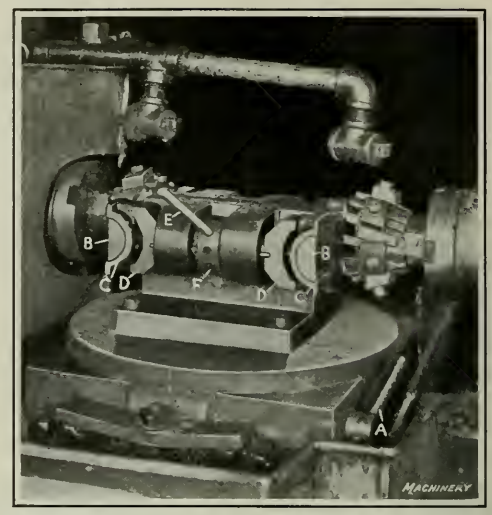


Fig. 8. Milling Base of Crankpin Bearing Caps for Studebaker Connecting-rods

millers. After referring to the key at the top of this diagram, the reader will require no description in order to understand the way in which these various cycles of movement take place. It may be interesting to note, however, that the following are the three methods under which the machine is frequently operated: The first of these automatically controlled cycles of table movements is shown at *A*. It consists of moving the table forward at 100 inches per minute to bring the work to the cutters, and then feeding the work across the cutters at the rate of feed provided on the machine, after which the spindle is stopped, the table movement reversed, and the fast traverse movement engaged to return the table to the starting point at 100 inches per minute with the spindle stationary. The second commonly used cycle of table movements is indicated at *C*. It consists of traversing the table forward at 100 inches per minute, feeding across the work, again traversing the table forward at 100 inches per minute until the work clears the cutters, and finally stopping both the feed movement and rotation of the spindle. When the work is removed, the table is traversed back to the starting point by shifting a lever on the feed-box by hand.

In operating under the conditions indicated at *A* and *C*, stopping of the spindle is automatically accomplished by tripping the feed mechanism and applying a brake to the spindle. After the work has been set up, manipulation of the main starting lever provides for engaging both the table movement and spindle drive. Owing to the interlocking mechanism, it is impossible to engage the feed without starting the spindle. The third commonly used method of operating the machine is indicated at *E*, this system being used when it is desired to set up a string of pieces on the table. Dogs are provided to give the fast table movement by which the spaces between adjacent pieces of work are traversed at a rate of 100 inches per minute; and other dogs provide for reducing the rate of table movement to the slow feed that is employed while the machine is under cut. By using the proper number of dogs, this sequence of movement can be repeated as often as may be desired. After the last piece has been milled, the spindle is stopped, the table movement reversed, and the table traversed back to the starting point at 100 inches per minute.

Milling T-slots in Work-head Spindle Carrier for a Grinding Machine

Fig. 1 shows one of the Cincinnati 18-inch automatic duplex millers equipped for simultaneously milling two T-slots at opposite sides of a work-head spindle carrier for a No. 1½ grinder. This job is done at the plant of the Cincinnati Milling Machine Co. The material is cast iron, and the operation is divided into two steps. The preliminary operation consists of milling a straight slot 17/32 inch wide by 3/4 inch deep by 3 5/8 inches long, this cut being taken by two high-speed steel end-mills which are set up in the opposed spindles of the machine, and driven at a speed of 91 feet per minute, with a feed of 4.6 inches per minute. The second step is to mill the T-slot part, which is 11/32 inch deep by 29/32 inch wide. High-speed steel T-slotting cutters of the usual form take this cut at a speed of 157 feet per minute, with a feed of 4.6 inches per minute. The total time consumed in the performance of both of these operations, including two chuckings of the work, is 3.3 minutes, which is the time per piece from floor to floor. The cycle of feed movements used for the performance of both of these operations is as follows: Traverse table forward at 100 inches per minute, feed work across cutters at 4.6 inches per minute, trip feed movement, stop spindle, reverse direction of table movement, and traverse it back to the starting point at 100 inches per minute.

Facing Bearings of Continental Connecting-rods

A duplex Cincinnati automatic miller is shown in Fig. 2, set up for simultaneously facing the bearings at the large and small ends of connecting-rod forgings at the plant of the Continental Motors Corporation, in Detroit, Mich. It will be apparent that four inserted-tooth cutters are used for this job, which are so spaced that one pair of cutters faces both sides of the large end of the forging, while the other two cutters perform the same operation at the small end of the work. The two forgings are held in an indexing fixture so that after one end of each of these forgings has been milled, the fixture may be indexed to bring the opposite ends of the two pieces of work into the operating position. Lever *A* is depressed to withdraw a tapered pin that locks the fixture in each of its two operating positions; and after the work has been indexed, a T-head wrench *B* is turned to tighten a clamping bolt that locks the fixture in place ready for taking the next cut. The large end of each of the forgings is located in this fixture by means of two V-blocks *C*, the upper one of each of these pairs of blocks being carried at the lower end of a bolt *D*. These V-blocks have the grooves running parallel to the direction of table travel, in order that they may receive the bearing cap bolt bosses on the forgings. At the small end of each piece of work there is a

V-block *E*, in which the groove is placed at right angles to the direction of the table travel, and a bolt *F* clamps block *G* down on the work, in order to secure it in V-block *E*. These V-blocks *E* serve the additional purpose of supporting the end thrust of the cutters. It will be evident that at the top of both bolts *D* and *F* there are sliding pins by which these bolts may be turned in order to clamp the work in the fixture. The clamping mechanism is, of course, identically the same at the rear ends of the two pieces of work, which are in the milling position as they are shown in Fig. 2.

In setting up connecting-rod forgings in this fixture, the method of procedure is as follows: The operator places a forging in each side of the fixture, and he then tightens the clamps on the forging at the left-hand side as the fixture is shown in Fig. 2. After this has been done, the feed is engaged and the operator then proceeds to tighten the clamps on the forging at the right-hand side of the fixture. The reason for following this procedure is that the length of cut on the crankpin bearing is substantially greater than that required on the wrist-pin bearing, so that sufficient time is allowed after the cut has been started at the large end of the work, held at the right-hand side of the fixture, to enable the operator to tighten the clamps on the second forging before the cutters come into engagement with the small end of this forging which is held at the left-hand side of the fixture. Such a method is the means of substantially reducing the idle time of the machine, and enables a higher rate of production to be attained. On this job, the work is fed to the cutters at the rate of 2.4 inches per minute, and the cutting speed is 204 feet per minute. The rate of production obtained is forty finished connecting-rods per hour. The cycle for the automatically controlled feed movement of the table is as follows: Traverse work to cutters at 100 inches per minute, feed work across cutters at 2.4 inches per minute, trip feed, stop rotation of spindle, reverse movement of table, and finally traverse the table back to the starting point at 100 inches per minute.

Milling Clearance Spaces between Bolt Bosses of Studebaker Connecting-rods

Fig. 2 shows a Cincinnati automatic duplex miller set up with the two opposed spindles at the same level, so that two pairs of cutters can be used to straddle-mill the ends of two forgings that are also held at the same level. It will be apparent from the illustration of the machine, however, that adjustment is provided for the two spindle heads, so that they may be placed at either the same level or with one spindle at a greater elevation than the other. This independent adjustment of the two spindle heads can often be successfully utilized to provide a more economical method of milling than would otherwise be possible. A case in point is shown in Fig. 4, which illustrates a good example of the way in which a Cincinnati automatic duplex milling machine may be arranged with the spindle heads at different levels, in order to provide for simultaneously milling the top and bottom sides of a piece of work. The job shown in this illustration consists of milling clearance spaces between bolt bosses on connecting-rods for motor car engines. The machine is shown in use at the plant of the Studebaker Corporation, in Detroit, Mich.

Two cutters are mounted on each arbor, one close to the spindle and the other near the opposite end of the arbor. The latter cutter has considerable overhang. For that reason, it was considered necessary to provide an outboard support for each of the arbors on this machine. It will be seen that the work-holding fixture is so designed that provision is made for supporting two of the forgings to be milled, but in this case both forgings have to be set up and milled at the same time, after which the table is returned to the starting point. It is then necessary to keep the machine idle during the time required to unload the fixture and set up two new forgings ready for the next operation. On this job, the sequence of rapid traverse, feed, and quick return movements of the table is the same as described for the previous milling operation. The rate of production obtained is sixty forgings per hour, which represents the time from floor to floor.

The fixture used on this machine represents quite an interesting example of tool design; and in connection with the following description the reader is referred to Fig. 6, which shows the construction in detail. It will be seen that the two connecting-rod forgings *A* are located by means of arbors *B* which enter the finished crankpin bearings, while at the opposite end short arbors *C* enter the wrist-pin bearings to prevent the work from turning on arbors *B*. Two slotted latches *D* are dropped over the heads of the clamping members *E* that slide inside the hollow mandrels *B*; and it will be apparent that while the heads of clamps *E* are made of such a size that the crankpin bearings will pass over them, the latches are large enough to hold the work on the arbors after they have been dropped into place. The final step in clamping the work is accomplished by turning a capstan wheel which fits on the threaded end of draw-bolt *F*. At its opposite end, this draw-bolt has a tapered head *G*, which engages corresponding tapers *H* at the ends of clamping members *E*.

The manner in which these clamping members are cut away so that they overlap each other is best shown in the cross-sectional view on the line *X*–*Y*. It will be evident that when draw-bolt *F* is pulled back by turning the capstan wheel, it causes the tapered head *G* at the opposite end of this bolt to engage the tapers *H* and pull the two clamping members *E* inward, thus drawing their heads firmly against the latches *D* that secure the connecting-rod forgings in place

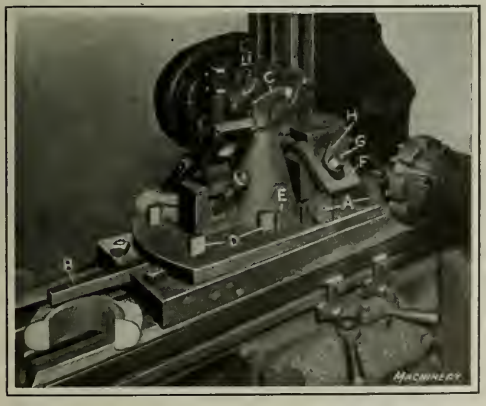


Fig. 9. Milling Base of Differential Bearing Caps at Plant of Studebaker Corporation. An Indexing Fixture holds the Work

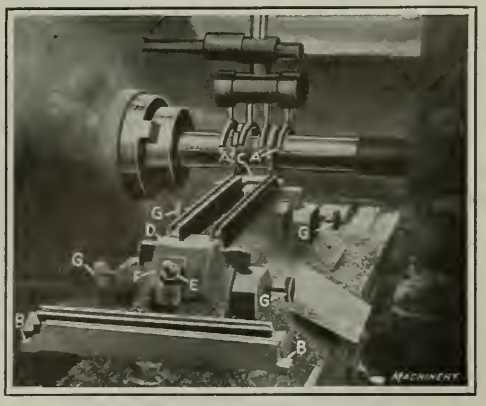


Fig. 10. Automatic Milling Machine with Air-cooled Cutters for performing Grooving Operation at Plant of Royal Typewriter Co.

on arbors *B*. After the milling operation has been completed, and it is desired to unload the fixture, the capstan wheel is loosened and compression spring *I* pushes back draw-bolt *F*, so that its hold on the clamps *E* is released. Two compression springs *J* are then able to push clamps *E* outward, so that the latches *D* are released and may be swung upward to allow the forgings to be lifted out of the fixture. Quite a detailed description was necessary in order to explain the features of design of this fixture, and for that reason it may appear that the method of loading and unloading the fixture is rather complicated. As a matter of fact, this is not the case, as the forgings can be set up or removed by simply giving a turn to the capstan wheel at the end of the draw-bolt *F*, and then lifting up the two latches *D*, if the fixture is to be unloaded; or dropping these two latches *D* into place, and then turning the capstan in the opposite direction, to clamp the two forgings in place ready to be milled.

Straddle-milling Bolt Bosses and Cutting off Bearing Caps of Studebaker Connecting-rods

Fig. 5 illustrates the work of simultaneously straddle-milling the bolt bosses at both sides of two connecting-rod forgings, and sawing off the crankpin bearing caps in the same operation. The Cincinnati automatic milling machine on which this job is done is used at the plant of the Studebaker Corporation. To provide for milling both sides of the forgings at the same time, it will be seen that the spindle head at the right-hand side of the machine has been sufficiently raised above the left-hand head, so that two pairs of cutters may be used to simultaneously straddle-mill the ends of the bolt bosses at opposite sides of the forgings. Located on the arbor between each pair of straddle-milling cutters, there is a small slitting saw which provides for cutting off the bearing caps at the same time the milling operation is performed. It will be noticed that the cutters which work at the top of the forgings are located on their arbor at a considerable distance from the spindle; and to avoid springing this arbor, an outboard support has been provided for it on the cutter-head at the left-hand side of the machine.

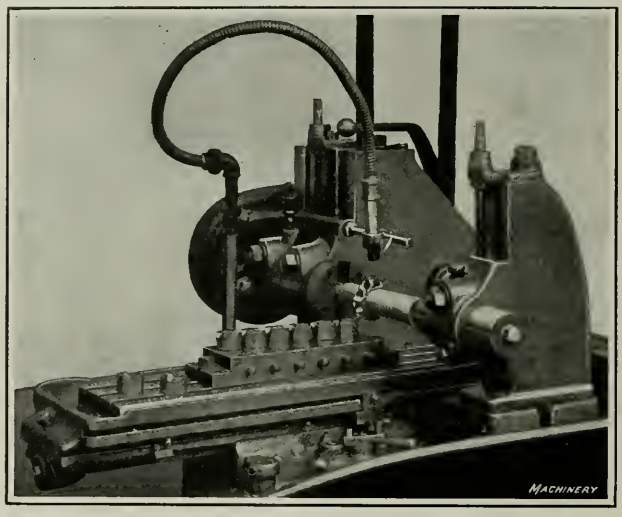


Fig. 11. Automatic Milling Machine equipped with String Fixture for milling V-slots in Rings for Clamps of No. 1½ Cincinnati Grinder Tooth-rests

Application of Time-saving Fixtures on Automatic Machines

The milling operation shown in Fig. 5 represents an extremely advantageous combination of equipment for attaining rapid production, because not only is the machine provided with automatic control for the feed and rapid traverse movements of the table, but an indexing type of fixture has also been provided, which enables the operator to devote his time to removing the milled forgings and substituting fresh blanks in their place, while the cut is being taken on two forgings held at the opposite side of the same fixture. This is what might be termed an indexing type of string fixture, because at each station two forgings are set up in line, so that a cut may be taken on both of them before it is necessary to return the table and index the fixture ready for the next cut.

It will be evident that the two forgings carried at each side of this fixture are located by means of mandrels *A* and *B*, which are a close fit in the crankpin and wrist-pin bearings, respectively. In designing this fixture, provision had to be made for supporting the two forgings at their large ends in such a way that the crankpin bearing caps would be prevented from falling off mandrel *A* and getting damaged by the saws and cutters after the slitting saws have cut them off from the forgings. This result is accomplished by the clamping bar *C* which is supported by a pivot *D*, so that it may be swung into place against the ends of the forgings. This bar *C* is secured by a pivoted link *E* which is slotted to fit over a small projection *F* on the end of the mandrel *A*. When it has been located in this position, clamping is accomplished by turning a small handwheel *G*, which manipulates a screw that is threaded into the end of link *E*, so that it may bind against the side of the projection *F* that passes through the opening in this link. In indexing the fixture, it is merely necessary to loosen the main binding screw *H* and release latch *I;* then after the fixture has been turned through 180 degrees, the latch enters a notch in the opposite side, after which binder *H* is tightened, and the fixture is in position for milling the next two forgings.

The sequence of automatically controlled feed and rapid traverse table movements used on this job is quite simple. It is merely a case of rapidly advancing the table to bring the work up to the cutters, after which the quick movement is tripped and the feed automatically engaged. Then when the work has been fed across the cutters, a dog disengages the feed, reverses the direction of table movement, and stops the rotation of the spindles, after which the table is traversed back to the starting point at high speed. Then the fixture is indexed to bring the next two forgings into the operating position, and the same sequence of movements is repeated, this cycle of operations being continued indefinitely, with very little idle time on the part of either the machine or its operator. On this job, the rate of production obtained is seventy forgings per hour, which represents the time from floor to floor.

Facing Seat for Crankpin Bearing Cap on Studebaker Connecting-rods

The Cincinnati automatic miller shown in Fig. 7 is used at the plant of the Studebaker Corporation for facing the crankpin bearing cap seat on motor car engine connecting-rods. It will be apparent that this is another example of a case in which the two spindle heads of a duplex machine are placed at different levels. But in this instance it is not necessary to have such a marked difference in the elevation of the two spindles, as in the cases shown in Figs. 4 and 5, because it is only required to have the cutters carried by the two spindles reach the faces of two connecting-rod forgings that are held one above the other on each station of the indexing fixture. In performing this operation, the sequence of movements is as follows: Rapidly traverse the table to bring the work up to the cutters, feed the work

across the cutters, automatically reverse the direction of table movement, stop the spindle, and rapidly traverse the table back to the starting point.

There are several interesting features in the design of the fixture shown in this machine. In setting up two forgings on either of the stations of this fixture, the finished wrist-pin bearings are slipped over pins *A*, each of which is carried on a slide *B*. At its crankpin end, each forging fits over a half-round block *C*, but at the time it is placed in the fixture the forging does not come firmly into contact with this block. After the two pieces to be milled have been put into place in this fixture, capstan wheel *D* is turned, with the result that it rocks link *E* about the pivotal support on which this link is carried. Link *E* is also pivoted to each of the slides *B*, and as it is moved by turning handwheel *D*, link *E* causes the two slides *B* and pins *A* carried by them, to move in opposite directions, thus clamping the crankpin ends of the two connecting-rods firmly against the half-round blocks *C*. The work projects sufficiently beyond these blocks *C* to allow the ends of the yoke to be milled.

In the position in which the milling operation is performed, the thrust of the cutters on the work is back against the body of the fixture, so that there is no tendency for the forgings to slide off their locating pins *A* and blocks *C*. Aside from the special means provided for holding the work, this indexing fixture does not call for a detailed description, because it is of the standard type used by the Studebaker Corporation, which will be more fully dealt with in a later article discussing the design and use of indexing milling fixtures. But at this time it may be stated that to release this fixture ready for indexing, it is merely necessary to manipulate the lever *F*; and after the fixture has been indexed through 180 degrees, swinging this lever in the opposite direction clamps the fixture in place ready for the next cut to be taken. The rate of production on this job is one hundred connecting-rods per hour, which represents the time from floor to floor.

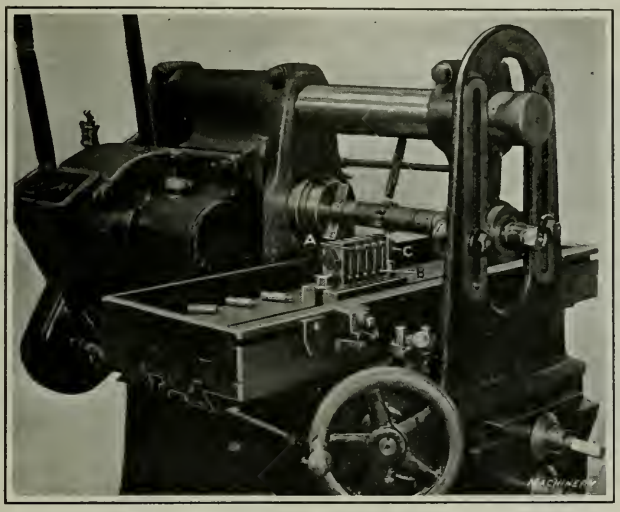


Fig. 12. Manufacturing Milling Machine equipped with String Fixture for milling Rack Teeth in Index-pins

Facing the Base of Crankpin Bearing Caps for Studebaker Connecting-rods

The milling operation illustrated in Fig. 8 is very similar to the one which has just been described. This job consists of milling the base of crankpin bearing caps that fit on the seats which were milled on the rods during the preceding operation. The fixture used on this Cincinnati automatic miller is also provided with a clamping lever *A* that serves the double purpose of accurately locating the fixture in the desired position and then providing means for clamping it in place while the cut is being taken. It merely remains to describe the method of holding the bearing caps in place on the fixture while they are being milled. As in the preceding case, there are two half-round blocks *B* on each station of the fixture, against which the two bearing caps are clamped. These caps *C* are clamped against blocks *B* by means of V-blocks *D* that engage the under sides of the bolt bosses on bearing caps *C*. The two V-blocks *D* are threaded right- and left-hand, respectively, so that they may be forced in opposite directions by means of a right- and left-hand screw which is turned by means of a handle *E* that may be slipped into any of the holes in hub *F*. On this job the rate of production obtained is one hundred caps per hour. The same sequence of feed and traverse movements of the table is used as in the preceding operation on connecting-rods.

Milling Base of Studebaker Differential Bearing Caps

Fig. 9 shows a Cincinnati 18-inch automatic miller set up for milling the base of differential bearing caps for Studebaker motor cars. On this duplex machine it will be evident that the two spindle heads are placed at the same level, so that a cutter carried by each spindle may be utilized to mill off the faces of one of the bearing caps. An indexing milling fixture is used for holding these castings, which is so designed that two pieces are held in position to be milled; and while the operation is being performed on these two parts, two other finished pieces may be removed from the opposite station of the fixture and fresh castings set up in their places. It will be apparent that this milling operation consists of facing off two surfaces *A* on each of the bearing caps, and as there is a space of about four inches between these two surfaces, dogs are arranged on the milling machine table to provide for first traversing the table at a rate of 100 inches per minute, to bring the work up to the cutters. Then a dog trips the rapid traverse and engages the feed movement, to mill the first face *A*. After this has been done, the rapid traverse is again utilized to move the table across the space between the two surfaces *A*, after which the feed movement is once more engaged automatically for milling the second surface on the work. At this point, another dog disengages the feed, stops the spindle, and reverses the direction of table movement, after which the table is returned to the starting point at high speed.

After two bearing caps held at one side of this indexing fixture have been milled, pin *B* is withdrawn and handle *C* is turned to release the binder that clamps the fixture in place during the time that the cut is being taken. The fixture is then indexed through 180 degrees, and after pin *B* has again located it in the desired position, handle *C* is turned in the opposite direction to reclamp the fixture. At each station, it will be noticed that there are two half-round blocks *D* which engage the under side of the lugs at each side of the differential bearing-cap castings, in order to locate them in position for milling. At each station there is also a pin *E*, against which the end of the casting is placed in order that this pin may support the thrust exerted by the milling cutters. The casting is held down in the fixture by means of a pivoted clamp *F*, and when it is desired to remove the milled casting, this clamp is released by first loosening bolt *G* about a half turn, and then swinging slotted latch *H* about the pivot which holds it on strap *F*. There is a hole in strap *F* of sufficient size to pass the nut on bolt *G*. This arrangement allows the clamp to be released by simply making a half turn of the nut, and is the means

of saving a great deal of time in loading and unloading the fixture. On this job, the rate of production obtained is one hundred finished bearing caps per hour.

Milling Grooves in Royal Typewriter Key Lever Brackets

Previous descriptions of milling practice performed on Cincinnati automatic millers have shown the application of machines provided with two spindles. Fig. 10 shows an example of production milling on a single-spindle automatic miller built by the Cincinnati Milling Machine Co. It is used at the plant of the Royal Typewriter Co. at Hartford, Conn., for milling a groove in the key lever bracket for a typewriter. The work is cast iron, and ordinarily no special provision would have to be made for cooling the cutters and work. In this case, however, the cutters are engaged in milling a groove 1/4 inch wide by 3/8 inch deep, and they are constantly in contact with both the bottom and sides of this groove during the entire time that the cut is being taken. For that reason there is very little opportunity to dissipate the heat generated by the cut. As a result, it was considered necessary to provide means for cooling the cutters, and the use of a blast of cool air was finally adopted for this purpose. It will be seen that at each side of both of the cutters there is a hood *A* in which holes have been drilled on the inner side. These hoods are connected with a compressed air line, so that while the machine is in operation, a stream of cool air is constantly impinging on the cutters. The application of this air blast to the cutters also serves the additional purpose of blowing away the chips, so that the cutting action is not retarded.

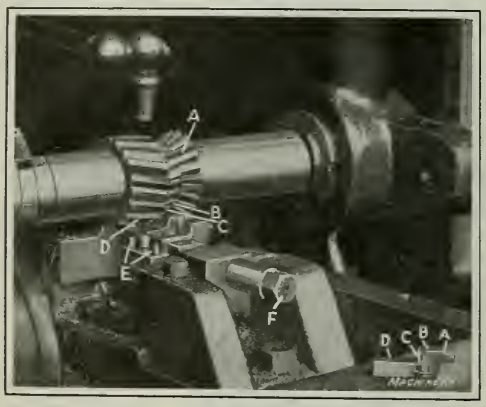


Fig. 13. Manufacturing Milling Machine equipped with Gang of Cutters for milling Four Top Faces of Typewriter Margin Stops at Plant of Royal Typewriter Co.

The dogs are set to rapidly traverse the table to bring the work up to the cutters, after which the feed is automatically engaged to pass the two castings under the milling cutters. After the cut has been completed, the spindle is stopped, the direction of table movement reversed, and the table is returned to the starting point at the high traverse speed. It has already been stated that the grooves in these key lever brackets are 1/4 inch wide by 3/8 inch deep, and the length of the groove is 13 inches. The rate of feed employed is 8.3 inches per minute, and the cutters, which are 2 3/4 inches in diameter, are driven at a speed of 135 revolutions per minute, which corresponds to a cutting speed of 97 1/2 feet per minute. The rate of production obtained on this job is 450 milled key lever brackets in a nine-hour working day.

The fixture in which two key lever brackets are held for the groove milling operation is designed to facilitate the work of setting up these parts, as far as possible. The location is obtained from the milled under side of the work, and the pieces are held down in the fixture by means of a lug *B* at each end. At the rear of the fixture, there is a bar *C* under which one of the lugs *B* on the work is slipped. Then a pivoted strap *D* is clamped down on the lug at the front end of the work. This strap *D* is secured by the nut *E* on a bolt, this nut being small enough to pass through the hole in strap *D*. A pivoted C-washer *F* is swung into place under the clamping nut at the time that the work is being secured in the fixture. Sidewise location and clamping of the work is accomplished by means of four knurled-head screws *G*. These screws engage the sides of the work at each end, and press them inward against a center stop on the fixture.

Milling V-slots in Steel Rings

Fig. 11 shows another Cincinnati single-spindle automatic milling machine which is engaged in machining a row of pieces mounted in a string fixture. It will be apparent from the illustration that the operation performed on this machine consists of milling a V-slot across the top of a steel ring, and that the string fixture is designed to hold six pieces of work. The material is low-carbon steel and it will be seen that the cut is taken by a special angular cutter with staggered teeth. The rings are 1 7/8 inch in diameter with walls 1/4 inch thick; and the slots to be milled are 9/32 inch deep by 13/16 inch wide at the top and 1/4 inch wide at the bottom. The cutter is made of high-speed steel; it is 3 1/2 inches in diameter and runs at 103 revolutions per minute, which gives a cutting speed of 94 1/2 feet per minute. The rate of feed is 3.87 inches per minute, and the actual production time from floor to floor is 1.1 minutes for each piece; that is to say, the hourly rate of production is fifty-four and one half pieces. For performing this operation, the dogs which automatically control the feed and traverse movements of the table are so arranged that the cycle is as follows: Traverse the work to the cutter, feed the six pieces under the cutter, stop the spindle, reverse the direction of table movement, and rapidly traverse the table back to the starting point.

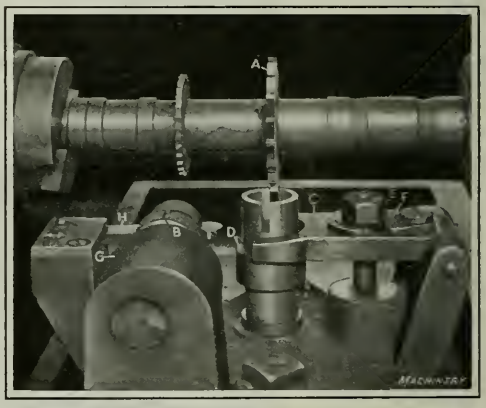


Fig. 14. Manufacturing Milling Machine equipped with Two Cutters and Duplex Fixture for First and Second Operations on Continental Motor Valve Tappet Guides

Cincinnati Plain Manufacturing Milling Machine

For use in the manufacture of parts of products in which there are large numbers of small or medium sized duplicate parts to be milled, the Cincinnati Milling Machine Co. builds a small machine of the column and knee type. It is a simple manufacturing miller equipped with a single-pulley drive, so that no countershaft is required; and it is made in two sizes, with 12 and 18 inches table travel, respectively. The drive is furnished by tight and loose pulleys 9 inches in diameter, and a 2-inch double belt direct from the main lineshaft. Twelve changes of speed are available, covering a range from 30 to 600 revolutions per minute. A simple and effective form of belt shifter is provided, which automatically

operates a brake and brings the spindle to a quick stop at the time the belt is thrown on the loose pulley. By reversing and interchanging four gears, four changes of feed may be obtained; namely, 0.011, 0.015, 0.022, and 0.032 inch per spindle revolution. The feed is provided with a tripping mechanism which may be set to limit the movement by hand anywhere within the full 12 or 18 inches traverse of the table, automatically engage the power feed, and also automatically disengage this feed at the end of the cut. The range of movements provided on the 12-inch machine is 12 inches longitudinal by 6 inches transverse by 10 1/2 inches vertical; and the corresponding movements on the 18-inch machine are 18 inches longitudinal by 6 inches transverse by 10 1/2 inches vertical.

Convenience of Method of Operation

In using one of these millers, the operator from his position at the left-hand end of the table at the front of the machine controls the feed movements with his right hand. The combination belt shifter and spindle brake lever is manipulated by the left hand, the work-holding fixture is immediately in front of the operator. He is never required to leave the working position. Assuming a piece of work has been placed in the fixture, the operator moves the table forward at the rate of 2 3/4 inches per turn of the handwheel, until the table dog comes into contact with a trip, which automatically engages the power feed of the table. At the end of the cut, a second dog disengages the table feed and stops the table, which is then returned to the starting point, again bringing the fixture immediately in front of the operator. The same cycle of operations is repeated after the fixture has been unloaded and fresh work set up. After carefully considering this cycle of movements, the reader will appreciate the way in which the operator's work has been simplified. The table may be moved forward as rapidly as possible without the need of slowing down as the work approaches the cutters, because the table dog automatically engages the power feed at the proper time, without any need of observing special precautions. This is the means of effecting a substantial saving in time and production cost. With the dogs properly set, the actual feeding distance is also reduced to slightly over the actual amount required to traverse the work past the cutters.

Milling Index-pin for Front Plate of Universal Dividing Head

Fig. 12 shows one of the 12-inch manufacturing millers in use at the plant of the Cincinnati Milling Machine Co., where it is employed for milling rack teeth in index-pins for the front plate of 10-inch universal dividing heads. There are five 24-pitch teeth to be milled, which have a face width of 3/8 inch. The material is machine steel, and it will be seen that the operation is performed by a special form of cutter which is 2 1/4 inches in diameter and runs at 88 revolutions per minute, which corresponds to a cutting speed of 52 feet per minute. The rate of feed is 0.022 inch per revolution of the cutter, which corresponds to a rate of 1.93 inches per minute. The actual production time on this job is 1.7 minutes per piece, which represents the time from floor to floor and corresponds to an hourly production of 35 1/5 pieces.

It will be apparent from Fig. 12 that provision is made for setting up five pieces of work at a time on this machine, a string type of fixture being used for the purpose. This fixture is of rather unusual design. The entire fixture body is made from a single block of steel, in the upper part of which five holes are drilled to receive the work *A*. In the lower part of the fixture there are five smaller holes *B*, and slots are sawed down from the top, passing through the work-holding holes and projecting down as far as the holes *B*. At the time they are delivered to this machine to have the rack teeth cut, the pieces of work are cylindrical in form, with the exception of the pointed end. Consequently, they can be slipped into place in the fixture, with the rear end projecting out to pass under the form cutter that mills the rack teeth. After the five pieces have been set up, nuts *C* are tightened on a bolt which projects through the body of the fixture. Tightening these nuts closes in the slots and thus affords a firm grip on the work.

Milling Right- and Left-hand Margin Stops for Royal Typewriters

Another application of a Cincinnati 12-inch manufacturing miller is shown in Fig. 13, which illustrates the use of a machine of this type at the plant of the Royal Typewriter Co., where it is employed for milling right- and left-hand margin stops for typewriters. These parts are made from forgings, and one right- and one left-hand stop are set up together, ready to have the milling operation performed on both of these parts at the same time. The operation consists of milling faces *A*, *B*, *C*, and *D* on the work, and for that purpose it will be seen that a gang of three cutters is provided on the arbor, two of which are plain cutters with spiral teeth, while the third is an angular cutter to provide for milling inclined face *A* on the work. In Fig. 13, the cutters are lettered to correspond with the faces of the work which are finished by them. Following the usual practice in setting up a gang of cutters, it will be seen that the mills on the arbor of this machine are arranged with the spiral angles of the teeth opposed, in order that the thrust exerted by the angular teeth may be neutralized as far as possible. The forgings to be milled are held in a special form of vise, and endwise location is obtained from the previously milled ends of the forgings, which are placed in contact with the pins *E*. After this location has been accomplished, screw *F* is turned in order to tighten the sliding jaw of the vise against the work. The rate of production obtained on this job is 700 stops in a nine-hour working day.

Milling Valve Tappet Guides for Continental Engines

At the plant of the Continental Motors Corporation, one of the 12-inch manufacturing milling machines built by the Cincinnati Milling Machine Co. is equipped with a fixture which adapts it for the performance of two different milling operations on valve tappet guides for motor car engines. One of these consists of milling a slot 1/4 inch in width by 3/4 inch in depth across the end of the guide, this being the operation performed by the cutter shown at *A*. The diameter of the work on which this slot is milled is 1 7/16 inches, and the thickness of the walls is 1/8 inch. The second operation is to mill a pin-slot *B*, which is located at an angle of 90 degrees from the slot milled by cutter *A*. This pin-slot is 5/32 inch in depth by 5/8 inch long.

In performing these two operations on valve tappet guides, the slot is first milled across the end of the work, because it is utilized as the locating point for milling the pin-slot *B*. For taking the first cut, the work is dropped into place over a pilot on the fixture and is held down by a pivoted strap *C* which comes into engagement with a flange *D* on the work. Strap *C* is furnished with a hole of sufficient size to clear nut *E*, and after the strap has been dropped into place on the work, pivoted C-washer *F* is slid under nut *E*, preparatory to clamping the work in place.

For taking the second cut, one end of the work is slipped into the horizontal cylindrical hole in block *G*, after which the work is located in the desired position for milling pin-slot *B* by means of a pivoted bar *H* that is of just the right width to fit into the first slot which was milled across the end of the work by cutter *A*. It will, of course, be apparent that for each traverse of the milling machine table, one piece is completely machined. After each table traverse, the piece in which the end-slot was milled during the preceding operation is set up in the second station of the fixture, ready for milling pin-slot *B*, and a fresh casting is set up in the first station under cutter *A*. On this operation, the cutting speed employed is 149 feet per minute for the small cutter and 211 feet per minute for the large cutter. The table is fed by hand and the rate of production obtained is sixty completely milled valve tappet guides per hour.

Designing a Special Machine

By F. E. JOHNSON

THE idea for a new machine is generally conceived through a desire for increased production, reduced manufacturing costs, or an improvement in the quality of the product. Before the design of a machine is developed, it is important to consider the various methods and possibilities of producing the work, so that the benefits and advantages that will be derived from the new type of machine will be fully investigated. The accompanying table shows the various stages in the development and production of such a machine. The final decision as to the style or type of machine that is required will result from a consideration of the output that is necessary, the nature of the work, and the accuracy and quality of the product that must result from the machining process. The machine may be hand-operated, semi-automatic, or automatic. There are usually several methods by which an object may be accomplished; the first problem of a designer is to determine which method will produce satisfactory results with the smallest cost and in the least amount of time.

STEPS IN THE DEVELOPMENT AND PRODUCTION OF SPECIAL MACHINES

Steps	Procedure of Development
1. Conception of the idea for a machine	Sketches Initial preliminary design
2. Consideration of the cost	Study of the sketches Study of the preliminary design Study of the present costs of machining operations Study of the possibilities of utilizing a standard type of machine
3. Decision as to the methods to employ, determined by: Approximate cost of the machine Output of work required Costs of production Quality of the work to be produced Nature of the work to be produced Time necessary to produce the design and the machine	Development of the final preliminary design if a new type of machine is required
4. Development of the design	General design Detail drawings
5. Construction	Pattern work Foundry work Machine shop work

Machinery

Value of Sketches in Working out Preliminary Details

Often a preliminary procedure in designing a machine is to make sketches to illustrate the various possibilities that may be attained by employing certain methods. An idea concerning a proposed method of accomplishing some purpose that cannot be clearly described by words, may be made clear by means of a sketch, and constructive criticism or suggestions for improvements in a design can be secured before the work is laid out to scale. It is not often possible to group the necessary assembly views of a machine on a single drawing to a full-size scale, and the common method is to plan the general arrangement by means of sketches in order to develop construction ideas and operating principles. Where the combined parts that constitute a unit of the machine are of a sufficient number to make it a complicated affair, it is generally necessary to make a drawing to scale in order to establish correct proportions for the component parts and to determine any interferences that may result by employing certain ideas and constructions.

Sketches generally serve to illustrate ideas and should not be depended upon for accuracy when proportioning details. The important details in the construction of a machine should be developed in a preliminary design to a point where it is possible to figure speeds, feeds, production, approximate costs, and the time that must intervene before a machine can be put into operation. The extent to which it is possible to determine these several factors without expending

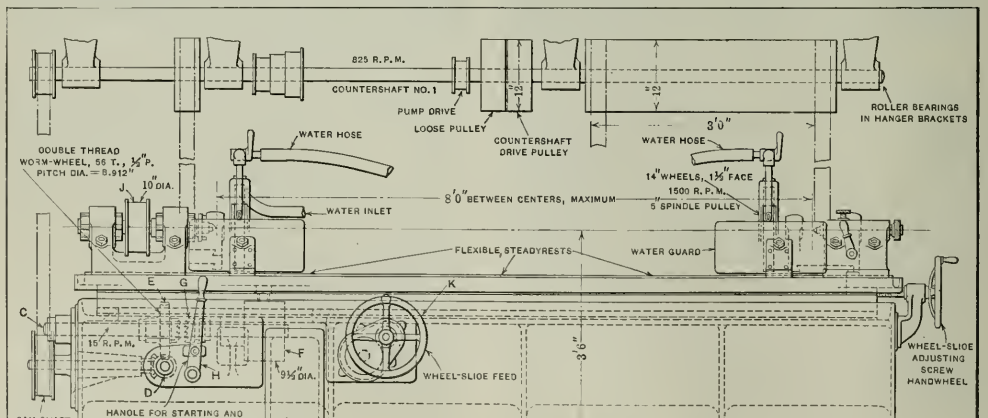


Fig. 1. Front View of a Special Duplex Grinding Machine

much time in developing the various designs depends upon the familiarity of the designer with standard constructions that may be incorporated in the machine. If standard designs of any units that may be employed for performing certain functions are on hand, a certain amount of time will be saved in proportion to the extent to which they are found adaptable.

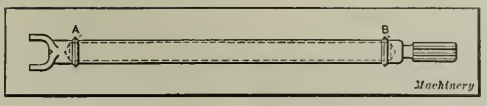


Fig. 2. Sketch of Work handled on Grinding Machine shown in Fig. 1

Developing the Initial and Final Preliminary Designs

After the operating principles of a machine have been decided upon, it is necessary to design the parts so as to permit their operation in the simplest and most efficient manner. A lay-out that is drawn to scale is required in order to establish general dimensions, approximate proportions of parts, and to determine whether the ideas which are in sketch form will prove practical when the attempt is made to assimilate them into the general arrangement. The scale to which a preliminary design can be made depends upon the general dimensions for a machine. As a full-size drawing is always the most satisfactory means for establishing good proportions for the various parts, a practice that has been followed to a limited extent in designing large machines of a new type that involve complicated mechanisms has been to draw some particular assembly view on a surface, the area of which will permit a full-size drawing to be made. This surface may be a blackboard, or a table especially prepared for the purpose upon which the lines are drawn with a lead pencil. Strips of paper tacked to a surface will not be found satisfactory for this work, because of the fact that the paper is affected by changes in atmospheric conditions.

Value of Cooperation between the Designer and his Assistants

A method that is more universally employed is to develop the machine in sections, which is known as the unit method of design. This manner of handling the design of a machine allows a division of the work to be made, and instead of the designer's working out all the details of the constructions personally, assistants aid him in developing the various units. With this cooperation the final results will generally prove to be more satisfactory. The initial preliminary drawing or design should outline all the fundamental principles that are to be developed in the machine, and should also be the means of determining the savings in time and expense that may be attained by introducing standard parts, units, or designs into its construction. It is evident that these factors can only be established by cooperation and that the initial drawing merely serves as a means for discussing the principles involved, which may lead to the development of a final preliminary design. Defects in the design and construction of a machine that are not apparent to the designer may be improved upon, if considered from a number of individual viewpoints and experiences, and a better solution for the problem in hand may result. In order to secure full cooperation from those concerned in the manufacture of the machine, the designer must be able to submit a plan that will convey the general idea of a machine as a whole, with the omission of confusing details that do not vitally affect the general principles of the construction. The details are worked out later in the final design.

The first step in the procedure of the design of a machine is to outline the various constructions to as small a scale as is considered practicable and to determine approximate proportions for important details. Ease of control, location of levers and handwheels, and operating conditions are important features to be considered. The different units of which the machine will consist may later be developed to such a scale as is considered convenient. When such a course is possible, the new machine should be designed along the lines of a standard type with the object of establishing certain elements as standard features, so that it may be utilized for more than one purpose of a similar nature. In some instances, it is possible to adapt it for more than one purpose by substituting tools, fixtures, chucks, or other attachments. The preliminary study and designs are valuable methods for determining what can or cannot be accomplished.

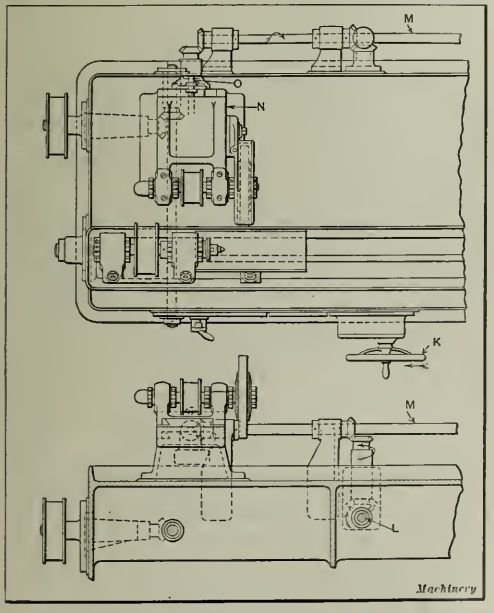


Fig. 3. Partial Plan and Sectional Views of the Headstock End of the Machine

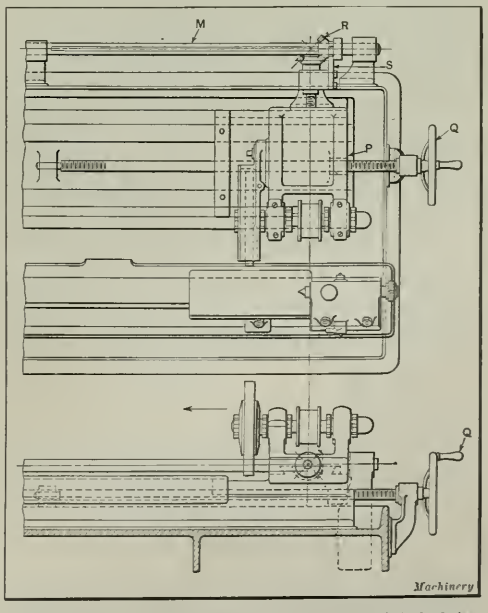


Fig. 4. Partial Plan and Sectional Views of the Tailstock End of the Machine

Objects Attained by Preliminary Design

The objects attained by a preliminary study and design of a machine are as follows: A simple design omitting confusing details; a study of the fundamental principles of the machine; cooperation in the designing work; a determination of the possibilities for effecting savings in the cost of the machine; a division of the work; a reduction of fatigue on the part of any one designer; a reduction of the designing costs; a reduction of the construction costs; a study of the possibilities for the standardization of parts; expeditious machine construction; and the development of the details.

Design of a Grinding Machine for Special Work

To illustrate the foregoing principles, the design of a special grinding machine will be described. A front view of a proposed special hand-operated grinding machine of the duplex type is shown in Fig. 1. The purpose for which the machine was designed is to grind off the fins that are formed by electrically butt-welding a yoke and splined stub shaft to a tube. A sketch of the work is shown in Fig. 2, and the fins to be removed are indicated at *A* and *B*. The saving that would result from the use of this machine is brought about by removing the two fins simultaneously by two grinding wheels. The advantages obtained by the use of a duplex grinding machine instead of a machine employing a single wheel may be estimated by following out the consecutive steps necessary to perform a complete grinding operation. On a single-wheel machine equipped with either hand or automatic feed for the wheel-slide, the time consumed in machining a piece of work would be as follows:

1. Placing the work between the machine centers..8 seconds
2. Removing one fin by grinding.....45 seconds
3. Turning the work end for end.....8 seconds
4. Removing the second fin.....45 seconds
5. Removing the work from between the machine centers.....8 seconds

Total time consumed in machining one piece....1 minute, 54 seconds

Non-productive time per piece.....24 seconds

On a duplex machine equipped with a hand-operated feed for the wheel-slide, the time consumed in machining one piece would be as follows:

1. Placing the work between the machine centers..8 seconds
2. Removing the two fins simultaneously.....45 seconds
3. Removing the work from between the machine centers.....8 seconds

Total time consumed in machining one piece....1 minute, 1 second

Non-productive time per piece.....16 seconds

It is obvious that a 100 per cent increase in production might be obtained by using a machine equipped with two wheels instead of one, if the time consumed in handling the work was not given consideration. The increase in production that may be obtained with a duplex machine is a gain of approximately 87 per cent, according to the preceding calculations. These figures are not taken from actual practice, but are merely used to determine the comparative values of the two different types of machines. It must be remembered that, in estimating the production of a machine, the idle time consumed must be considered. It is evident that the approximation of comparative values of different methods for machining the work can be accomplished in some instances without developed designs.

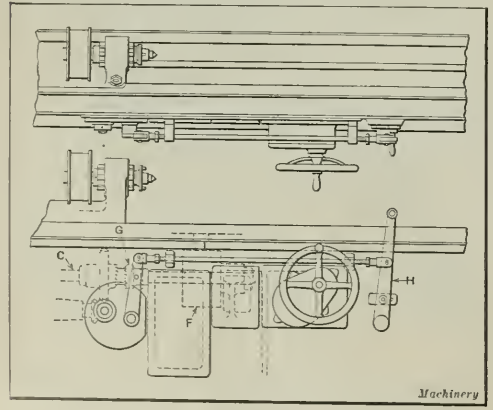


Fig. 5. View showing Modifications of Preliminary Design

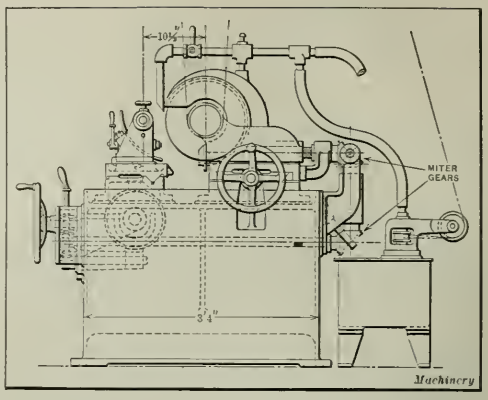


Fig. 6. End View of the Special Duplex Grinding Machine

The value of a duplex machine might be enhanced by adding an automatic arrangement for feeding the wheel-slides to the work if a large production is required, so that a workman might operate two machines. The nature of the work to be produced and the output required are the controlling factors that determine to what extent automatic features may be profitably provided. In estimating the daily or weekly production that may be obtained from a machine, it is necessary to deduct a percentage of time that will be lost in various ways.

Special Duplex Grinding Machine

The machine shown in Fig. 1 is designed to support the work on centers and spring steadyrests, the work being driven by two pins on a faceplate. Only a 2½-inch movement of the work-slide is required to keep the wheel faces in good condition. A cam is used for operating the work-slide, so it may be timed to retard the slide slightly at the end of a movement. There is a live center in the headstock. In the case for which this machine is used it is not essential that the work be perfectly concentric after the grinding process, as it is only a rough-grinding operation. The work is of various lengths and diameters, and for this reason adjustable features and variable work speeds are provided. The different lengths of work are, respectively, 5, 6½, and 8 feet between centers and the tube diameters vary from 1½ to 3 inches. The camshaft *C* is driven by worm *D* and worm-wheel *E*, the latter, in turn, being driven by a bevel gear and a driving pulley arrangement as shown. For each rotation of the cam-drum *F* the work-slide receives two forward and reverse movements. A clutch *G*, which is operated by a hand-lever *H*, is provided for starting and stopping the work-slide. The headstock work-spindle pulley *J* is belted to a driving pulley overhead. The two grinding wheel slides are traversed by means of the handwheel *K*.

A plan view and a partial sectional view of the headstock end of the machine are shown in Fig. 3. The handwheel *K* is geared to the shaft *L*, which, in turn, drives the shaft *M* by means of bevel gears. Shaft *M* operates the wheel-slide feed-screws. The wheel-slide *N* is compound, and may be adjusted by means of screw *O* to compensate for unequal

wear of the grinding wheels. A plan view and a partial sectional view of the tailstock end of the machine is shown in Fig. 4. The shaft *M* traverses the wheel-slide *P* transversely across the bed by means of a pair of bevel gears. Slide *P* is also compound, but the saddles of this slide are at right angles to each other. When adjustment is necessary in order to grind a short length of work, the adjustment is made by means of the handwheel *Q* which traverses the wheel-spindle head in the direction indicated by the arrow to the position where it is required. The tailstock is then adjusted to its proper location. The bevel gear *R* is keyed to the shaft *M*, and is held in the proper relation to its mate by means of the carrier *S*. The 12-inch drum that is shown on the countershaft in Fig. 1 drives the grinding wheel at this end of the machine. A water tank and pump with the necessary connections are furnished for wet grinding.

As previously mentioned, one of the values of a preliminary design is the possibilities it offers for obtaining constructive criticisms or suggestions for improvements in the construction of the machine. As an illustration, in Fig. 5 there is shown an improved construction for the camshaft *C* and hand-lever *H* that operate the camshaft clutch *G*. This modification was decided upon after the preliminary design was made, because as shown in Fig. 1, the cam-drum *F* is not well supported and the hand-lever *H* is located in a poor position.

The bed of the machine is of a simple and rigid construction, and no boring is required in machining it. The various brackets and supports for the shafts are bolted to it, and clearance and hand-holes are cored for inserting brackets and for assembling the parts. The hand-holes are provided with suitable covers. An end view of the machine is shown in Fig. 6.

Conclusion

To reduce the costs in constructing this machine, the design suggests possibilities for the purchase of various parts such as shafts, gears, pulleys, handwheels, bushings, water pump parts, spindles, etc., if such parts are not on hand. The unit method of design was employed in developing this machine. This method of handling a new machine allows the work of construction to be started by the machine and pattern shops before the drafting work is entirely completed. As the various units are developed and detailed the drawings may be sent to the shop.

* * *

SETTING THE TAILSTOCK CENTER OF A LATHE

Considerable trouble is often experienced in setting the tailstock center of a lathe for taper turning. The center may have been adjusted to within 0.002 or 0.003 inch of the desired setting and then, in making the final adjustment, it may be moved over too far or in the wrong direction. This trouble can be eliminated by using an indicator against the movable part of the tailstock. After the tailstock has been set to approximately the desired position in the regular way, a very accurate adjustment is obtainable by using the indicator as stated, and should the center then be moved too much or in the wrong direction, it can be returned to its former position immediately and without difficulty. F. S.

* * *

A resolution has been introduced into Congress by Senator Edge of New Jersey, providing for a federal commission to devise a policy of cooperation between workers and employers. The bill calls for an appropriation of $25,000. The commission is to be instructed to study the relations between the employing and working elements in the United States, to devise a general policy of counsel and cooperation between these elements throughout the nation, and to report on a plan for a permanent joint council with representation of both employers and workers. The commission would consist of four employers and four representatives of workers to be appointed by the President, and to serve without compensation, none of whom would be employes or officials of any government department.

THREAD-CUTTING MECHANISM OF A NORWEGIAN LATHE

An engine lathe now being manufactured by Brödrene Sundt, Christiania, Norway, is equipped with two lead-screws for cutting both inch and metric screw threads, and the gearing is so arranged that threads of very coarse pitch, or helical grooves with leads up to 12 inches, may be cut, in addition to the usual range of pitches for threads. The headstock, which is the geared type, is so designed that its gear ratios may be utilized in connection with screw cutting, the different gear combinations being used to drive the lead-screw. With this arrangement, the total number of pitches obtained in the ordinary way will be multiplied by the number of gear ratios in the headstock. For example, if the lathe is set to cut ½ inch pitch, and the ratio of the gearing between the driving pulley and spindle at this particular time is 24 to 1, then by turning a handle the pitch may be changed from ½ inch to 12 inches; or if a metric thread of, say, 8 millimeters pitch were being cut, the pitch would be changed to 192 millimeters ($24 \times 8 = 192$).

The headstock of the lathe has eight different gear ratios, and it is said that the stress on the gearing is not much heavier when cutting the large pitches than when cutting the finer ones. There is one lead-screw for the inch pitches and one for the millimeter pitches. The metric lead-screw also serves as a feed-rod; in fact, it is practically a threaded feed-rod. When used as a feed-rod, the threads are not engaged by the nut on the carriage, as there is a keyway which transmits the feed motion through worm and spur gearing in the usual manner. The apron has separate nuts for engaging each screw, but they are both operated by the same handle, and only one can be engaged at a time. By means of this additional screw on the feed-rod, metric threads can be cut without using translating gears and by employing the same gearing as for the inch pitches. Both lead-screws run at the same speed, and either one may be disconnected when the other is in use. The inch lead-screw is ¼ inch pitch, and the feed-rod 4 millimeters pitch; hence, when the lathe is geared for cutting 1/16 inch pitch, it is also geared for cutting a pitch of 1 millimeter with the metric lead-screw.

The change-gear box in connection with one set of spur gears and the gear ratios of the headstock provide for cutting 342 different pitches, there being 167 inch pitches and 175 millimeter pitches. These different pitches are obtained by shifting the handles or levers and without changing any gear; and if other gears are inserted, an entirely different series of 342 pitches may be obtained. The maximum pitch is 12 inches. The pitches are divided into a large series and a small series. The latter, which is for general use, is obtained when the lead-screw is driven from the spindle in the usual manner. In the small series there are 37 inch pitches and 37 millimeter pitches. The large series is obtained when the lead-screw is driven from the driving pulley through the headstock gearing.

This lathe may be used for cutting worms intended for worm-wheels based on the module system. (The module of a gear is equal to the pitch diameter in millimeters, divided by the number of gear teeth). With eleven change-gears, 69 module pitches may be obtained, having a range of from 0.75 to 60.

The cross-feed screw of this lathe is connected to the feed-rod, or metric lead-screw, with gearing, so that spiral grooves may be cut on a plane or flat face; as, for example, when making the scroll of a chuck. There is a fixed ratio between the movement of the cross-slide and that of the carriage. For instance, on one lathe if it is geared for ½ pitch with the inch screw, and 8 millimeter pitch with the millimeter screw, a spiral of 4 millimeter pitch will be obtained, the cross-slide moving half as fast as the carriage when using the metric screw. By means of a special device, the carriage may be moved automatically along the bed while the spindle is stationary.



Planning and Controlling Production

An Outline of the System Used by the R. K. LeBlond Machine Tool Co., Cincinnati, Ohio, for Routing the Work through the Plant According to a Predetermined Plan, and Controlling the Production

By IVAN R. DeARMOND
Production Engineer, R. K. LeBlond Machine Tool Co., Cincinnati, Ohio

A SYSTEM has been developed by the R. K. LeBlond Machine Tool Co., Cincinnati, Ohio, for adequately planning and controlling the production of a normal working force of about one thousand men. This system provides complete records of all the information that may be required in the office at any time, with regard to the condition of any order passing through the shop. It also provides a complete record of the stock on hand, both of rough castings and finished parts. It is the object of this article to describe briefly the main features of this system.

The work of planning and controlling the production is in the hands of the planning or manufacturing control department, a general view of which is shown in the heading illustration. The original order specifying the type of machines to be made is first sent to the planning department from the order department. The order then passes to the engineering department, which fills in on this order the unit numbers of all the component units of the machine, and a description of the various units; this gives the planning department the information required for ordering the parts for the various units. As soon as this information has been filled in, the order is returned to the planning department and constitutes the original record for this department. The order and all subsequent records are so keyed that all repair parts that are made later for the machines built can be easily traced back to the correct detail drawings to which the parts were made.

In a plant employing a large number of men, and having a great many departments through which the work must pass, one of the most important features in securing efficient and rapid production is the systematic planning and routing of the work through the shop. This article describes the system employed by the R. K. LeBlond Machine Tool Co. in planning and controlling production, and shows the records that are kept, by means of which the information concerning the progress of the work, the stock on hand or required, and the location of a job at any time may be quickly determined. This system makes it possible for the planning department to follow up the work and to see that it is completed in accordance with the time estimates.

Bill of Material

The machines built by the R. K. LeBlond Machine Tool Co. are all produced on the unit system; that is, headstocks, gearboxes, feed-boxes, etc., are all individual units assembled completely and kept in stock. A tracing, Fig. 1, known as the "bill of material" is provided for every one of these units. This tracing specifies the name of the unit—headstock, taper attachment, etc., as the case may be; it further specifies the symbol or number by which the unit is known, and then gives in separate columns the names and symbol numbers of all the parts necessary to complete the assembly of one unit. In this detailed list, castings, steel parts made especially for the unit, and stock parts are separated, making three main divisions. For the castings, the following items are specified: The number of castings required for one unit; the name of the part for which the casting is required; the symbol number as used on the drawing; and the material—cast iron, semi-steel, malleable iron, or steel. For the steel parts, the number of individual parts for each unit; the name of the part; its symbol number; and designation of material, forging, etc., are specified. For the stock parts, the following items are specified: The number of parts required for one unit; the size by which the stock part is known or designated—as a ⅜-inch gib screw; the name of the stock part—hexagon nut, washer, taper pin, etc.; and the name of the part for which it is used in the unit; finally, the stock part number by which the stock part is designated is given.

This bill of material furnishes the planning department with all the information required as to the parts necessary to assemble the units described on the original order for the machines to be built, and may be considered as the basic data from which all subsequent forms are filled in.

Foundry Unit Requisition and Production Unit Checking Sheet

The original bill of material is a tracing from which blueprints are made, to be used as needed. This blueprint is cut up for ordering the castings, the section describing the required castings being pasted to a sheet headed "Foundry Unit Requisition," Fig. 2, which is an order for the castings required for a lot of machines. This requisition goes from the planning de-

MACHINE 37" Heavy Duty Single Pulley Brown Lathe UNIT Taper Att. UNIT NO. NN-75A

SHEET No. DATE 8-23-18 REVISED DATE SHOP ORDER

AMT	CASTINGS		SYMBOL NUMBER	MAT
1	Taper Att. Bed Bracket		NN-75A-1	C.I.
1	" " Slide		NN-75A-2	"
1	" " " Gib		NN-75A-3	"
1	" " " Bracket	UNIT TAPER ATT.	NN-75A-4	"
1	Guide Bar		NN-75A-5	"
1	" " Shoe		NN-75A-6	"
1	" " " Gib		NN-75A-7	"
1	" " Clamp Handle		NN-75A-8	"
1	Taper Att. Slide Plate		NN-75A-9	"
1	Cross Feed Bush		NN-75A-11	"

AMT	STEEL		SYMBOL NUMBER	MAT
1	Guide Bar Swivel Plug		NN-75A-1-8	SIL.
1	" " Shoe " "	UNIT TAPER ATT.	NN-75A-6-5	"
1	" " Adj. Bush " "		NN-75A-7-5	"
2	" " " Screw " "		NN-75A-8-5	"
1	Cross Feed Screw		NN-75A-11-5	"
1	" " " Front Collar		NN-75A-2-5	"
1	" " " Rear "		NN-75A-3-5	"
1	" " " Pinion "		NN-75A-11-5	"
1	" " " " Sleeve		NN-75A-4-5	"
2	Taper Att. Slide Plate Washers		NN-75A-9-5	"
4	Bed Bracket Clamp Stud		NN-75A-10-5	"
2	" " "		NN-75A-12-5	"

AMT	SIZE	STOCK NAME		STOCK PART NUMBER
2	3/8	Gib Screws		T-55
		(1-Guide Bar Shoe		
		(1-Taper Att. Slide		
1	7/8	Tdlot Bolt		AG-746
1	7/8	Guide Bar	UNIT TAPER ATT.	AG-758
		Hex Nuts		AN-71
2	7/8	Guide Bar		
		Washers		AU-71
1	7/8	Guide Bar		
2	7/8	Hex Cap Screw		C-715
4	3/4	Slide Plate Clamping		D-535
4	3/4	" "		D-535
1	3/4	" Bracket		D-536
		Hex Nuts		AN-71
4	7/8	Bed Bracket		
		Flat Nut		AO-41
2	1/2	Slide Bracket		AO-41
2	1/2	" Plate		
		Washers		AU-71
4	7/8	Bed Bracket		
		Adj. Nut		BA-352
1		Cross Feed Screw		

AMT	SIZE	PARTS NAME	STOCK PART NUMBER
		Taper Pin	
2		Slide Bracket	CB-114
2		" Plate	CB-114
		Straight Pin	
2		Cross Feed Screw Front Collar	CC-155
		" " " Rear "	
		Flat Key	
1	1/4	Cross Feed Screw Pinion Sleeve	BO-118
		Woodruff Key	
1	3/8	Cross Feed Screw Pinion Sleeve	BP-210
		Feather Key	
1	9/16	Cross Feed Screw Pinion Sleeve	BQ-164

Fig. 1. Bill of Material which is made out for Every Unit of a Machine, listing All the Parts Required to complete the Unit

partment to the casting order department, and in this way the castings are ordered directly from the blueprint of the original bill of material, which eliminates mistakes as far as possible. The ordering of the steel parts that have to be made for a given number of units is taken care of by a "production unit checking sheet" and the shop ticket, yet to be described, together with a blueprint of the part to be made.

Shop Ticket

Assume that a certain number of units are to be made. In order to call for the machining of the parts for these units in the shop a shop ticket, Fig. 3, is used. This consists of three sections, perforated so that they may be detached easily, all carrying the same lot number, which appears twice on Section 3. The lower number is covered by

FOUNDRY

"UNIT" REQUISITION 123

REQ. No	AMT	CASTINGS		SYMBOL NUMBER	MAT.	No. LOTS TO COVER AMT.	AM'T. NOW ON STOCK	OR'DR. TO DATE	AMT. ORD.	DATE WN'TD	DATE F'LD	REMARKS
	1	Taper Att Bed Bracket		NN-75A-1	C.I.					10 7/20		
	1	" " Slide		NN-75A-2	"					10 6/16		
	1	" " " Gib		NN-75A-3	"					10 6/23		
	1	" " " Bracket	UNIT TAPER ATT.	NN-75A-4	"					8 6/20		
	1	Guide Bar		NN-75A-5	"		2			6 6/20		
	1	" " " Shoe		NN-75A-6	"		4			10 6/20		
	1	" " " Gib		NN-75A-7	"					9 6/23		
	1	" " " Clamp Handle		NN-75A-8	"		1			10 6/21		
	1	Taper Att Slide Plate		NN-75A-9	"					12 6/23		
	1	Cross Feed Bush		NN-75A-11	"					10 6/20		

REMARKS:-

MACHINE 37" Lathe.

UNIT Taper Attachment. UNIT NO. NN-75A.

AMOUNT TO RUN 10 SHOP NO. 2947

DATE CHECKED 6/2/19 DATE ORDER PLACED F'O'RY. DEP'T. SHEET No

DATE REC'D. F'DRY. DEP'T. DETAIL REQ NOS:- FROM TO

FORM 118

Fig. 2. Foundry Unit Requisition, used in ordering Castings Required for a Lot of Machines. The Section describing the Castings is cut from a Blueprint made from the Original Bill of Material (Fig. 1) and pasted on the Foundry Unit Requisition, as shown

the blueprint, which is pasted on the blank space of the ticket and overlaps both the name, symbol and lot number, protecting them from the dirt; because of this protection the reserve lot number may be depended upon even if the upper one is effaced.

After all the necessary information has been filled in on all the sections of the ticket, it is sent to the engineering department, where the print, with the same symbol number as on the shop ticket, is attached. This symbol number is taken from the bill of material. Instead of holding up the whole ticket to make all necessary entries in the planning department before delivering it to the engineering department, Section 1 is detached and Sections 2 and 3 are delivered to the engineering department immediately. All necessary entries are then made from this stub, while the detail print is being made. After the job goes on the floor, the same stub with heading "This Job will be in Your Department Next" is filed one department in advance of the job, in the "department control board," which will be described later, according to the date the job is due to be in that department.

Section 2 is used by the foreman of the first department receiving the work, as an order for the material to be delivered to his department. It is returned to the planning department and is a record of the kind and amount of material used for that job. This record is then entered in the cost book. The back of this same stub (see Fig. 4) is arranged to keep a record of the dates the ticket is delivered and received by each department through which the ticket must pass to prepare it for shop use. This, combined with the schedule card, which will be described later, gives a complete record of any delay that may have occurred from the time the ticket is first issued until the details reach the finished stock-room. It also shows which departments put forth every effort to overcome any delay that may have occurred before the work was received by them.

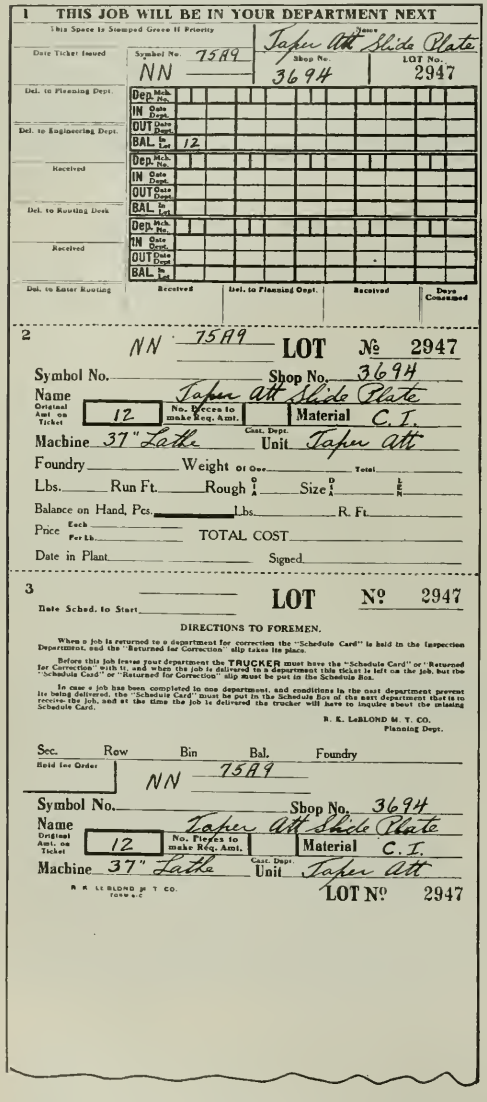


Fig. 3. Shop Ticket for ordering the Machining of Parts

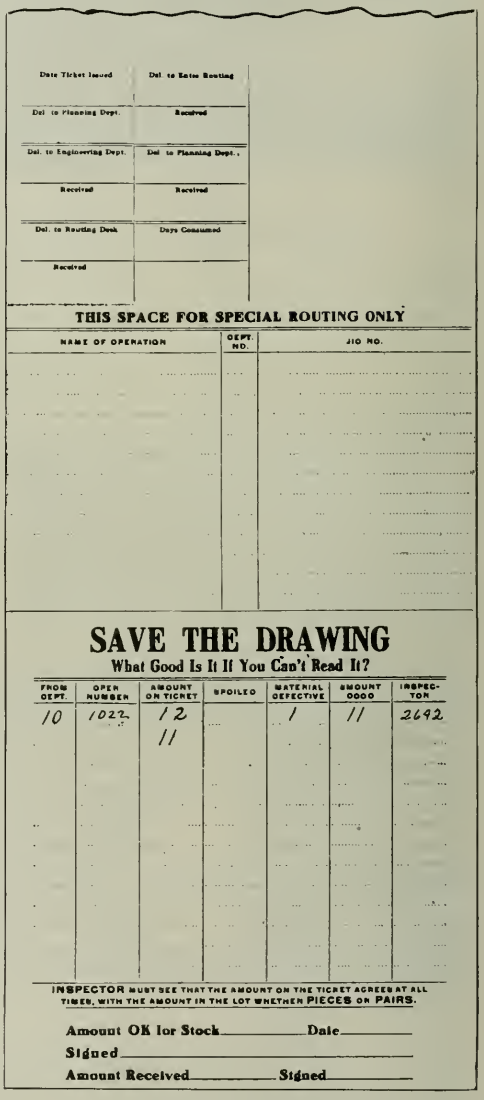


Fig. 4. Back of Shop Ticket shown in Fig. 3

THE R. K. LEBLOND MACHINE TOOL CO.

NAME Apron SYMBOL NO. N.H- 150 C-1

OPERATION	DEP NO	JIG NO		
Plane Top	10	1-N.H. 150 C		SET
Drill & Tap Top	8	1-N.H. 150	Drill Jig	
Surface	35	N.F. & N.H.	Surface Plate	
Mill Dovetail 2 Spots	9	2-N.H. 150 C	Mill Fix. & Dovetail Cycle	"
Mill Ecc Bush Spots	9			"
Mill Index Lever Spot	9			"
Bore Sides & Ends	8	3-N.H. 150 C	& N.H. 1993 - Drill Jig	"
Drill Oil Holes	8			"
Paint	11			"
		1-N.H. 150 C	Adj. Planing Tool	

Fig. 5. Routing Card which indicates Order in which Work is to pass through Shop

Section 3, or the shop ticket proper, remains with the material to be machined, from the time the job enters the first department, until it is checked in the finished stockroom, where it is filed. The reverse side of the ticket (see Fig. 4) provides space for the routing in case the part is not regular enough to warrant having the routing made up on tracing cloth and blueprinted, as shown in Fig. 5. In the space on the lower half of the back (Fig. 4) the inspectors enter the necessary information required to give a complete history of the lot the shop ticket accompanies.

Routing Card

The routing card shown in Fig. 5 specifies the order in which the work is to pass through the shop, contains information indicating when time study is made and time is set, and also shows the numbers of the jigs that are to be used on the job. The method of time study and rate setting was explained in the July number of MACHINERY in the article dealing with the methods employed for this purpose by the R. K. LeBlond Machine Tool Co. The routing is also copied in the cost book, so that the actual as well as the estimated cost of the work can be recorded.

Department Control Board for Schedule Cards

Fig. 6 shows the rack for schedule cards, of which one is placed in each department. After the schedule dates have been determined by means of the calculating calendar (the construction and use of which will be described later), the schedule card (Fig. 7) and Section 2 of the shop ticket (Fig. 3) are placed in the rack of the first department receiving the work, according to the date on which it is due to start.

This rack has a pocket at the lower left-hand corner where the schedule cards are placed by the trucker when jobs are brought into the department. From here they are removed, dated, and filed by the "shop tracer." The stamped dates show the actual dates on which the job enters and leaves each department; one color is used in the morning to indicate A. M. and another in the afternoon to indicate P. M. When a job reaches the inspection department, it is "dated out" of the machining department.

The left-hand section of the board is used to hold all schedule cards on jobs not as yet being worked on. This section is divided into columns headed "Next Month," "This Month," and "Last Month," and each column, in turn, is subdivided into thirty-one pockets, one for each day of the month. This arrangement and the schedule cards filed according to their respective dates give the foreman a graphic idea of the relation of all jobs in his department, at all times, with the requirements of the erecting floor for the coming months.

The right-hand section of the board is also divided into columns, headed "Next On," "On Machine," and "Jobs Finished," and contains a pocket for every machine in the department under each of the headings. This arrangement enables the foreman to lay out his work for all machines in his department so that the job and tools for same may be secured and placed near the machine, in order to go ahead with the new job as soon as the present one has been completed. When the schedule card is placed in the last column headed "Jobs Finished," it is a signal to the trucker that the job must be moved immediately to the inspection department. The machine number on the pocket holding the schedule card for the job that is to be moved gives the trucker the location of the job in the department. Located at the lower right-hand corner is a pocket for the convenience of the department, being used as a distribution box for general



Fig. 6. Rack in which Schedule Cards are filed in Each Department

SYMBOL NO. NN 75A9 SIZE Taper Attachment NAME Slide Plate LOT NO. 2947

Dep. Mch. No.	DATE FILED	12		9		8	11
IN Date Dept.	A. M.	7-1	6-28	7-5		7-9	7-12
OUT Date Dept.	IN SHOP	7-3		7-8		7-11	7-16
BAL. In Lot	P. M.	12					
Dep. Mch. No.		17					
IN Date Dept.		7-16					
OUT Date Dept.							
BAL. In Lot							
Dep. Mch. No.							
IN Date Dept.							
OUT Date Dept.							
BAL. In Lot							

1002 SHOP NO.
DATE TO BIN 7-16
DETERMINED R
SCHEDULED R
AMT. IN STOCK
LAST OUT / CK. OUT DATE / AMT

Fig. 7. Schedule Card for recording the Progress of the Work

information from the department to other parts of the plant.

In addition to the schedule card, showing the condition of the work in the department, there is also a so-called "advance tracer," which is filed one department in advance of the job and according to the date the job is due in the department. This shows the foremen which jobs will reach their departments next, and how they stand as to schedule, giving them advance information concerning jobs that have been delayed, and making it possible for them to lay their plans and aid in overcoming this condition. This same advanced tracer, which is Section 1 of the shop ticket, Fig. 3, travels through the planning department each time it is moved to the next department and in this way it is possible to keep the Rand file, later to be referred to, up to date.

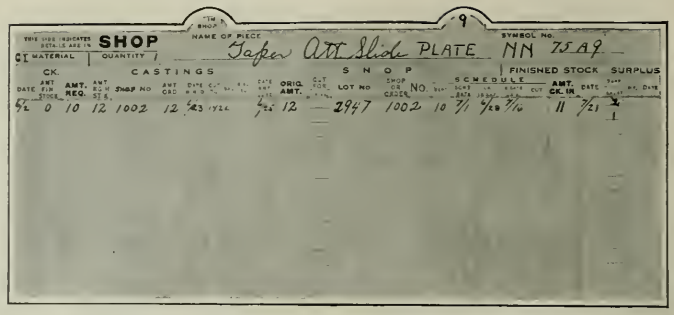


Fig. 8. Balance Card containing a Complete Record of the Number of Parts on Hand for Any Given Job

Balance Card

Fig. 8 shows a card arranged to give a complete record of the balance of parts on order, in rough and finished stock, and in process of machining; also a record of the lot and shop number by which the lot is to be identified, the number of the department which receives the job first, the date it should start and finish, when it actually entered the shop, and the amount received in finished stock. Under the headings "Amt. Req." and "Shop No." at the left of the card, are shown the number of parts required for a given order, and the shop number for which the parts are needed. At the extreme right is shown the number of parts being carried over all present requirements, which is the "Surplus."

Fig. 11 shows the back of this card. On this side of the card are recorded all shortages of spoiled and defective parts, and number of parts required to fill all repair orders. This record, showing the amount spoiled or defective and the lot number on which the shortage occurred, is referred to when determining the amounts to be run on future lots. In this way some of the small lots that would otherwise have to be run to complete the amount required are eliminated.

Rejected and Corrected Work Notice

If, after any operation, it is found that the part must be thrown out, the inspector makes an entry on the shop ticket, Fig. 4, and then makes out a "Rejected Work" slip, Fig. 9,

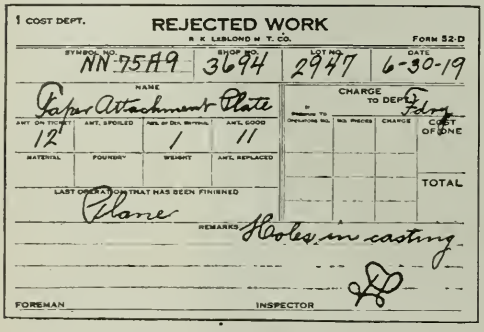


Fig. 9. "Rejected Work" Slip

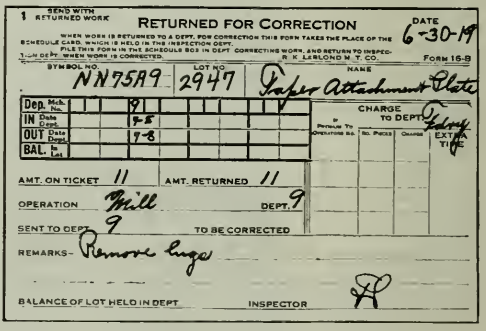


Fig. 10. "Returned for Correction" Slip

of which there are three copies of different colors—one gray, one yellow, and one pink. The gray copy passes to the cost department for its records. The yellow copy stays with the defective work, and the pink copy goes to the planning department, where it is kept and the information obtained from it entered on the form shown in Fig. 11, where all shortages are entered. In case the shortage reports relate to defective castings, the planning department copy is turned over to the casting order department where the nature of the defects is taken up with the foundry and an effort is made to determine the cause of the trouble, and eliminate it.

Fig. 10 shows a form of which four copies are made in different colors—two gray (one printed with black and one with red ink), one yellow, and one green copy. This form is used when a part is returned for correction. One copy is sent with the returned work, one copy stays in the inspection department, one goes to the cost department, and one to the planning department, so that the latter may have a complete record of the state of the work in the shop at all times.



Fig. 11. Back of Balance Card shown in Fig. 8, on which is recorded Shortages of Parts

Scheduling Work through the Shop

The actual purpose of the planning or manufacturing control department

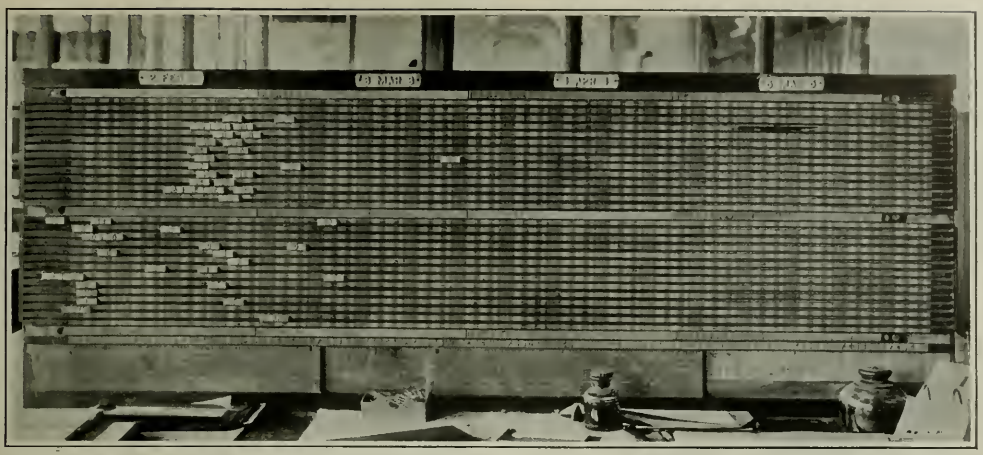


Fig. 12. Calculating Calendar used in determining Time Required for Each Operation so that Work will be started in Time to be completed on a Given Date

is to schedule the work through the shop so that every unit may be completed at a given time, and to see that the performance required by the scheduling is lived up to. In order to determine the actual time required for each operation, and to start the work in time so that it may be ready on a given date, the calculating calendar and slide-rule are used, as shown in Fig. 12. This calendar is so arranged that it covers a number of months, subdivided into weeks, and has a space for each date in the month. Sundays and holidays are also marked in such a manner that they are easily distinguished. Sliding pieces are employed, carrying the department numbers. A slide-rule at the bottom is provided which makes it possible to rapidly determine the date when a job should be started in order to be finished on a given date, when the number of full working days for its completion are known. In order to schedule the work through the shop, allowing the required time for each department, the time record card, Fig. 13, is used, as this gives the number of minutes actually required to perform the work on one piece, and also, for convenience, the number of days necessary to complete a lot of twenty-five, fifty, or one hundred pieces, as the case may be.

In addition to the machining time, one or two days for each department are allowed, and in this way the total time required for passing the part through the shop is easily determined. The slide-rule at the bottom of the calculating calendar, Fig. 12, is then used as previously explained for setting the date when the work must be started through the shop in order to be completed in a given time, and the sliding pieces on the calculating calendar itself are employed for determining the exact date when the work should pass from department to department, as obtained from the data on the time record card. The result obtained from the slide-rule for determining the exact date when the work should pass from each department to the next is then recorded in the space provided on the schedule card, as shown in the illustration Fig. 7.

Schedule Card

The schedule card, Fig. 7, is arranged to show the time allowed to complete the operations in each department, so that the parts for each lot will reach the assembling floor at the proper time. Owing to the fact that each schedule card is dated back from the finishing date of the unit of which it is a part, and to the fact that different groups of units have different finishing dates, it is possible to keep the jobs in each department well scattered as to their schedule requirements. Since the schedule cards are filed in the "department control board" according to the dates when the jobs are due in the department, the relation of one job to another is brought out graphically, showing at a glance which jobs are one or two days or two weeks behind, or four, five or six days ahead of schedule, no matter how great the variety of parts in the department may be, for different units of varying assembling dates.

As the schedule card moves with the job from department to department, the actual dates on which it is traveling are stamped opposite the specified dates, as shown in Fig. 7, under Department No. 10. This arrangement does away with misunderstandings and assures every foreman a square deal. The schedule card carries the same symbol number, name, lot number and shop number as the shop ticket.

Actual Record of Time Required in the Shop

The work may not pass through the shop according to the schedule determined upon by the planning department, and therefore a record of the actual results obtained in the shop must be kept. This record is maintained by a Rand visible file, which shows immediately on what dates the jobs entered the last department, whether in the morning or afternoon, and the balance of operations still to be completed to finish the lot, and also shows graphically the relative progress of all parts required to complete the unit. In addition, it shows if any

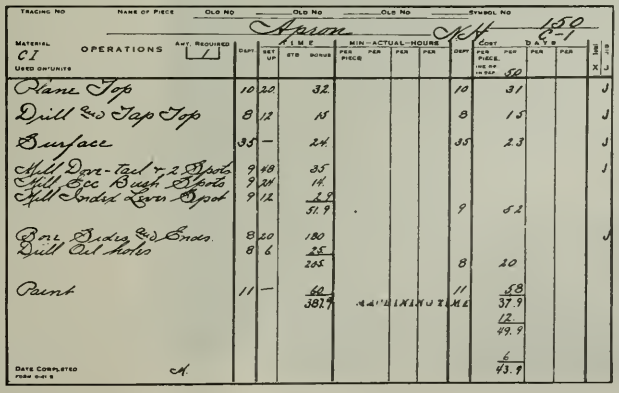


Fig. 13. Time Record Card on which Required Time for Each Operation is recorded

of the parts are lagging behind schedule. When a job is returned for correction, the green copy, Fig. 10, comes to the planning department, as already mentioned. This card is put into the Rand file and is a constant reminder that the lot is being delayed and probably will require special attention to keep it up to schedule. As soon as the correction is made, the copy which followed the work is sent to the planning department, and the green copy is removed from the visible file. In this way all jobs are "worked" through the shop according to the relative requirements as given on the schedule.

* * *

MILLING RACK TEETH ON MULTIPLE-SPINDLE MILLING MACHINE

On the measuring type of gasoline pumps manufactured by S. F. Bowser & Co., Inc., Fort Wayne, Ind., a great many cold-rolled steel racks are required, which are of the form and dimensions shown in Fig. 1. In order to provide for the economical manufacture of these pieces, it was decided to make use of a planer type milling machine built by the Ingersoll Milling Machine Co., Rockford, Ill., as shown in Fig. 2, equipped with a gang of rotary gear-cutters on the arbor, the number of cutters used being equal to the number of teeth which have to be milled in the racks. Through the use of this equipment it is possible to obtain a very satisfactory rate of production because there are three separate work-holding fixtures mounted on the milling machine table, each of which holds twenty-eight racks, making a total of eighty-four racks completed at each traverse. From Fig. 2 it will be seen that the racks are clamped into these fixtures by means of set-screws at the end and steel hold-down straps over the tops of the racks between the ends and the point where the teeth begin. At the points where clamping bolts for these hold-down straps are located, it was found necessary to put bars of steel across the fixture in a direction parallel to the racks. During the first operation of the fixture the gear-cutters milled teeth through these bars to match the teeth in the racks. It will, of course, be apparent that the cross-bars are necessary to provide a bearing for the clamping bolts that secure the hold-down straps in place.

In order to obtain smooth operation, the gear-cutters are mounted on the arbor with the teeth staggered. This avoids the shock which would be produced if all the gashes and all the teeth of cutters along the arbor were in a straight line. The cutters are 6 inches in diameter and revolve at a rate

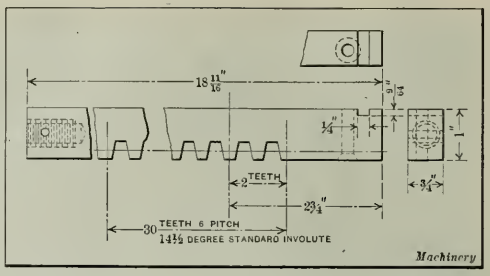


Fig. 1. Steel Rack with Thirty Teeth which are cut simultaneously on a Milling Machine equipped with a Multiple Gear-cutter

of 30 revolutions per minute, which corresponds to a cutting speed of approximately 48 feet per minute. The work is fed to the cutters at a rate of 1 inch per minute so that it only takes approximately two minutes to cut the teeth in each rack, allowing for setting up the machine and reloading the fixture. In other words, the rate of production is approximately 30 racks per hour. In addition to the gear-cutters mounted on the arbor, an auxiliary head is provided on the machine which carries the milling cutter for use in machining the small slot, 9/64 by 1/4 inch in size, on the under side of the racks. The possibility of doing this at the same time that the teeth are cut saves a second setting of the work. A copious supply of soluble oil cutting compound is delivered to the cutters and work, to serve the double purpose of preventing heating and washing away chips. Owing to a tendency for the racks to spring out of line during the milling operation, it is necessary to straighten them under a press before they are ready for assembling. This requires about five minutes for each rack.

The method of operating this machine for the performance of rack-cutting operations will doubtless prove of interest. It is the practice for the operator to load the fixture nearest the cutters, after which the machine is started. Owing to the slow rate of feed, which is only 1 inch per minute, plenty of time is available for loading the second and third fixtures before they have reached the milling cutters. After the third fixture has been loaded, the first fixture will have passed under the milling cutters so that the operator can begin unloading the finished racks at this point. Then, when the milling of the racks held in the third fixture has been completed, the table is returned by the quick traverse movement ready to prepare for the next cut. The next step is to load blanks into the first fixture, and after this has been done the feed movement of the table is engaged to start cutting teeth in these racks. Then the operator can proceed with removing the finished racks and substituting fresh blanks in the second and third fixtures in the order named. While this is being done, the machine is cutting the racks held in the first fixture, so that there is very little time lost by the machine while the operator is setting up work in the fixtures. It will be obvious that this method enables the work to be done with great rapidity as compared with other common methods of rack cutting.

E. K. H.

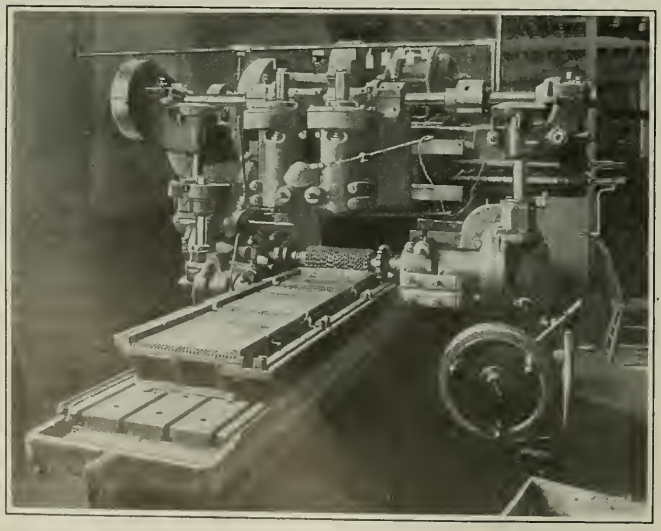


Fig. 2. Multiple-spindle Milling Machine equipped for cutting Teeth of Rack shown in Fig. 1

* * *

The United States Shipping Board has relinquished all control over ocean freight rates, the rate control now being vested in the ship owners. The principal shipping lines affected will be those operating between North and South American ports and the Mediterranean.

Cylinder Patterns

By Joseph A. Shelly



First of Two Articles Describing Methods of Laying Out and Constructing Patterns and Core-boxes for Pump Cylinders

STEAM cylinders such as are used in pump work are of three general styles: (1) The single cylinder with a foot cast as an integral part or with a pad to bolt a foot against; (2) the single cylinder designed to bolt to a bed with the steam chest on the side; and (3) the duplex form in which two cylinders are cast en bloc.

The single cylinder pattern, Fig. 1, has a staved barrel, and the breast and foot are screwed from the inside. The only loose pieces are the projecting lugs on the breast face, which is cut away to receive them; these pieces are usually of hard wood and fastened with wire skewers. The breast is the first piece to be fitted. The pieces that compose it are dogged together, planed to the barrel circle, as at *A*, Fig. 2, and fitted to the drag side of the barrel, which is laid on a flat board, as at *B*. When both pieces are in place, the outline of the breast is laid out as at *C* and cut. The breast face, fitting piece, and exhaust boss are put in place, and the core-prints located as at *D*. When the cylinder is to be mounted on a bed, the parting must be the opposite way, as at *E*, and the foot on one side must be loose to pick in; on the breast side where the foot overhangs at each end, these pieces are also loose. In this type of cylinder, the breast is not central, and the steam ports must follow the contour of the barrel at the ends; the breast must also be curved to suit (see view *A*, Fig. 4) running from a point that is square with the parting at the breast face to a circle concentric with the barrel.

The duplex cylinder *B*, Fig. 4, is parted through the center, below the breast face and where the foot joins the barrel; it is molded in a three-part flask. The exhaust, instead of coming through a boss on the side, is brought through the end in the center, both cylinders exhausting through the same opening. A tail-print is used to carry the exhaust core. These cylinders may be either single- or double-ported which will not affect the arrangement of the core-prints for carrying the cores.

Steam-port Core-boxes

When the breast is central, it is customary to make only a half core for the ports, and in the case of small cylinders these are sometimes made a part of the body or bore core, as shown at *A*, Fig. 3. This makes a core that is fragile and hard to handle, so the general practice is to make the cores separate. In making this core-box, the lumber is dressed and the ports laid out. The main piece and the two side pieces are clamped to a battened bottom board, and the dowel-holes bored, as at *B*. After the ports are cut, the dowels are fitted and the pieces will then go back into their proper places. The ports of the casting are usually chipped on the sides and ends, 1/6 inch being the usual allowance, so this "chipping strip" must be provided for at the ends by fastening a thin piece to the bottom board between the openings. Where the ports abut against the body core it is necessary to fasten pieces to the side to make the round. The ports should be laid out from the center with a pair of dividers, as everything must be central if the two halves are to go together and match. It is usual to lay out the exhaust on this core-box, although the exhaust core is made in a separate core-box; a print, however, must be provided to center the exhaust core, and this is placed on the steam-port core-box.

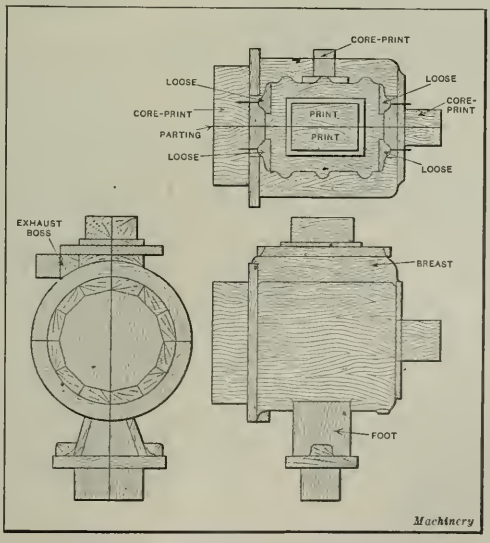


Fig. 1. Pattern for Steam Cylinder

On large cylinders, instead of the cores being together they are made separate to fit individual prints placed on the breast face and sometimes prints placed in the body core-boxes. Such boxes are made the full width of the port, as illustrated at *C*. Boxes for ports that are off center are also made full width, and where a section of the port must follow the cylinder they are built up as at *A*, Fig. 5; the pieces that form the outside of the core-box are made to correspond.

Another type of core-box used on very large work is made with two side pieces and a bottom to form one side of the core, as illustrated at *B*. A strickle is used to form the other side. This style of box can also be applied to cores that are off center by making a strickle to follow the straight part at one end and the curve at the other. Upright cylinders with the breast made as part of the cylinder head have a short port and a long port on opposite sides of the cylinder, running through projecting pieces placed on the sides and cutting through the flange on the ends; these cores are carried by prints on the ends of the pattern and others placed in the bore core-box.

Exhaust-port Core-boxes

Exhaust-port core-boxes, owing to their form, must either be whole boxes or, if in halves, they must be made right and left. The coremaker does not like small boxes of this type made whole, and is very likely to use them sep-

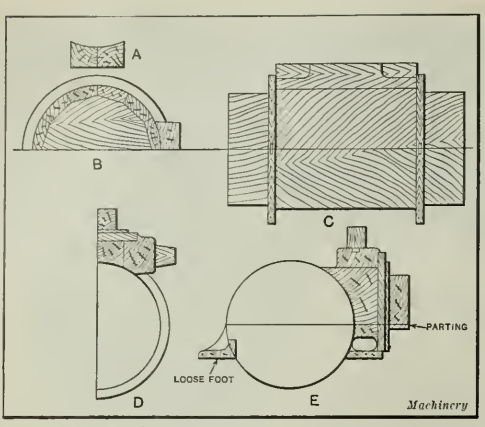


Fig. 2. Details of Pattern Work on Cylinder

arately and paste the two halves of the core together, but in making the boxes the patternmaker will obtain a better match if he dowels the pieces together even if the pins are afterward cut off and ends placed on the boxes. In the mold, the core is supported by the print on the boss and is centered by the print placed in the steam-port boxes.

To avoid making two boxes, a "double-ender" is sometimes made to stop off right and left, as illustrated in Fig. 6. The steam is introduced into some cylinders through an opening in the side that extends through a boss which is about on a line with the exhaust opening, but to the rear of it. The first opening mentioned cuts into a pocket cored in the breast face, the core being a part of the steam-port core. The core that makes the opening is separate and supported by a print on the boss.

Pump Cylinders

A pump cylinder *A*, Fig. 7, is considered a rather complicated piece of core work, and although the type shown is not as complicated as some others, it will serve to illustrate how this kind of pattern work is done. This is what is known as a "compact cylinder," both suction and discharge valve plates being cast as part of the cylinder. The suction opening is on the side and the discharge is through a separate cover bolted to the top. The opposite type to the compact type has separate suction and discharge valve plates and separate suction and discharge boxes. These cylinders are built on heads laid out and made as at *A*, Fig. 8, the curved ends being worked to form before the cylinder is staved; the two half-heads are doweled for this purpose. The heads are fastened to a straight board for staving, and if the cylinder is long, intermediate heads are put in to add stiffness. The barrel and the fillet and round corner that connect it with the side are worked to shape with hand planes, after the two halves are staved and doweled together, dogs being used to hold them. The plate that forms the top is fastened by screwing to the ends of the heads and when they are in place the pattern should be corner-blocked inside for further strengthening, and perhaps a bar fitted lengthwise for rapping and lifting purposes. This bar should be notched into the heads so that it will be about ⅛ inch below the joint face; it should be a stout piece, as it will receive some hard usage.

Facing pieces to form the projection of the flanges beyond the ends of the cylinder are next fastened in place; these may be turned, but are made more quickly on the band saw and are just as good. Leather fillets may be used. To produce the flange thickness, these facing pieces are backed up,

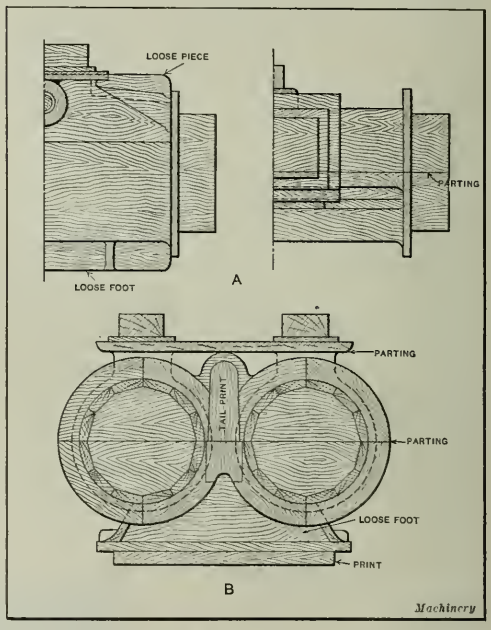


Fig. 4. Pattern for Duplex Cylinder

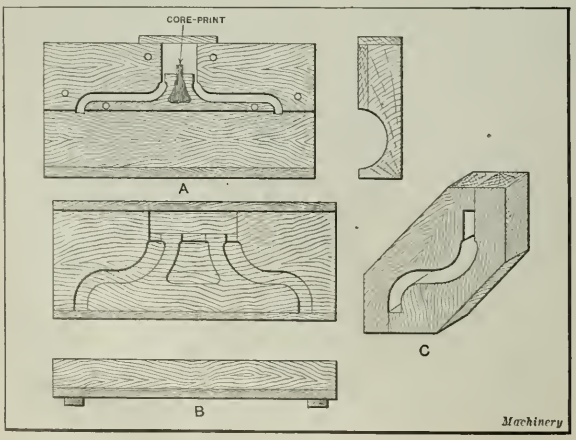


Fig. 3. Steam-port Core-boxes

as at *B*, Fig. 8. If the barrel is to be enlarged at the ends, as it sometimes is to form a chamber, the enlargements or "swells" should be fitted. The facing pieces on the top that come at the bottom of the drag and the top of the cope must be loose and may be arranged to dovetail into the pieces at the ends, as shown at *C*. When the foot and suction boss have been fitted and fastened, leather fillets are applied and the corners rounded, after which the pattern is sandpapered and given a coat of shellac. There should be a core-print on the foot, a print at each end to carry the bore core, one on the suction hub or boss, and four prints on the top face to help carry the cores that form the discharge chamber, as shown at *D*. These prints on the top face correspond to the valve seat openings; the cores for forming the other openings are just long enough to cut through the metal.

Pump Cylinder Core-boxes

The chambers in a pump cylinder are connected by passages or ports or by circular openings into

which the valve seats are screwed unless it is the type of pump with separate valve plates, in which case the coring problems are greatly simplified. There are many different arrangements of valve plates and the location of the suction opening also varies. A typical lay-out for a piston pump is shown in Fig. 7. The suction is on the side of the cylinder, or is sometimes made lower down and brought through the part of the casting that forms the foot, and the water is drawn into the suction chamber through the suction valves into the cylinder and forced out through the discharge valves at the top.

Fig. 9 shows another arrangement of cores in which the suction is under the cylinder and enters at the end, the suction valves being at the bottom. This cylinder is for a plunger pump, the plunger working in a sleeve fitted into the opening in the central partition. This arrangement of the suction is also applied

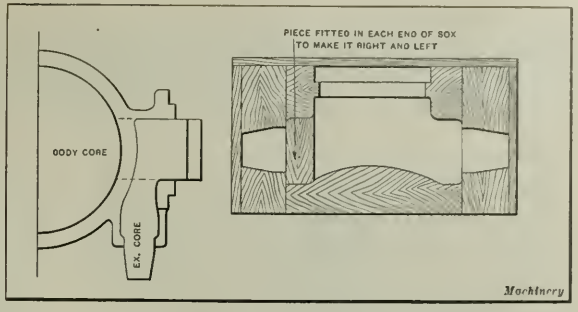


Fig. 6. One Form of Exhaust Core-box

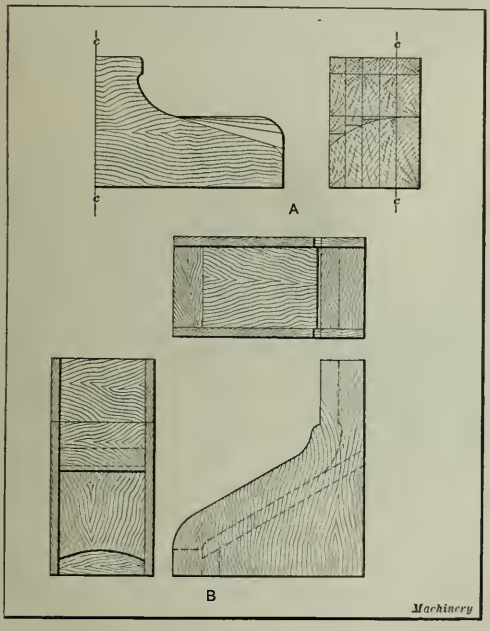


Fig. 5. Details of Steam-port Core-box Construction

to some piston pumps. The cylinder in this case is round at the end and opens into a square or rectangular chamber in which the valves are placed.

These different chambers are formed by separate cores as far as is possible to simplify the work. In Fig. 7, the core for the suction opening and chamber is made in one core-box and the core for the ports and chamber under the discharge plate is made in another core-box. The ends of the ports in the core-box are made circular to fit the bore core against which the port cores abut. The valve plate openings are made with separate cores set in core-prints placed in the boxes; these prints are usually made ½ inch thick, and where possible they are set opposite one another in adjoining chambers so that the small core will have a seating in both of the larger bodies of sand as at *B*; this arrangement, however, will often interfere with the setting of the cores as a whole, so each core will have to be set in one of the larger cores and abut against the other as at *C*. Another arrangement to insure an even thickness of plate is to make the prints smaller than the openings and the core shouldered, as at *D*. In arranging for cores of this kind it must be borne in mind that they are to be pasted in the print and will have to be made about 1/16 inch thinner than the lay-out to allow for this.

The bore core for the cylinder shown in Fig. 7 is straight, but this is not always the case, as the ends are frequently enlarged to form a counterbore where the ports cut in, as at *C*, Fig. 10. When a removable lining is to be used, this chamber at the rear end is larger than at the front and a facing must be made for the flange of the lining to fit against. The core for such a cylinder is shown at *D*. These enlargements are made on the bore core, and the ends of the port cores must be made to fit against them; the box is usually made to fit the smaller end and strickled down to fit the larger so that there will be no trouble in changing the box right and left.

The suction core-box *A*, Fig. 10, is made on a bottom board to which the valve seat prints are fastened and the frame is doweled. The frame of the box is fastened at the corners except on the side where the suction opening comes; here it parts at the center to release that part of the core. In making the box for the ports and the discharge, the valve seat prints are fastened to a board that is fitted to the box so that it will slip out with the core, but two of these openings at the joint are cut out to match the prints placed on the pattern. This box makes two cores—one right and one left—and they must be fastened together to make a whole core; it is on the circular ends of this box that the strickles are used to make the ports fit the projections on the bore core. This core is sometimes made in a box that forms a complete core, the side marked *X* (view *B*, Fig. 10) being made the bottom of the box; this is not as convenient as the

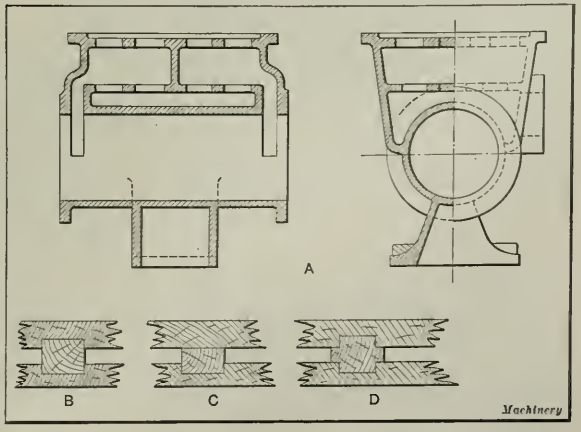


Fig. 7. Pattern for Pump Cylinder

method previously described, nor does it lend itself well to alterations. The most common alteration is the placing of hand-hole openings at the ends, and these are cut out of the ends of the box. If ribs are required in the ports to connect them with the walls of the suction chamber to prevent the ends of the cylinder from pulsating when the pump is running, they are made to draw through the ends, being fitted to openings cut for this purpose and being checked into the other side of the port.

The main core-box for the type of cylinder shown in Fig. 9 is made with the joint on the line *cc*. The ends are half round and the center portion square or rectangular. The box is made to the dimensions of the deepest side, measuring from the top, and loose blocks are fitted to the bottom to form the more shallow half. Core-prints are fastened to the bottom as well as to the loose pieces to carry the valve seat cores.

In handling work of this kind, where a number of cores are put together to form an interior, the work should be

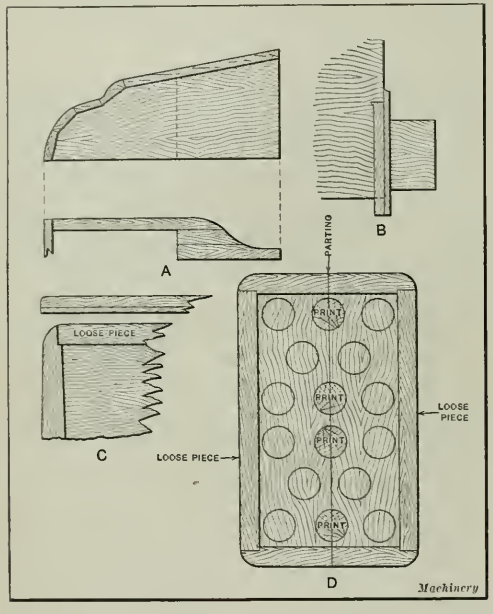


Fig. 8. Details of Pump Cylinder Pattern

carefully laid out and the boxes just as carefully made; otherwise the total dimensions of the cores may be too small or too great. It is essential that the valve seat openings come directly over each other and it is the practice to leave $\frac{3}{8}$ inch finish on these holes so that they will be sure to machine in line with each other.

The second and concluding article on cylinder patterns will describe methods of constructing patterns for vacuum pumps, jacketed cylinders, and cylinder heads, feet, and discharge covers.

* * *

The *United States Federal Reserve Bulletin* calls attention to the effect of the huge "favorable" balance of trade in raising prices. As the financing of foreign trade is an investment rather than a banking proposition, it is suggested that the domestic consumer, when asked to finance export trade, should remember that the outstanding effect of such financing upon too great a scale would necessarily cause an increase in the prices which he himself must pay for the things he needs.

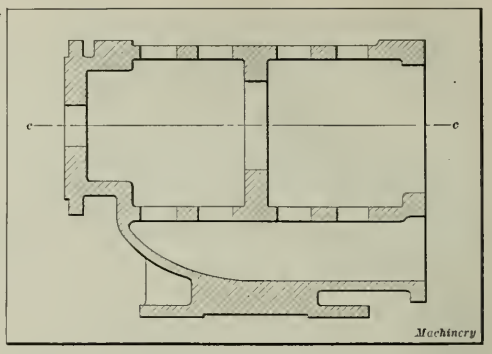


Fig. 9. Another Type of Pump Cylinder

WORLD'S IRON AND STEEL OUTPUT

The *Economist* (London, England) for May 31, 1919, published the following figures of the iron and steel output of the principal producing countries of the world, which had been furnished to it by the National Federation of Iron and Steel Manufacturers.

Year	United Kingdom	United States	Germany*	France
Pig Iron	Long tons	Long tons	Metric tons	Metric tons
1900	8,960,000	13,789,000	8,521,000	2,714,000
1905	9,608,000	22,992,000	10,988,000	3,077,000
1910	10,012,000	27,304,000	14,793,000	4,032,000
1911	9,526,000	23,650,000	15,534,000	4,426,000
1912	8,751,000	29,727,000	17,753,000	4,939,000
1913	10,260,000	30,966,000	19,292,000	5,207,000
1914	8,924,000	23,332,000	14,392,000	†
1915	8,794,000	29,916,000	11,790,000	†
1916	9,048,000	39,435,000	13,285,000	1,447,000
1917	9,420,000	38,621,000	13,142,000	1,684,000
1918	9,066,000	39,052,000	11,590,000*	1,297,000
Steel				
1900	4,901,000	10,188,000	6,646,000	1,565,000
1905	5,812,000	20,024,000	10,067,000	2,240,000
1910	6,374,000	26,095,000	13,699,000	3,390,000
1911	6,462,000	23,676,000	15,019,000	3,681,000
1912	6,796,000	31,251,000	17,302,000	4,428,000
1913	7,664,000	31,301,000	18,959,000	4,687,000
1914	7,885,000	23,513,000	14,973,000	†
1915	8,550,000‡	32,151,000	13,258,000	†
1916	9,196,000‡	42,774,000	16,183,000	1,952,000
1917	9,804,000‡	45,061,000	16,587,000	2,232,000
1918	9,591,000‡	45,073,000	14,874,000*	1,912,000

*Including Luxemburg up to October, 1918. The returns for November and December, 1918, do not include the production of Luxemburg, Saar district, and the disannexed Lorraine Province.
†No returns. ‡Including steel castings.

* * *

The first public exhibition of gages on record was at the Centennial Exposition in Philadelphia in 1876, where standard plug and ring gages, micrometers and measuring machines were shown.

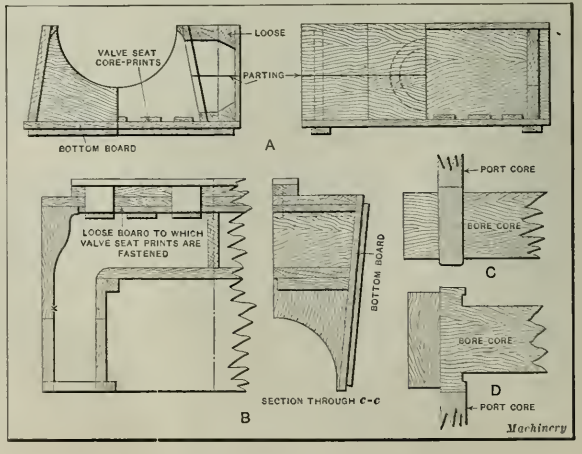


Fig. 10. Pump Cylinder Core-box Construction

LETTERS ON PRACTICAL SUBJECTS

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Fig. 1. Clamp with Holder and Special Grooved Jaw removed

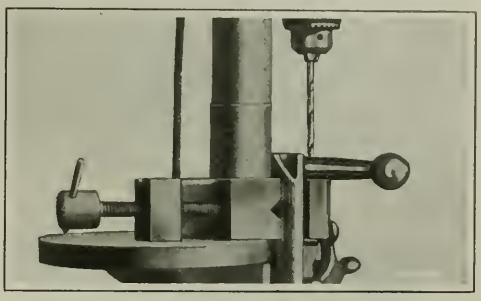


Fig. 2. Clamp used for holding Rifle Bolt while drilling

A TOOLMAKER'S CLAMP

The clamp which is illustrated and described in this article was designed by the writer for the purpose of handling work of various shapes and under various conditions. It has proved of great value and will doubtless be found of use in any tool-room or experimental room. The device may be securely held to the bench by a special bench clamp which is shown at *F*, Fig. 1; in this illustration the clamp is slid entirely out of the holder *A* and the special grooved jaw *E* is removed. This jaw has 90-degree horizontal and vertical grooves milled in both faces and is reversible for the purpose of allowing either a wide or a narrow groove to be used. This feature permits a wide range of cylindrical work to be held in the clamp and makes the use of a separate V-block unnecessary. The clamp proper *D* may be slid in the holder to any desired position and may be located anywhere on the bench, or overhanging it, if required (see Fig. 3).

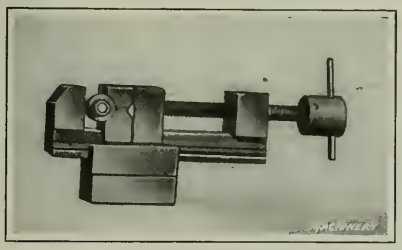


Fig. 3. Holder with Clamp in Place, showing Grooved Jaw for clamping Cylindrical Work

It is obvious that the clamp may be used with or without the holder or the grooved jaw, in which case it becomes simply a plain clamp. Work may be laid out in this clamp while it is fastened to the bench and may then be removed to the drilling machine, surface grinder, or other machine without disturbing its position in any way. The clamp, when removed from its holder, may be used on any side as shown in Fig. 2, where one of the many uses of the clamp is presented. In this case it is holding the bolt of a Springfield rifle in a difficult position for drilling, the clamp, as will be noted, resting upon its side and holding the cylindrical work in a true vertical position.

The construction of the jaws *B* and *E*, Fig. 1, with lugs extending over the side of the body of the clamp, is a feature which enables the jaw to be guided squarely and prevents any side motion. The construction of the holder and clamp is shown in detail in Fig. 4 in which the same reference letters that are used in connection with Fig. 1 are employed. With the aid of this illustration, no extensive description should be necessary to enable the reader to construct the device. The sizes used in making the clamp

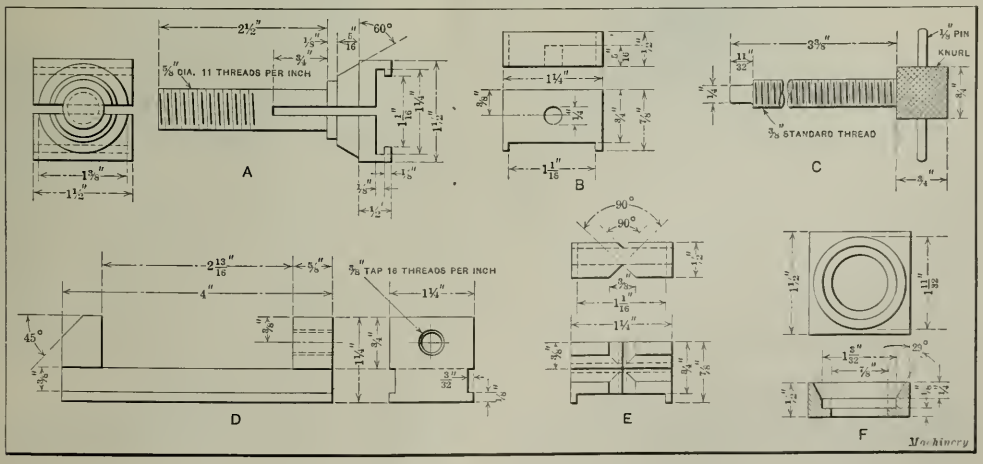


Fig. 4. Detailed Construction of Toolmaker's Clamp and Holder

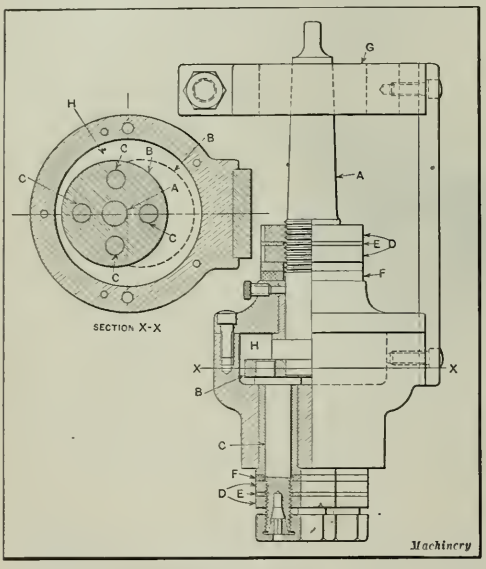
should be governed by the material and conditions at hand, and should be in about the proportion shown in Fig. 4; however, if the given dimensions are followed exactly, the resulting clamp will be found a convenient size for a wide range of work.

The clamp is gripped firmly in its holder by a slight turn of a wing-nut, which is threaded to the end of holder *A* on the under side of the bench, and when this is loosened, the clamp may be slid forward or backward, swung to any angle in the horizontal plane, or removed entirely without difficulty. The pivot-pointed operating screw *C* should be a good fit in the head of the clamp, and its turned down end should also be a good fit in the hole in the rear jaw *B*. This will prevent the jaw from having any tendency to lift while in use. In cases where it is necessary to hold such work as light tubing, an additional grooved jaw may be used, giving four bearing points instead of three.

Rochester, N. Y. HENRY B. GRAVES, JR.

FOUR-SPINDLE DRILLING ATTACHMENT

The illustration shows a half-sectional side elevation and a sectional plan view of a drilling attachment having four spindles that are driven in an unusual manner. The projection on the lower end of the main spindle *A* is located eccentrically in relation to the spindle, and is inserted in the



Drilling Device in which Four Spindles are driven without the Use of Gears

center of the circular plate *B*. The four spindles are constructed similarly to spindle *C*, as shown in the side elevation having projections on their upper ends which are located eccentrically in relation to the respective spindles, these projections also being inserted in the plate *B*. As spindle *A* makes a complete revolution it transmits an eccentric movement to plate *B* by means of the projection on its lower end, which causes each of the four spindles *C* to make one complete revolution, the projections on the spindles acting as cranks. The dotted circle in the sectional plan view shows plate *B* after spindle *A* has made half a revolution.

This design is more economical than the usual practice of using gears for this purpose, and it permits holes to be drilled close together. All the spindles and plate *B* are made of steel and hardened. The main spindle *A* and the four spindles *C* are adjustable vertically by means of nuts *D*, which are prevented from loosening by tongued washers *E*. The washers *F* are made of fiber as a means of reducing friction, and the spindle bushings are of phosphor-bronze. The space *H* is always filled with grease. The attachment is secured to the drilling machine by means of bracket *G*.

Detroit, Mich. W. L. BARKLEY

DIES FOR DRAWING A DIFFICULT SHAPE

In the following are described the various dies used in the manufacture of a steel shell of unusual shape, which requires the use of five sets of drawing and forming tools. The accompanying illustrations show the dies and the shell as it appears after each successive operation. The metal used in making the shell is cold-rolled strip steel, 0.035 inch thick, and the blank is 5 13/16 inches in diameter. All parts of the dies are hardened and ground. It will be noted that corresponding parts of the different dies have the same reference letters throughout the description. The functions of the various parts of the die shown in Fig. 1 will be described, but only those features of the other dies that are radically different will be mentioned.

A combination die is shown in Fig. 1, which cuts the blank and draws it to the shape shown. This is a standard type of die and is designed for use on a press having the ordinary rubber buffer attachment and plate for pins *P*. The form-

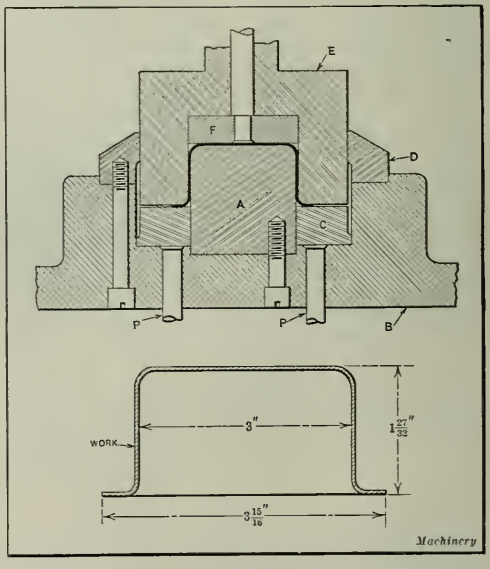


Fig. 1. Die that cuts the Blank and performs the First Drawing Operation

ing die *A* is secured to the cast-iron die-block *B* by three small screws and is recessed into the die-block to insure concentricity with the remaining die parts. The drawing ring *C* is the part upon which the flange of the shell is formed. The steel blank is laid upon the cutting ring *D*, and as the punch *E* descends past the cutting edge of ring *D*, the blank is cut to the required size; as the punch continues to descend, the shell is drawn to the shape that is shown. The knock-out pad *F* ejects the shell from the punch on the return stroke of the press. The faces of the punch and of the drawing ring between which the flange of the shell is held, are ground parallel, which enables the shell to be seated evenly on the drawing ring.

The die shown in Fig. 2 is used to reshape the shell as indicated in the illustration. The drawing ring *C* is made so that it fits the inside of the shell, and the end is rounded, which permits the metal to be readily reshaped; also, the

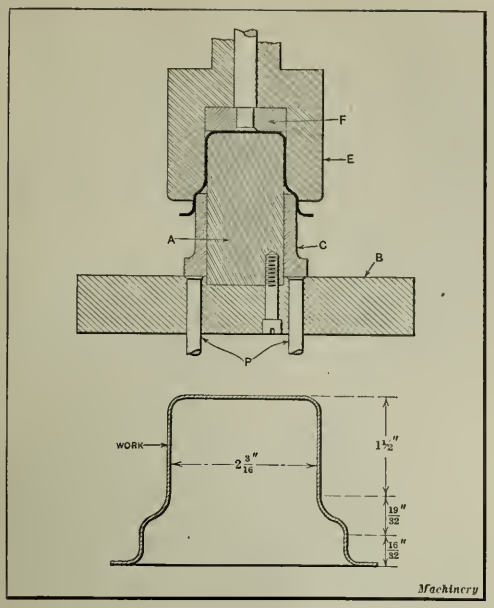


Fig. 2. Die used in reshaping the Shell

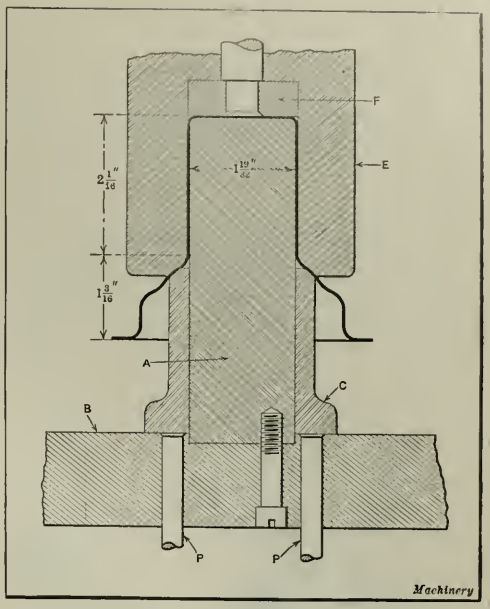


Fig. 3. Die used for Next Step in reshaping

end of the opening in the punch *E* is correspondingly shaped for the same purpose. Fig. 3 shows a die that is also employed to reshape the shell by reducing the small end, the construction being similar to that of the die shown in Fig. 2.

The die used for redrawing the small end of the shell, and for forming the flared part as well as the larger diameter, is illustrated in Fig. 4. The drawing ring *C* serves a double purpose: First, by reason of its being raised to a certain height by means of springs, it acts as a gage for locating the shell in the die *A*, previous to the forming operation; and second, after being pushed down against the top surface of the die by the action of the press, it serves as a die in which the large diameter of the shell is formed. It will be noticed that in this operation, the flange on the shell is flattened out between the ring *C* and the punch *E*, thus preparing the shell for the final operation on this end.

The die that completes the work on the shell is shown in Fig. 5. Both the forming die *A* and the cutting ring *D* fit into recesses in the die-block *B*. A small cutting die *G* is secured on the top ' die *A* as shown. In this operation, as

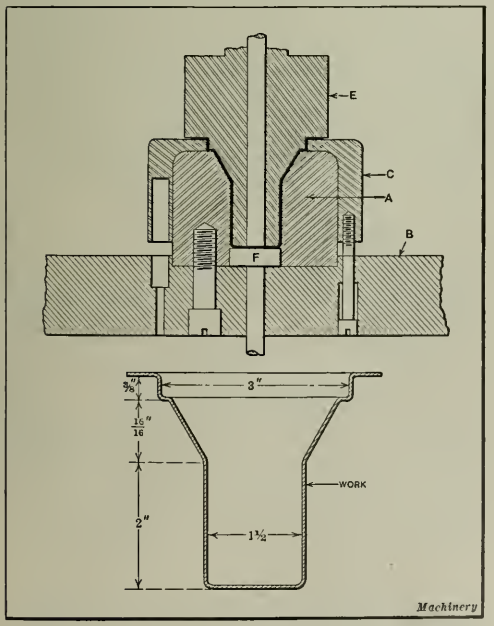


Fig. 4. Die that redraws the Small End of the Shell and forms the Flared End

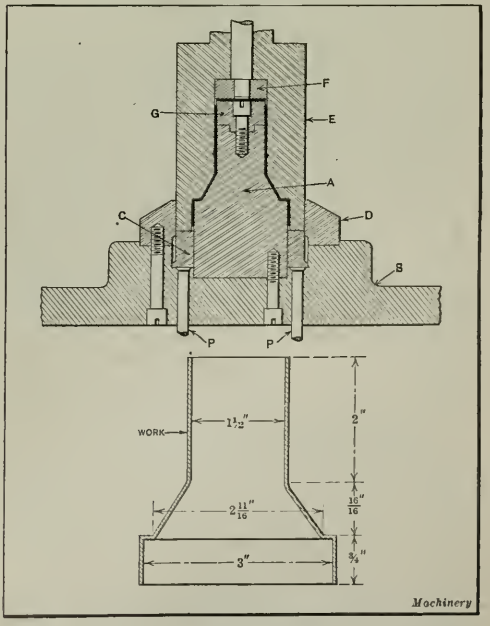


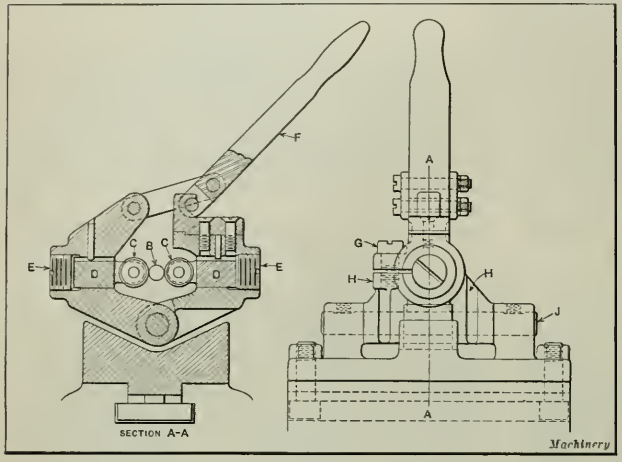
Fig. 5. Die that cuts out the End of the Shell and performs the Final Forming Operation

the face of punch *E* descends past the cutting edge on ring *D*, the flange of the shell is trimmed, and as the press completes its downward stroke, the shell is formed as shown and the bottom of the shell is pushed out by die *G*. This is possible because the cutting edge of die *G*, when the punch is in this position, extends 1/16 inch higher than the end of the long cylindrical part of the shell. The knock-out pad *F* forces the shell out of the punch on the upward stroke of the machine.

Toledo, Ohio J. BINGHAM

ADJUSTABLE KNURLING FIXTURE

The knurling attachment shown in the accompanying illustration is designed to be mounted on the cross-slide of a lathe, and can be set up and adjusted as quickly as the old-fashioned knurling tools which are clamped in the toolpost.



Knurling Device which may be adjusted for Several Sizes of Work

In this device, the work *B* comes between the knurls *C*, as may be clearly seen in the illustration. These knurls are secured in the holders *D*, which may be adjusted laterally by means of the plugs *E*. The holders are prevented from turning, through the provision of a pin-key which engages a keyway in each holder. The adjustment permits the knurling of work from ¼ to 1 inch in diameter. The knurls are forced against the work by means of lever *F* which produces a leverage of 8 to 1. One side of the swivel arms *H*, into which the adjusting plugs *E* are screwed, is slotted so as to permit the plugs to be clamped by means of the screw *G*. The swivel arms *H* are pivoted on shaft *J*, which permits the knurls to adjust themselves to the surface to be knurled, even if the work is not concentric with the lathe center. By the use of this device four times as much work has been accomplished as with the old method in the same amount of time, and the work is more uniform.

Lowell, Mass. RICHARD A. DAMON

SHOP-TRAINED MEN VERSUS COLLEGE MEN AS SHOP EXECUTIVES

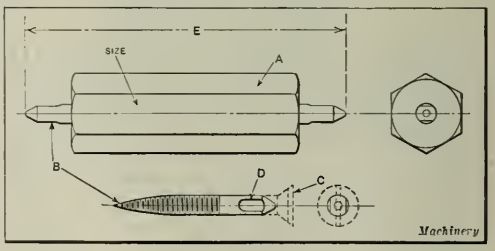
In the article entitled "Promoting Cooperation between Employer and Employe" which appeared in the July number of MACHINERY, it was stated that it is lately becoming more and more the general practice to give the higher positions of a concern to college graduates. The reason why college graduates are chosen for the higher positions instead of shop-trained men, is a matter of great concern to many men who have not had the advantage of a higher education but who could easily fill the same position because they have had years of shop experience. It has been proved innumerable times that the man who advances, step by step, from the bottom makes the best executive. He understands that which he directs others to do, knows what men are worth and how to handle them, and is often capable of settling disputes that would otherwise result in friction or costly strikes. Another reason why a shop-trained man makes the best executive is because a workman dislikes to take orders from a superior whom he knows could not actually do the work himself, but he has respect for a superior whom he knows to be competent of doing any job in the shop. For this reason, practically trained executives get more work out of the employes with less friction.

It generally takes several years to teach a college man the practical side of a business, whereas the practically trained man, provided he has the proper executive ability, is in an excellent position to assume the authority of directing men. As a matter of fact, not all college men possess the proper executive ability necessary to manage a shop; and no amount of college training will fit one man to direct another. Executive ability is born in a man, and is seldom acquired. College-trained men are, of course, necessary in many positions, but it is impossible to run any manufacturing business with only college men for executives. If no opportunities are offered to the practically trained men, they often seek positions in other fields where there are better chances for advancement.

FRED PRICE

LENGTH GAGE

An inexpensive length gage which is not elaborate but will meet the requirements as regards accuracy, may be made by using a piece of wood for a handle and two wood-screws for gaging points. Such a gage is shown in the illustration, and is especially adapted for use on large work such as locomotives, large dies, etc. The handle, or body *A*, should preferably be made of soft wood and of hexagon shape, so as to prevent the gage from rolling, as well as to provide a convenient surface for identification or size markings. The wood-screw gaging points *B* are screwed into the ends of the handle and the heads *C* cut off, after which the body of the screws is pointed and the sides flattened as shown at *D*. This flattening is to permit adjustment by means of a wrench, if required, to sizes established by micrometers or by other means. The length *E* to which the gage may be adjusted, is limited by the length of the wood-screws, a number of which may



Length Gage comprising a Wooden Handle and Two Wood-screws

be easily carried in any tool-kit. The gage will withstand much handling, because of its simple construction.

North Troy, N. Y. D. R. GALLAGHER

* * *

The United States Training Service of the Department of Labor reports that, because of inadequate training, the output of seven million out of the ten million workers engaged in manufacturing is 50 per cent less than it should be.

Conditions in the Machine Tool Trade

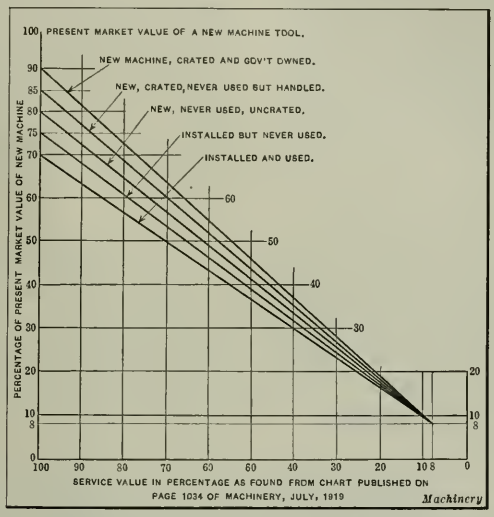
MACHINE tool dealers report a very decided improvement in business. As an indication of this it may be mentioned that deliveries are now quoted way ahead in the future in many instances, and that several machine tool builders have raised prices, in some cases due to the fact that the increases made during the war period were not sufficient to cover the increases in material, labor and taxes, and in other instances due to the fact that temporary cuts in prices had been made early this year with a view to stimulating trade; but it was found that these reductions in prices were more than warranted by the conditions, and a return to former prices had to be made. It is no longer the automobile business alone that is in the market for machine tools, but there is an indication of a general industrial revival, and the only sign of apprehension at the present time is the uncertainty of the attitude of labor, caused very largely by the still increasing cost of living. It is to be hoped that the efforts made by the Government to curb the rise in living costs will aid in stabilizing labor conditions.

Exports of Metal-working Machinery

The monthly report on exports of metal-working machinery from the United States during the month of June has just been published by the Department of Commerce, Washington, D. C. According to this report the total exports of metal-working machinery were valued at $8,606,565, of which $3,444,079 represented the value of machine tools. Among machine tools, lathes represented the largest single item or $1,712,899. Belgium imported machine tools from the United States for over $500,000 and other metal-working machinery for nearly the same amount. France took machine tools for over $700,000 and other metal-working machinery for over $1,300,000. England imported machine tools to a value of about $900,000 and other metal-working machinery to a value of nearly $1,000,000, while Japan imported machine tools to a value of about $275,000 and other metal-working machinery to a value of nearly $500,000. In all cases lathes represented a very substantial part of the exports or about $375,000 to Belgium, $250,000 to France, $450,000 to England, and $160,000 to Japan. The Italian imports of machine tools amounted to less than $150,000 and of other metal-working machinery to about $60,000, these comparatively low figures being due to the restrictions on imports imposed by the Italian Government. It is interesting to note that the exports of machine tools to the South American countries are increasing. Chile imported lathes for over $86,000, and other metal-working machinery to a value of nearly $130,000; Argentina imported metal-working machinery for over $80,000, and Cuba for $65,000.

Government Price-fixing Chart for Determining the Selling Price of Standard Machine Tools

The Machine Tool Section of the office of the Director of Sales, P. S. & T., General Staff, War Department, Washington, D. C., now headed by V. C. Kylberg as acting chief, since Charles E. Hildreth resigned from the office of chief of the section, has devised methods for appraising and fixing the selling price of government-owned machine tools. The work of appraisal has been materially simplified by the separation of what is known as "service value" of a machine tool (the methods for determining which were shown on pages 1034-1035 of the July number of MACHINERY) and the "money value" that must be obtained in sales. The latter value is determined by the graphical chart shown in the accompanying illustration. This chart is the result of the analysis of much technical data on appraising, and a series of conferences with the representatives of the various bureaus, faculties of technical schools, prominent industrial engineers, and the War Readjustment Committee of the American Society of Mechanical Engineers, and the entire plan has met with the combined approval of these various bodies. The method of using the chart may be briefly described as follows:



Government Price-fixing Chart for Standard Machine Tools

1. Ascertain the present market price of a new machine tool of the same size and make and having the same equipment.

2. Obtain by the use of the chart shown on page 1034 of the July number of MACHINERY the condition of the tool in percentage.

3. Determine in regard to crating, installation, etc., which of the price lines in the accompanying chart is to be used.

4. Enter the chart on the base line with the condition-percentage, as ascertained by (2); then follow from the base line vertically to the price line, as ascertained by (3); and then follow from the point of intersection horizontally to the left margin, and read the price percentage.

5. Multiply this price percentage by the present market value of a similar new machine having the same equipment. The result will be the minimum selling price which may be accepted in selling a government surplus machine tool.

Example—The graphical appraisal chart illustrated on page 1034 of the July number of MACHINERY, shows that a "normally used" machine at the end of four years has a service value of 72 per cent. Enter the price chart herewith on the base line at 72 per cent, follow the vertical line to the price line which in this case is the line marked "Installed and Used," and from the point of intersection follow the horizontal line to the left margin, where it is found that the selling price is 51 per cent of the present market price. Assuming that the present market price of a similar machine is $2000, multiply $2000 by 0.51, which gives $1020 as the minimum selling price of the machine.

The principal advantages in making appraisals by a graphical chart and of the method used for determining the selling price, are as follows: The possibility of differences of opinion in appraising are minimized; the time and cost of making appraisals is reduced to a minimum; the simplicity of the method enables appraisals to be quickly and accurately

made; and the uniform method of appraisal for all standard types of machine tools in all government bureaus is made possible.

Restoration of Foreign Patent Rights

A formal statement relating to the interests of citizens of the United States as far as they relate to industrial property, has been issued by the State Department. According to this statement, the general system of industrial property rights as it existed before the war is restored by the peace treaty in cases where they were suspended by the war, except as noted below. American-owned industrial property rights in Germany and Austria which have become invalid by reason of failure to pay annual dues or taxes, or meet other formal requirements, may be revalidated. Failure to adequately "work" a patent in Germany or Austria during the war is waived as a cause of forfeiture of industrial property rights; and furthermore, the period in which foreign inventions need not be "worked" in Germany and the other signatory countries is extended to two years after the war. Americans who have been prevented by the war from patenting their inventions and registering their trademarks in Germany or other belligerent countries, may now do so. Measures taken during the war by the United States in licensing or liquidating German patents are recognized as valid and remain effective. Americans retain the right to sue for infringements committed during the war by Germany or German subjects; but the liability of the United States, or those acting for it, for infringements incident to the prosecution of the war, is waived by Germany for herself and her citizens.

The New French Tariff on Machine Tools

Since the removal of restrictions upon the importation of machine tools into France, referred to on page 1198 in the August number of MACHINERY, the import duties on machinery of this class have been increased 200 per cent as compared with the rates which applied before the war. The minimum present tariff rates are given in the accompanying table, and these rates apply equally to machine tools from the United States and from the United Kingdom.

TARIFF DUTIES ON MACHINE TOOLS IMPORTED INTO FRANCE

Weight of Machine Tool	Duty per 100 Kilograms, Francs	Duty per 100 Pounds, Dollars[1]
More than 25,000 kilograms (55,000 pounds)	30.50	1.70
From 5000 to 25,000 kilograms (11,000 to 55,000 pounds)	36.00	2.01
From 1000 to 5000 kilograms (2200 to 11,000 pounds)	48.00	2.68
From 250 to 1000 kilograms (550 to 2200 pounds)	72.00	4.01
250 kilograms or less (550 pounds or less)	150.00	8.36

Machinery

[1]Based on exchange rate of 8.15, August 22, 1919

Most machinery not classified as "machine tools" is dutiable under another item of the French customs tariff which comprises all complete apparatus not otherwise specified. The rate under the general tariff applicable to imports from the United States is now 40.50 francs per 100 kilograms, or $2.26 per 100 pounds, while the rate of the minimum tariff applying to imports from the United Kingdom and certain other countries is 37 francs per 100 kilograms, or $2.06 per 100 pounds, the exchange rate on August 22, which was 8.15, being used as a basis for these calculations. The new rates on machinery not classified as "machine tools" involve an increase of 170 per cent over the former rates; and the increase in the duty on small hand tools (presumably also including what we ordinarily term "small tools") is 170 per cent. The form in which these increases are expressed in the new law is by means of coefficients, by which the former duties are multiplied. For example, the coefficient for machine tools is 3, while that for complete apparatus not specified and for small hand tools is 2.7.

In this connection it should be mentioned that the Bureau of Foreign and Domestic Commerce, Department of Commerce, Washington, D. C., maintains a Division of Foreign Tariffs, the principal duties of which it is to answer tariff inquiries. Manufacturers in doubt about tariff rates in any foreign country should write to the Division of Foreign Tariffs to obtain exact information on any question of interest to them. In addition, it might be mentioned that Tariff Series No. 25 contains the Customs Tariff of France. This volume is for sale by the Bureau of Foreign and Domestic Commerce and may be obtained by application to this Bureau.

* * *

INTERNATIONAL MACHINERY EXPOSITION

The Merchants & Manufacturers Exchange of New York City has announced that on October 15 the International Machinery Exposition to be held at Grand Central Palace, New York City, will be opened. The exposition, which is permanent in its nature, will occupy 50,000 square feet of floor space in what is claimed to be the largest exposition building in the world and will include a comprehensive display of machine tools, woodworking machinery, engines, etc. Altogether eight permanent industrial expositions will be conducted on the eight upper floor of the Grand Central Palace. The four lower floors will be used for temporary exhibits, such as the annual automobile show, the motor show, etc. Any inquiries relating to the exposition may be addressed, prior to September 15, to Merchants & Manufacturers Exchange, Suite 421, 405 Lexington Ave., New York City, and after that date to the Grand Central Palace.

* * *

AMERICAN STEEL TREATERS' SOCIETY TO MEET IN CHICAGO

The American Steel Treaters Society, which will hold its Convention in the Seventh Regiment Armory, Chicago, Ill., September 23-27, has announced the program for the meeting which includes a great number of papers on practically all the phases of heat-treatment of steel. The list so far published contains no less than thirty-five papers by prominent engineers and metallurgists well known in the heat-treating field. There will be sessions both in the forenoon, afternoon and evening of the first two of the Convention days and on the third day there will be two sessions followed by an informal banquet at Hotel Morrison in the evening. Friday and Saturday, September 26 and 27, there will be an exhibit in the Seventh Regiment Armory of apparatus and equipment relating to the heat-treatment of steel.

* * *

C. E. JOHANSSON VISITS AMERICA

C. E. JOHANSSON, the well-known inventor and developer of the Swedish gages, arrived in New York on the S. S. *Stockholm* August 26 from Sweden. Mr. Johansson plans to stay from eight to ten weeks in the United States. During his stay in this country he expects to visit a great number of the larger manufacturing establishments with a view to studying their needs for gages and measuring tools. He will also devote part of the time superintending the establishment of his methods in the new factory in the United States in which the Johansson methods will be used for producing the gages and measuring tools known by his name. The new factory will be located at Poughkeepsie, N. Y.

* * *

A manufacturer in the Philippine Islands expects to embark on the manufacture of rope and for this purpose desires to secure information regarding rope making machinery from makers of this type of machines in the United States. Manufacturers interested in this matter may communicate with the Bureau of Commerce and Industry, Manila, P. I., through the Department of Commerce, Washington, D. C.

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW AMERICAN METAL-WORKING MACHINERY

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Smalley-General Thread Milling Machine. Smalley-General Co., Inc., Bay City, Mich..... 78
Brown Compensated Pyrometer. Brown Instrument Co., Philadelphia, Pa. 79
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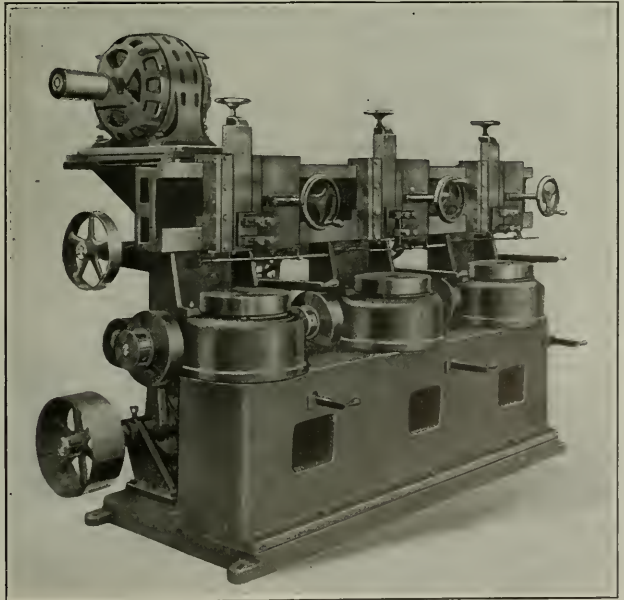
Moline Vertical Gang Lathe

THE Moline Machinery Co., Moline, Ill., has recently developed a vertical gang lathe which was originally designed for use in facing pipe flanges, although it may be successfully employed for handling various other classes of work. This machine is built in duplicate units except the base, housing and rail, and each unit has independent control of the speed and feed. The number of units which are assembled in a gang varies according to the nature of the work which is to be handled on the lathe, the practice being to assemble together as many units as one operator can conveniently handle. Three units are shown assembled together in the accompanying illustration; and it is stated that the design of all members of this lathe have been worked out in such a way that they are proportioned to resist all normal stresses to which they will be subjected.

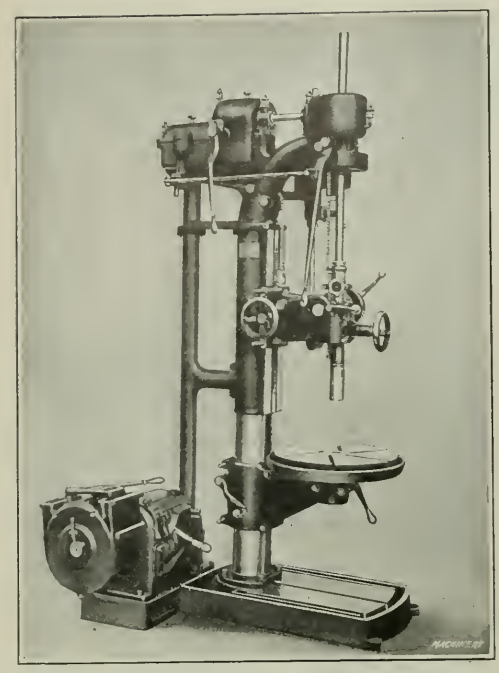
Power for driving this machine is transmitted through a three-pitch hardened spiral pinion and bronze gear, giving a total ratio of reduction of 12 to 1 between the driving shaft and the table; and if so desired, additional reduction can be obtained between the motor or countershaft and the driving shaft. Power for operating the feed mechanism is transmitted through worm gearing and a rack and pinion. On the machine shown in the illustration, only horizontal feed is provided, but machines of this type can also be furnished with vertical and angular feed, if so desired. The saddles are designed with a long narrow guide, and the rotating table is similarly constructed to tables used on standard boring mills. Each table is furnished with a 90-degree vee and a central trunnion bearing.

Principal dimensions are as follows: Diameter of table, 13½ inches; actual swing, 16 inches; travel of saddle on rail, 7 inches; vertical travel of tool-head, 5 inches; height of table, 38 inches; distance between units, 36 inches; weight of the 3-unit machine, 8000 pounds.

Machine tools of special design are often advantageously employed for the performance of repetition manufacturing operations. In designing the Moline vertical gang lathe, a marked departure has been made from established practice in lathe design. This machine was developed for facing pipe flanges, and its construction includes principles of design that are employed in building lathes, vertical boring mills, and drilling machines. Machines of this type can be constructed to meet the requirements of various operations where the nature of the work is such that one operator can take care of several lathe units.



Vertical Gang Lathe built by the Moline Machinery Co.



Upright Drilling Machine built by the Fosdick Machine Tool Co.

FOSDICK UPRIGHT DRILLING MACHINE

The Fosdick Machine Tool Co., Cincinnati, Ohio, has recently added to its line an upright drilling and tapping machine which is shown in the illustration that accompanies the following description. It will be apparent that the general appearance of this machine is similar to an average upright drilling machine, but the gearing, friction clutches, feed mechanism, quick-return, etc., are constructed along the same general lines as similar members of the Fosdick heavy-duty radial drilling machines. A channel surrounds the machine base and provides for returning the coolant into a large reservoir. An unusually long bearing is provided for the table arm on the column, and it is internally ribbed, in a manner similar to that employed in the construction of roof trusses. Provision is made for raising or lowering the table from either side of the machine, and the table may be swung around the column to clear the base, when it is required to set up large pieces of work on the finished surface provided for that purpose. There is no danger of the table accidentally dropping when it is unclamped. Through a special arrangement of the table T-slots, these slots are made to terminate exceptionally close to the center. Heavy ribs run inward directly toward the hub, and provide a good rigid table so that work of any shape may be securely clamped without springing.

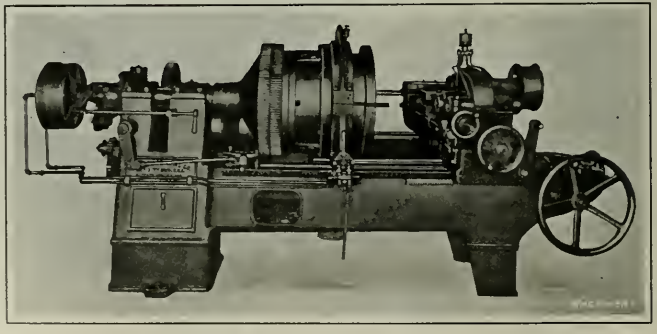
A handwheel is used to raise or lower the spindle head, and a depth gage and automatic trip are furnished on the spindle, which may be set to graduations in any position in the entire length of travel. The spindle quick-return mechanism acts instantly and requires only one hand to operate it. Power feeds are all obtained by a single lever which is located within easy reach of the operator while seated at the front of the machine, although it has been placed high enough not to interfere with the operating levers on the drilling machine head. The hand feed may be fed ahead of the power feed without disengaging the latter mechanism, which is particularly advantageous for starting large drills. A friction reverse tapping mechanism is incorporated in the construction of every machine, being placed between the initial drive and the back-gears.

Bronze bearing bushings are driven into bored holes, which affords an unusually rigid form of bearing construction; and ball bearings carry a number of important parts of the mechanism including the spindle, both crown gears, the vertical driving shaft and friction bevel pinion, the feed-worm, and the feed bevel gear. A metal chart indicating speeds and feeds for various classes of high-speed work is attached to the machine in a position where it is conveniently read. Drive is transmitted from a constant-speed belt through a gear-box that furnishes the proper cutting speeds for drills ranging from 3/16-inch carbon to 2 1/2-inch high-speed steel; and slower rates of speed are available for the performance of heavy tapping or boring operations in holes up to 5 inches in diameter. Constant- or variable-speed motors can be supplied on new machines, or motor drive may be substituted for belt drive after a machine is placed in service. Such changes may be conveniently made, as the parts of all driving mechanisms on these machines are made interchangeable. A pump and piping are furnished for delivering coolant to the work through a flexible tube, and a compound, tilting, or square table may also be supplied.

A 25-inch size of Fosdick upright drilling machine is shown in the accompanying illustration, and the important dimensions of this machine are as follows: Capacity for drilling, to center of 25-inch circle; maximum distance from spindle to base of machine, 49½ inches; maximum distance from spindle to table of machine, 33 3/4 inches; taper of spindle hole, No. 4 Morse; number of spindle speeds, 12; range of spindle speeds, 49 to 550 revolutions per minute; number of geared feeds, 5; range of geared feeds, from 0.004 to 0.028 inch per revolution of the spindle; horsepower of motor required to drive machine on average work, 3 to 5; horsepower of motor for driving machine under continuous operation, 7 1/2; and net weight of machine, approximately 2350 pounds. A machine equipped with a constant-speed belt drive and a round table is shown in the illustration, in addition to which machines may be furnished with variable-speed motor drive and a compound table with micrometer dial adjustments and a vertical milling support.

SMALLEY-GENERAL THREAD MILLING MACHINE

The Smalley-General Co., Inc., Bay City, Mich., is now building a No. 1 thread milling machine which is equipped with the necessary attachments to adapt it for milling threads on pipe flanges and for the performance of similar thread milling operations. The same general principles



No. 1 Pipe Flange Thread Milling Machine built by the Smalley-General Co., Inc.

which are employed in the construction and operation of other Smalley-General thread milling machines which have been described in MACHINERY, are employed on the present machine, so that a detailed description is unnecessary. Consequently, the following article will be devoted to an explanation of the attachments that are used to adapt this machine for the performance of flange thread milling operations. A feature of this equipment is that its use makes it unnecessary to employ highly skilled workmen for the performance of flange threading operations where a milling machine of this type is employed.

In order to give the hob the proper travel to produce tapered threads, a taper attachment is furnished on the machine. This attachment is made exceptionally heavy, because in performing these flange threading operations, the thread is cut right from the rough metal without previously boring the work. Air-operated chucks are furnished when compressed air is available in the shops where the machine is to be used. With such an equipment it only takes a few seconds to chuck or remove the work, and in addition, the piece is held more rigidly in an air chuck. The chucks are equipped with "false" jaws to adapt them for holding various sizes of flanges, and they are so arranged that they will take any size of flange up to 23 1/2 inches outside diameter. The chuck body is threaded on the main spindle, as in the case of a lathe, and a staggered toothed gear of broad face is placed at the front, which delivers power to the chuck directly at the point where it is needed, not only furnishing a powerful drive, but also freedom from vibration.

A driving shaft carrying the pinion is driven through a worm-gear by another shaft having a three-step cone pulley, so that three changes of speed may be obtained. With a two-speed countershaft, this gives a total of six available speed changes. A power-feed facing attachment driven from the main spindle, gives three rates of feed; namely, 1/16, 1/8, and 3/16 inch per revolution. The attachment is so designed that it can be reversed, and it is provided with trips to throw out the feed when the tool is traversed through the proper distance. Various rates of feed are obtained by a shifting gear. The cutting speed is approximately 50 feet per minute. The milling spindle is back geared in the ratio of 3 to 1, and, as in all Smalley-General thread milling machines, each speed of rotation bears a definite relationship to the milling speed. The machine is equipped with a pump which forces cutting fluid up from a tank in the base, and thence through a flexible pipe to the cutting tool.

BROWN COMPENSATED PYROMETER

Until recently, the determination of furnace and kiln temperatures by means of thermo-couples was attended with complications and difficulties which made practical men impatient, and in some instances doubtful in regard to the intrinsic value and reliability of the method. Technical men, however, have realized from the beginning that, within certain temperature limitations, the results obtained by the use of thermo-couples were not only accurate, but also could be made "direct reading," provided the thermo-couple be connected with a galvanometer which would indicate the actual value of the E. M. F. obtained by heating. On first consideration, this problem did not seem difficult of solution, since it is an established fact that the E.M.F. or voltage of a thermo-couple bears a direct relation to the difference in temperature between its hot and cold ends. It is also true that the movable coil of a millivoltmeter will be deflected to an extent which is directly proportional to the E.M.F. of the thermo-couple. Therefore, it would seem the simplest operation imaginable to connect the thermo-couple and the instrument together by means of insulated conductors, figure the scale in temperature values, and regard the problem as solved.

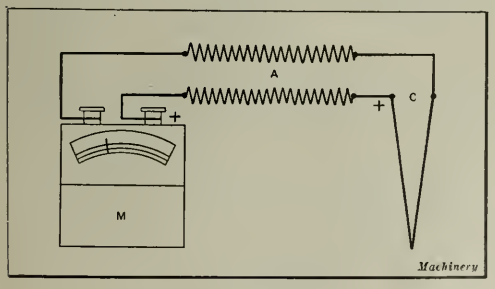


Fig. 1. Wiring Diagram



Fig. 2. Compensated Type of Pyrometer made by the Brown Instrument Co.

Unfortunately, however, we have also to contend with factors which cannot be ignored if accurate results are required; namely, line resistance, thermo-couple resistance, and the resistance of the indicator itself; because, to be precise, a direct-current millivoltmeter actually is not a millivoltmeter at all, except in name, but is a milliameter or current indicator. All instruments of the d'Arsonval type depend primarily upon current for their operation, and the extent of the deflection obtained with any given current is established by the intensity of the magnetic field, the controlling force of the springs, and the number of convolutions or ampere turns in the movable coil, and not by a remote E.M.F. Therefore, if the conductors which carry the current from the source of E.M.F. to the terminals of the instrument do not have a negligible resistance, then, in accordance with Ohms' law, there will be an appreciable fall of potential along the line, with the result that the movable system will receive a diminished current, and therefore be low in its readings. To reduce such errors to a minimum, it is desirable that the instrument resistance be as high as possible, so that the line and thermo-couple resistance may be proportionately insignificant. For instance, when this is not the case: If the resistance of the millivoltmeter *M*, Fig. 1, is 300 ohms, and the resistance of the line *A* and the thermo-couple *C* is 3 ohms, the current through the circuit will be reduced practically 3 parts in 300, or 1 per cent, and the instrument indications will be 1 per cent low. Figured in degrees F. this would mean an error of approximately 14 degrees in 1400 degrees F., if a thermo-couple were used. The advantage of high-resistance instruments, therefore,

becomes evident. For instance if the pyrometer has a resistance of 600 instead of 300 ohms, and the line resistance remains the same, an error of 3 parts in 600 will result or only 0.5 per cent instead of 1 per cent, or, about 7 degrees in 1400 degrees.

Until within the last five years it was customary to use a so-called low-resistance pyrometer to measure the current from the thermo-couple. These instruments had from two to five ohms internal resistance and were naturally materially affected by the external resistance of the thermo-couple and leads. In the past few years, high-resistance pyrometers have been almost universally adopted. These instruments have an internal resistance of usually from 300 to 1200 ohms. The higher the resistance, the less the effect on the readings due to variations in line resistance. But with an increase in internal resistance, something had to be sacrificed, and usually control or torque is weakened. In consequence, the instrument is not as substantial or dead beat, and, due to the use of lighter springs, is more apt to be affected by spring fatigue. It has been found by trial that an instrument of medium resistance (about 300 ohms) can be produced in a satisfactory and substantial form, but an instrument of this class is necessarily affected in its indications when leads of considerable length are employed. Material variations in the length of thermo-couples are also a source of error, as well as the introduction of compensating leads. When compensating leads are employed, as well as long wires, in connecting the thermo-couple with the instrument, it is a common practice to reduce the resistance of the instrument in order to offset the effects of line or external resistance. At best this is a method that is of doubtful value, since it interferes with checking the scale by comparison with a standard, and does not compensate for changes in the resistance of the line or thermo-couple, due to variations in temperature.

Various devices and attachments have been made for use in connection with indicating and recording millivoltmeters and pyrometers, by means of which the instruments will remain direct reading, and at the same time be compensated for external or line resistance. Inventions of this class range all the way from a simple step rheostat connected in series with the "dead" resistor of the instrument, to the elaborate and complicated apparatus employing the substitution and deflection methods, the potential of the thermo-couple being first balanced against another potential derived from a dry cell; and after an intermediate operation and an inter-comparison of deflections, the effect of line resistance is finally balanced out by means of a rheostat, and direct deflections are obtained from the thermo-couple current.

Paul D. Foote and T. R. Harrison, physicists of the Bureau of Standards in Washington, D. C., recently invented a simple means of obtaining the same result, which has been incorporated in a compensated pyrometer recently placed upon the market by the Brown Instrument Co., Philadelphia, Pa. By this means, the effect of line and thermo-couple resistance is eliminated through an operation which is so simple that anyone can use the instrument and obtain accurate results. Consequently, this improved pyrometer should appeal to practical men who want results, and do not care especially how the instrument functions provided its indications can be relied upon. In testing with this apparatus, it is only necessary to connect the thermo-couple with the instrument binding posts in the usual manner, press a button, turn a knob, and take a reading, which will be a correct E.M.F. of the thermo-couple at its hot end, even if the line is miles in length. In fact, the line may have as much resistance as 15 ohms. The following advantages are claimed for this improved type of pyrometer: It is direct reading throughout the entire range of temperatures that can be measured; the use of dry cells or standard cells is unnecessary; accuracy of the pyrometer is independent of line or thermo-couple resistance; and the temperature coefficient is a negligible factor.

"BOYERGRIP" FOR CHICAGO PNEUMATIC HAMMERS

For use in connection with pneumatic hammers which are employed for the performance of riveting and chipping operations, the Chicago Pneumatic Tool Co., 1060 Fisher Bldg., Chicago, Ill., is developing a device known as the "Boyergrip." An enlarged view of this device and a smaller picture of the grip applied to a Chicago pneumatic hammer are shown in the illustration that is presented in connection with the following description. It is claimed that the use of this device is the means of enabling pneumatic hammers to be used more rapidly and with less danger of injuring the operator.

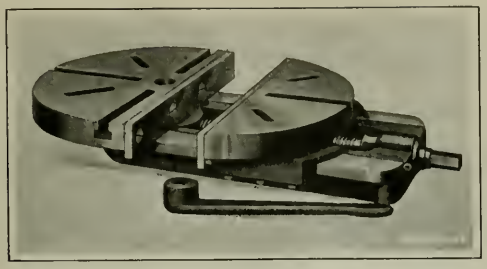


"Boyergrip" for Use in Connection with Pneumatic Chipping and Riveting Hammers made by the Chicago Pneumatic Tool Co.

The Boyergrip fits over the muzzle of most makes and sizes of riveting hammers, and there is a firm, full-hand control for the operator, without requiring him to grasp the heated cylinder. In this way, the Boyergrip combines an ideal handle and an absolutely safe rivet-set retainer. Its use allows the riveter to get back of the hammer with the full weight of his body, without having to "strong-arm" the work. Perfect control of the hammer is afforded, with an unobstructed view of the work; and in driving hot rivets, there is less danger of the workman's burning his hands or of squeezing his fingers. This device is made of a very good grade of steel, and it is so simply and strongly constructed that there is practically no danger of breakage.

"QUICKGRIP" COMBINATION TABLE AND VISE

It will be apparent from the illustration presented in connection with this description, that the device here illustrated and described is a combination drilling machine table and vise. It fits any type of drilling machine, it being merely necessary to remove the regular table and drop the combination vise and table into the socket. The vise jaws are faced with machine steel, and hardened jaws can be furnished to special order. All parts are interchangeable, so that the jaws can be replaced at any time without special fitting. The vise screw is 1¼ inches in diameter and it has four threads per inch. The screw runs in a bronze nut. Four T-slots are machined in the table to provide for clamp-



Combination Drilling Machine Table and Vise made by the Sprague-Hayes Mfg. Co.

ing work in the usual way. The only special fit required in applying this device to any make of drilling machine, is to turn the shank to fit the socket of the machine, the shank being readily detached from the table for that purpose. This device is a recent product of the Sprague-Hayes Mfg. Co., 40-44 E. Larned St., Detroit, Mich. The table is 16 inches in diameter with the jaws closed, and the jaws open 8 inches.

NELSON UNIVERSAL ANGLE-PLATES

The Nelson Tool & Machine Co., 253 Norfolk St., Newark, N. J., has recently added to its line a large universal angle-plate and a 90-degree angle-plate. In designing the former tool, a distinct departure was made from previous models of angle-plates of this company's manufacture, both as regards the features of construction and sizes in which the plates are made. Formerly this company manufactured only small toolmakers universal angle-plates, and the regular 6 by 9 universal angle-plates. The new line will cover three sizes; namely, 7½- by 9-, 10- by 12-, and 14- by 18-inch sizes. Attention is called to the following points in which there

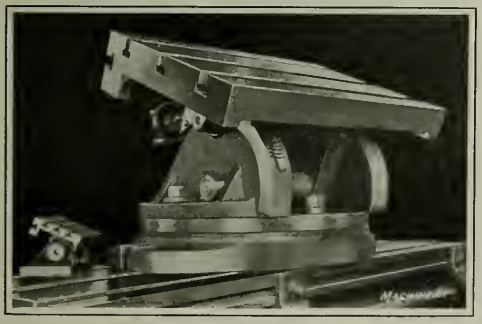


Fig. 1. Improved Type of Universal Angle-plate made by the Nelson Tool & Machine Co.

is a difference of design between the new line of plates and those formerly made: Vertical adjustment up to 90 degrees is accomplished by means of a handle operating a worm-wheel sector which is cut in the periphery of the upright that carries the swivel, the design having been worked out in such a way that dirt cannot become lodged in the mechanism.

Vertical locking is accomplished by two ¾-inch bolts running in T-slots cut into vertical plates projecting down from the under side of the table. These slots are located at an ample distance from the center line of the swivel so that adequate clamping power is secured. Provision is made for adjusting the angle-plate through a complete circle in a horizontal plane, a graduated collar being provided on the base for that purpose. Five bolts are furnished for locking the swivel to the base, including a center bolt and four other bolts of large diameter. A feature of the design of these plates is that the table never overhangs the base, regardless of the position in which it is set, thus assuring rigidity and enabling the angle-plate and work to pass between the housings of a small planer. The feature of a narrow face and T-slot finished at right angles to the main face of the plate is provided on this tool, in common with other angle-plates made by the Nelson Tool & Machine Co. Hardened stops provide for locating the table in a horizontal position.

Fig. 2 shows the new Nelson 90-degree angle-plate which also has the same feature of a second face and T-slot to which reference has just been made. Plates of this type are made in a wide range of sizes, varying from 3 by 3½

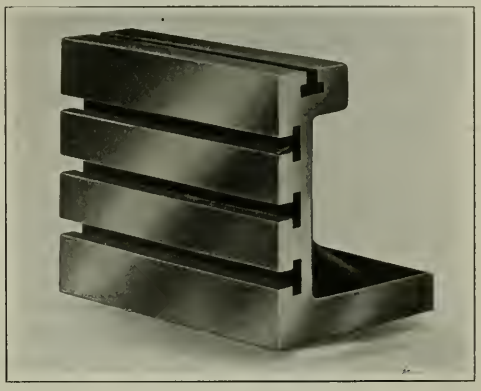


Fig. 2. 90-degree Angle-plate made by the Nelson Tool & Machine Co.

inches up to 14 by 18 inches. Vertical ribs insure rigidity. The plates may be used singly or in pairs for a variety of purposes in both the tool-room and production departments, the more important applications being in setting up work on milling machines, planers, shapers, drilling machines, etc.

COATS CYLINDER BORE GAGE

For several years the Coats Machine Tool Co., Inc., 110-112 W. 40th St., New York City, has been engaged upon the development of a cylinder bore testing gage for use in connection with the Prestometer fluid micrometer gage of its manufacture. The design of this device has recently been perfected, and the gages are now being manufactured for use in testing the bore of gasoline engine cylinders, where great accuracy is required. The design of this gage represents a departure from usual practice in the construction of apparatus for testing cylinder bores. A pistol grip and trigger are provided to prevent an unskilled operator from "shooting" the liquid violently up and down in the Prestometer tube, should he try to introduce the gage into the cyl-

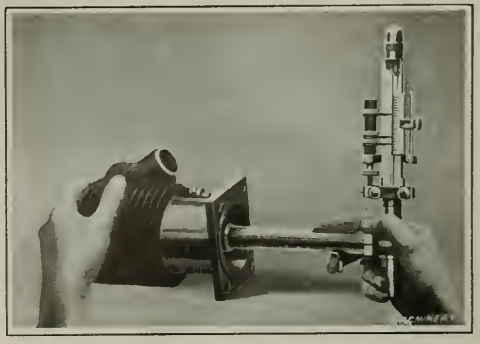


Fig. 1. Cylinder Bore Gage developed by the Coats Machine Tool Co.

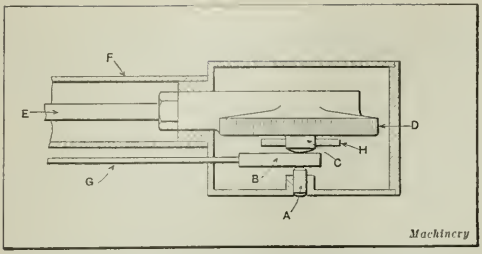


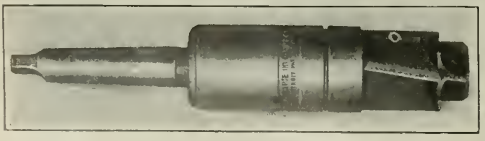
Fig. 2. Cross-sectional View showing Arrangement of Mechanism of the Coats Cylinder Bore Gage

inder in a slightly cocked position. Referring to the diagram, Fig. 2, attention is called to the fact that sliding pin *A* is not brought into action until the gage is well inside of the cylinder to be tested. Connection between pin *A* and button or pin *C* is then accomplished by pulling the trigger which introduces a wedge *B* between the sliding pin and the button *C* that is soldered to the diaphragm of the fluid gage.

The way in which this testing outfit operates is as follows: A fluid chamber *D* is carried inside of the body of the gage, and an indicating tube *E* projects out through the tubular handle *F*. At the side of the fluid chamber *D* nearest to sliding pin *A*, there is a diaphragm connected to pin *C*. Pin *A* projects slightly beyond the wall of the gage body and engages the bore of the cylinder to be tested. A handle *G* attached to wedge *B* enables the wedge to be pushed into the proper position to obtain the desired relationship between pins *A* and *C*. In this way, connection is established between pin *A* and the diaphragm on fluid chamber *D*, so that variations in the cylinder bore will impart movement to sliding pin *A*, which will be transmitted to the column of liquid contained in the tube of the Prestometer fluid micrometer gage. With this form of gage, it may sometimes be necessary to test cylinders in a vertical or horizontal position, and to compensate for the variation in the level of the liquid, due to the weight of the column of liquid when in a vertical position, a weight such as the one seen at *H* is applied to pin *C* carried by the diaphragm. Additional bushings or packing pieces may be attached to the outside of the gage body which enters the bore of the cylinder to be tested.

COMBINATION CORE DRILL AND COUNTERBORE

To avoid the necessity of first drilling cored holes before counterboring them, the Eclipse Interchangeable Counterbore Co., Inc., 1618 St. Aubin Ave., Detroit, Mich., has recently developed a tool which performs the two operations simultaneously. It is particularly designed for machining cored holes to prepare them for inserting plugs, but there are numerous other applications for which a tool of this kind will be found useful. These core drills or reamers are perfectly interchangeable with the standard pilots on Eclipse cutters; in other words, it is not necessary to purchase special cutters to take these core drills, and the range of sizes for each set of cutters is sufficient to meet any normal requirements of an average shop. An important feature of these core drills is the method of automatically aligning them with the cutter, which is independent of the shank, the alignment being controlled by channels which are so arranged that the core drill is bound to be concentric with the cutter at all times while it is in operation.

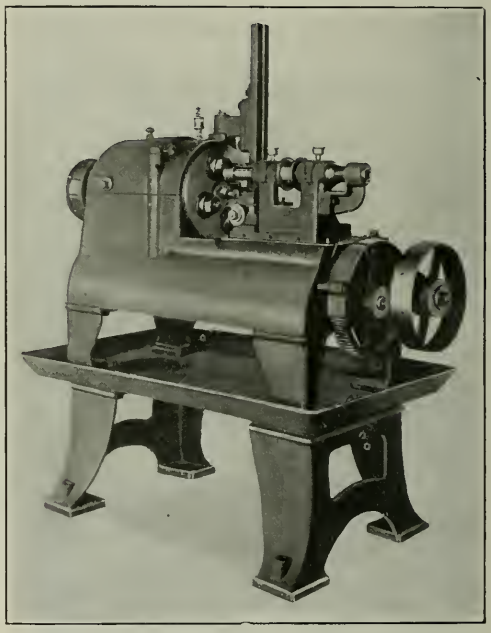


Combination Core Drill and Counterbore made by the Eclipse Interchangeable Counterbore Co., Inc.

KENT NUT SEMI-FINISHING MACHINE

The Kent Machine Co., Kent, Ohio, has recently placed on the market a nut semi-finishing machine which has sufficient capacity for handling nuts up to the ½-inch size. This machine is of the four-station, horizontal turret type, with a hand-loaded magazine feed. At the first station, the nut is taken from the feed mechanism, and it is screwed on the revolving spindle; at the second turret station, the roughing cut is taken; at the third station, the finishing operation is performed; and at the fourth and last station, the nut is automatically removed from the spindle.

As the nut is revolved upon its own axis, the chamfer is made concentric with the axis of the tapped hole. There is no necessity for starting or stopping of the spindles, as



Nut Semi-finishing Machine built by the Kent Machine Co.

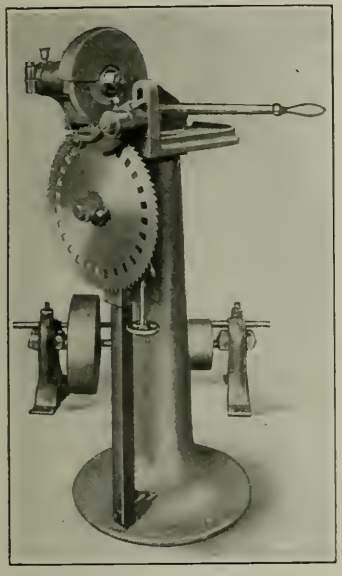
the work can be screwed on and off these spindles while they are revolving. This is the means of substantially increasing the output of the machine. The spindles are made of nickel steel, and they run in tapered adjustable bearings which are bushed with a special grade of bronze. All gears in the turret head are made of steel, and they are completely enclosed. The complete machine weighs approximately 3000 pounds.

EARLE "SIMPLEX" SAW GRINDING MACHINE

The "Simplex" hand grinding and beveling machine built by the Earle Gear & Machine Co., 4705 Stenton Ave., Philadelphia, Pa., for use in sharpening circular cold metal saws, has recently been redesigned. Although the general mechanical characteristics of the original machine have been retained, many improvements of considerable importance have been made in the design. The sliding head is so constructed that it thoroughly protects the double V-slide when the wheel is in its working position, and an adjustable gib is provided

for taking up wear. This means that the true bearing of the slide may be maintained indefinitely, which is a most important point, as any lost motion in this slide results in a rounding of the teeth and failure to grind square cutting edges. The position of the operating lever is adjustable, as the fulcrum pin on which it swings is held in a slot and may be moved forward or backward to suit the convenience of the operator. Attention is called to the fact that the brackets which carry the pressure screws and the pawl are of simpler design and of sturdier construction than was the case on the original machine. Many unnecessary parts have been eliminated from the mechanism, and the pawl has been made adjustable.

Principal dimensions of this improved "Simplex" grinding machine are as follows: Maximum diameter of saw blades which can be ground, 38 inches; minimum diameter of saw blades which can be ground, 12 inches; size of grinding wheels used on the machine, 8 inches in diameter by ¾ inch face width, with an arbor hole 1 inch in diameter; height from floor to center of spindle, 43 inches; diameter of base of machine, 18 inches; size of countershaft pulleys, 6 inches in diameter by 2¾ inches face width; speed of countershaft, 765 revolutions per minute; weight of machine and countershaft crated for shipment, 400 pounds.



"Simplex" Saw Grinding Machine built by the Earle Gear & Machine Co.

A countershaft and two grinding wheels are furnished as regular equipment for the machine, and an instruction sheet has been prepared which gives complete information regarding the correct method of grinding saw blades. This machine can be used for sharpening any kind of circular saws which come within its capacity. It not only sharpens saw teeth but also bevels the cutting points. By beveling every alternate tooth and topping the square tooth to a smaller radius than the roughing or beveled tooth, the chips are enabled to flow more freely on the sides of the cut, which prevents them from clogging between the saw teeth. As a result, a greater cutting speed and coarser feed can be used without dulling the cutting points of the saw too rapidly.

MC CABE DOUBLE-PURPOSE GEARED-HEAD LATHE

In the April, 1918 number of MACHINERY, there was published a description of a lathe, the feature of which is that variable swings from 14 to 40 inches may be obtained. Briefly, this is accomplished by mounting the headstock and tailstock on cross-slides and by locating the rear V-ways of the bed considerably lower than those in front, so that by moving the line of centers transversely to the rear, the additional swing is obtained. Substantially the same type of lathe is now being built at the shops of the American &

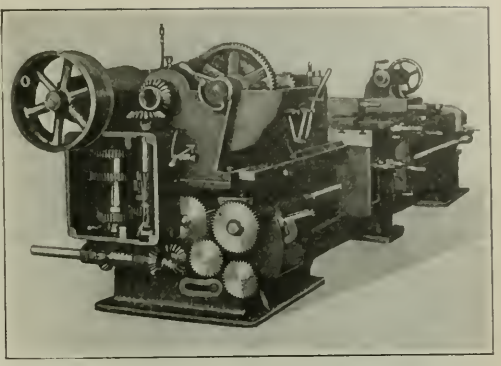


Fig. 1. Double-purpose Geared-head Lathe built by J. J. McCabe Lathe & Machinery Corporation

British Mfg. Co., Providence, R. I., for the J. J. McCabe Lathe & Machinery Corporation, of 149 Broadway, New York City, except that the four-step cone-pulley construction has been replaced by a geared head, by means of which twelve spindle speeds are obtained.

The spindle is mounted in heavy bronze bearings in the gear-case, and carries four sleeve gears and a driving gear *A*. For direct drives the driving shaft, which is located in the rear part of the case, carries four gears for driving gear *A* through the sleeve gears. Adjacent to the largest gear *B* of the four sleeve gears, there is mounted on the sleeve a sliding collar with pins for engaging gears *A* and *B*, which is operated by lever *C*. Direct transmission of power is thus obtained through the sleeve gears to the spindle. The selection of the driving shaft gear is accomplished by shifting levers *D*, which operate sliding clutch cones on the driving shaft, each of which carries a spring plunger. When a cone is slid into contact with its gear, a certain amount of slippage will occur until the plunger comes into line with a bushed hole in the gear and locks the two together. This arrangement prevents the shock which would be caused by a sudden engagement of the gears.

Each of the four direct driving speeds may be reduced by driving through the back-gear *E*. By throwing lever *C* to the left, the sleeve gear drive is disengaged and the back-gear shaft clutch is engaged, the drive then being from the driving shaft through the back-gear and a pinion that meshes with gear *A*. The back-gear shaft is located at the front of the case. Four more speed reductions are obtained by driving the internally geared faceplate by a pinion (operated by handle *F*) on a shaft located below the back-gear shaft. When the pinion is slid into mesh, the faceplate pinion-shaft is driven from the back-gear shaft, and the clutch on the back-gear shaft is disengaged, causing the pinion that

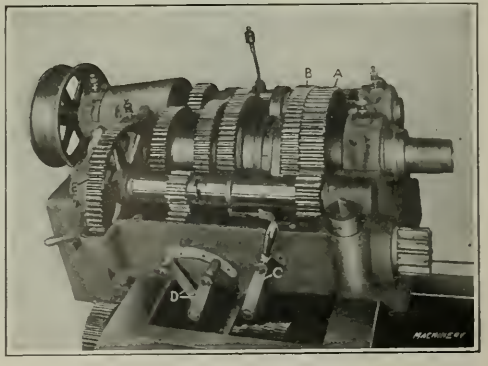


Fig. 2. Arrangement of Gearing in the Head of the McCabe Lathe

drives gear *A* to become inoperative. Power from the driving shaft is then transmitted through the back-gears to the faceplate pinion-shaft.

The twelve speeds obtainable, using a pulley speed of 250 revolutions per minute, are as follows: Direct drive, 184.2, 130.7, 93.7, and 59.3; back-gear drive, 16.8, 11.7, 8.5, and 5.4; faceplate pinion drive, 4.9, 3.4, 2.5, and 1.6 revolutions per minute. The gear-case and cover are heavily constructed, conforming to the rugged design of the entire lathe—a necessary precaution for withstanding excessive strains encountered on heavy lathe operations. The top surface of the cover is cast with a seat for mounting a motor when desired. The apron design and the forty-two quick-change-gear feeds are the same as those of the original lathe.

"WISCONSIN" DRILLING MACHINE

The Dauber-Kratsch Co., Oshkosh, Wis., has recently developed the "Wisconsin" all-gear-driven, 20-inch drilling machine, which forms the subject of the following description. In working out the design of this machine, great care has been taken to make all parts of liberal proportions and to simplify the mechanism as far as possible in order to remove all unnecessary complications from the method of operation. It will be apparent that the machine has a geared head and a single pulley drive, which eliminates the shifting of belts to obtain speed changes. The lever which engages different combinations of gears in the speed-box is located at the left-hand side of the machine, as shown in Fig. 2. These gears are engaged or disengaged through friction clutches which enable speeds to be instantly changed without shock or vibration, and speed changes can be made while the machine is running at full speed. The clutch gears are mounted on roller bearings, making it unnecessary to run the gears in a bath of oil. Bronze bushings are provided for the end bearings of the gear shafts, these bearings being lubricated from the outside of the box by means of oil-cups. The drive from the gear-box to the spindle is through a pair of bevel gears.

It will be apparent from the illustration that the column

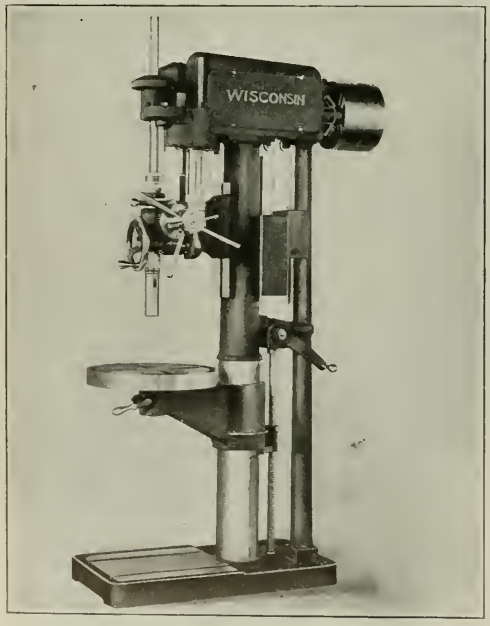


Fig. 1. Gear-driven 20-inch Drilling Machine built by the Dauber-Kratsch Co.

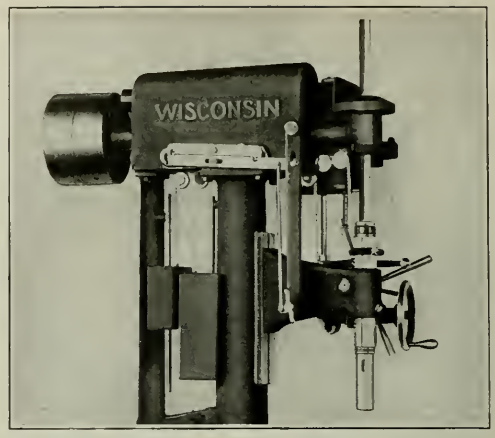


Fig. 2. Opposite Side of Dauber-Kratsch Drilling Machine showing Arrangement of Gear Changing Lever

is reinforced by a strut which supports the back end of the gear-box and also relieves the column of bending stresses induced by the pressure of the drill. A ground cylindrical bearing for the table support is furnished at the lower end of the column. The base is made heavy enough to properly support the machine, and its top surface is finished to provide for setting up work that is too large to be conveniently mounted on the table. Two T-slots are machined in the base for securing such work in place. The table support is made in the form of a box section and is extremely rigid. It is clamped on the column by a single binding screw operated by a hand-lever. It will be seen that four T-slots are machined in the table, which is 20 inches in diameter. The hole at the center of the table is in perfect alignment with the center of the spindle, so that a boring-bar may be used in the spindle where it is necessary to machine large holes. The table is clamped to its support by a conveniently located lever, and raising or lowering of the table is accomplished by a screw located at the back of the column. Provision is made for swinging the table at right angles to its normal position when it is desired to set large pieces of work up on the base of the machine.

Both the table and base are provided with a large oil trough for collecting cutting lubricant, and counterweights for both the spindle and sliding head are placed between the column and strut, where they run on guides. The machine is equipped with a sliding head, and all-geared power feed; also, there are a wheel for operating the hand feed and a large pilot wheel for quickly returning the spindle. The spindle is made of high-carbon steel and is furnished with a ball thrust bearing at its lower end. Four changes of feed are available for each spindle speed, and four changes of spindle speed are provided. If so desired, a two-speed friction countershaft may be furnished to give eight spindle speeds. It will be evident from the illustration that all gears on this drilling machine are thoroughly enclosed to exclude dirt and to afford protection for the operator. If so desired, a tapping attachment may be provided; and an automatic stop, that may be set in any desired position, provides for drilling holes to a specified depth. Where desired to employ individual motor drive, a base will be provided with an extension for the motor; and the belting arrangement of the machine is such that individual motor drive may be conveniently applied.

Principal dimensions of this machine are as follows: Capacity, for drilling to center of a 20¾-inch circle; spindle movement, 8 inches; maximum distance from spindle to base, 41¼ inches; maximum distance from spindle to table, 29 inches; minimum distance from spindle to base, 26¼ inches; movement of sliding head, 7 inches; diameter of spindle,

1¼ inches; diameter of table, 20 inches; Morse taper hole in spindle, No. 4; diameter of column, 6 inches; height to top of gear-box, 73 inches; extreme height to top of spindle, 83 inches; dimensions of driving pulley, 10 inches diameter by 3¼ inches face width; working surface of base, 18 by 19 inches; floor space occupied by machine, 18 by 40 inches; range of feed changes, 0.007, 0.010, 0.018, and 0.025 inch per spindle revolution; and net weight of machine, 1000 pounds.

GREAVES GEARED-HEAD LATHE

The Greaves Machine Tool Co., Cincinnati, Ohio, has recently put on the market a new 24-inch single pulley drive, geared-head engine lathe. Special attention was given to the construction of this machine, in order to make it adaptable for both light and heavy work. The apron is of box form and the side and rear walls are cast integral, the front plate being removable. All gears can be exposed, or removed by taking off the front plate, without dismantling the apron from the machine. The gears are made of steel and all studs and gears are supported at both ends, with lubrication provided from one centralized point. The rack pinion is hardened and it has an additional outboard bearing at the inner face of the rack. Adjustable longitudinal feed stops are provided for the carriage, these stops operating in either direction; and a positive lockout is furnished to prevent engaging the feeds and lead-screw at the same time.

The longitudinal and cross feeds are independent of each other, and are operated by positive clutches which can be engaged or disengaged by a quarter turn of the handles shown on the front of the apron. Both cross and lateral feeds can be engaged at the same time. The feeds and lead-screw are reversed in the headstock by a lever operating at the right side of the apron. A single bevel pinion is used, which is held in a fixed position in the apron and is always in mesh with the bevel gear. The lead-screw and feed-rod are supported at both ends of the apron, preventing any strain on the gearing that may be caused by the sagging of the lead-screw and feed-rod. The ratios of lateral and cross feeds to the lead-screw are 10 to 1, making it possible to cut scrolls or spirals from 5 to 280 per inch, with the feeds which can be read directly from the index-plate on the gear-box. Special or coarser scrolls or spirals may be cut by changing the outer gears on the quick change box. Engaging the lateral and cross feeds simultaneously causes the tool to follow a path forming an angle of 45 degrees with the center line, or 24 inches taper per foot. By using the taper attachment in conjunction with the two feeds, the angle can be increased or decreased to form a maximum of 30-inches per foot, or a minimum of 18 inches per foot.

The bed is of unusually great depth and is heavily braced with box section girths which extend the full depth of the bed. In addition to the cross girths, a double wall brace is cast lengthwise in the center of the bed, extending its full length. A rack on top of the girths engages a pawl, which

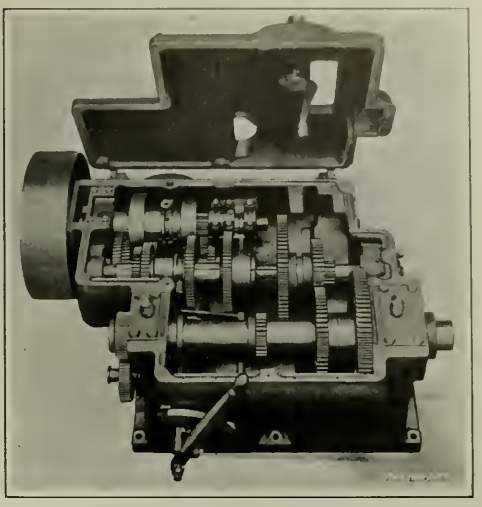


Fig. 2. Arrangement of Gearing in the Head of the Greaves Lathe

braces the tailstock against the tail end thrust when heavy work is placed between the centers. The sections of the bed directly under the vees, and extending below the top of the girths, are reinforced, being three times as thick as the side walls. These reinforcements are intended to minimize all twisting strains. The top of the rear vee is on a level with the front flat bearing, allowing the headstock and tailstock spindles (located back of the bed center) to be lowered and brought as close to the bed as possible, to insure rigidity.

The carriage has a full length bearing on each vee and a wide flat bearing on the inside front vee. It is also provided with an additional 15-degree angle bearing for the full length of the carriage, which prevents the carriage from creeping when taking heavy cuts. The bridge is of box form and of unusual width and depth. Felt wipers are provided in the ends of the wings for the vees and also for the flat bearing. The carriage has an oil trough around the front and rear wing, which delivers cutting lubricant to the center of the bed. A chasing dial is provided for thread cutting, which can be disengaged when not in use. The forward, stop and reverse movements of the carriage are controlled by a lever on the right side of the apron, which operates the lead-screw and feed reverse gears in the headstock.

The lower, center and upper slides of the compound rest are rectangular in shape, so as to eliminate the overhang of tools at any angle at which the rest is set. The center slide can be clamped at any angle with four bolts; and the bottom and top slides are provided with taper gibs located on the left side of the dovetail. The cross-feed and top slide screws have micrometer dials graduated to 0.001 inch. The bottom slide is graduated for any angle up to 90 degrees. The tailstock is of massive construction and is heavily braced to withstand any strain to which it may be subjected. The base is ribbed with cross girths and the bearing between the base and top is accurately scraped.

The tailstock has a very long bearing on the ways and is kept in alignment with the head by a vee on the rear, and it has a large flat bearing on the front way. A wide tongue on

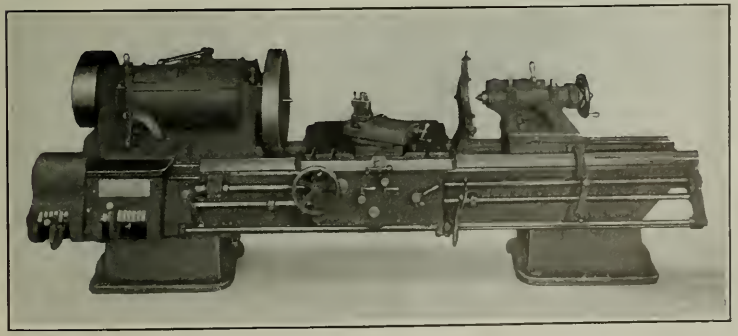
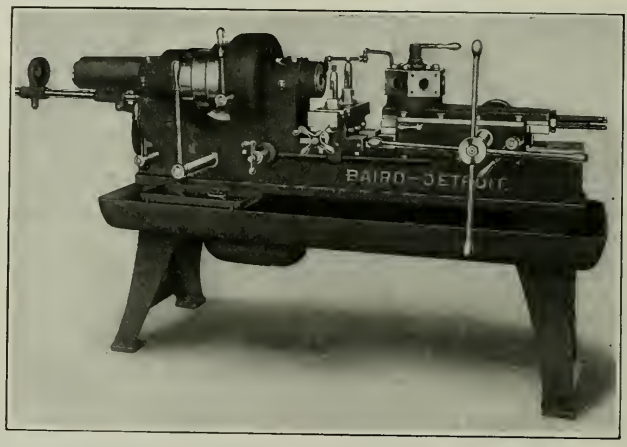


Fig. 1. 24-inch Geared-head Lathe built by the Greaves Machine Tool Co.

the base is fitted into a groove in the tailstock to keep the spindle in perfect alignment with the head spindle and at the same time to take end thrust when cutting toward the tailstock. Provision is made for setting over the tailstock by two screws, and the base is graduated to 1/16th inch, so that the set-over may be accurately read. The tailstock is clamped to the bed by four bolts, two of which extend to the top of the barrel, all being accessible from the front. A pawl which engages with a rack in the bed holds the tailstock against the end thrust. The spindle is clamped downward by two clamp plugs spaced 7 inches apart, which are operated by a single lever. It is claimed that clamping the spindle in two separate places avoids springing the spindle out of alignment. The tailstock is designed to permit the compound rest to be swiveled to 90 degrees when turning short work of small diameter.

The quick-change-gear box is a separate unit mounted on the front of the bed and contains all the mechanism for making fifty-four screw threads and feed changes. Threads from two inches to twenty-eight threads per inch may be cut. Two handles are used to obtain the entire range of threads and feeds. Provision is made for changing the gears on the outer end of the gear-box for cutting any special threads including metric. Guide slots are milled in front of the box which guide the tumbler into correct position before engagement. A direct-reading index-plate is located on the front of the box and the tumbler handles are easily accessible to the operator. The single pulley drive, geared head has twelve speeds ranging from 7 to 300 R.P.M. in geometric progression, that are obtained with sliding gears. No frictions are used except on the driving shaft for forward or reverse motion.



Baird-Detroit Hand Screw Machine built by the Baird Machine & Mfg. Co.

Start, stop, and reverse, and changes of speed are controlled by a single lever. Inward movement of this lever engages the forward friction and throws out the reverse friction on the driving shaft; and when placed in the neutral position, it disengages the frictions, relieving the gearing of all strains and allowing the gears to slide freely. Any speed may be obtained while the machine is under cut by a right or left movement of the same lever. The action of the lever is self-locking so that the gears cannot be shifted until the friction is released. The start, stop and reverse of the spindle is controlled by the lever shown at the right side of the apron. Power is transmitted to the spindle through gears directly back of the front spindle bearing, eliminating any vibration or torsional strain on the spindle. The lever at the front of the headstock engages the spindle direct or through the back-gears; it also has a neutral position which permits revolving the spindle by hand for chucking or similar work.

The gears are made of chrome-nickel steel, pack-hardened and heat-treated, and the bearings are bronze bushed and run in an oil bath. The spindle is made of high-carbon hammered crucible steel, and it has hardened front and rear bearings which run in bronze boxes. The spindle has a double nose, the smaller diameter being grooved to a standard size and acts as a pilot to the chuck or faceplate. The large diameter is threaded and the front face or shoulder is of ample width and ground accurately at right angles to the small diameter. The chuck or faceplate is piloted to the threads by the small diameter, and when drawn up against the shoulder, the front face of large diameter trues up the chuck or faceplate.

Motor Drive

Attention is called to the fact that as the ratio of the gearing in the head is very high, and the strain on the driving shaft is comparatively light, a pivoted motor belt drive is recommended. The motor which acts as a belt tightener, is attached to a bracket which is pivoted in the cabinet leg on the back side of the lathe and exerts eighty pounds tension for each inch of width of the belt. The driving pulley and motor pulley being of liberal diameter and width, all of the power is transmitted to the lathe. Either an A. C. or a D. C. motor running at approximately 1200 revolutions per minute may be used. Motor control is eliminated by the use of a constant speed motor. Only a rheostat for starting and stopping is required, and this can be located at any convenient place. The motor is placed near the floor so as to eliminate any possible vibration due to the armature being out of balance, and the head is left clear and accessible to all parts. The motor can also be placed on top of the head of the machine, belting down to the driving pulley, the motor being stationary but adjustable for tightening the belt. Gearing may also be substituted in place of the belt. A taper attachment, a turret on the carriage, a turret on the ways, and other attachments may be furnished when desired. These lathes are built in sizes ranging from 18 to 30 inches swing; and, in addition to the geared head type, they are also built with a three-step cone pulley and friction double back-geared head.

BAIRD-DETROIT HAND SCREW MACHINE

The Baird-Detroit No. 4 hand screw machine is a recent product of the Baird Machine & Mfg. Co., 54-56 Jefferson Ave., Detroit, Mich. In working out the features of design, care has been taken to place all levers within easy reach of the operating position, and to provide other features that facilitate production. It will be seen that the head is cast integral with the bed, and self-oiling bronze-bushed bearings support the spindle. The spindle is made from a high-carbon steel forging, with the hole bored from solid metal, and other surfaces machined to approximate size, after which the spindle is finished by grinding. Liberally proportioned friction clutches are provided, which have wide bearing surfaces and engage and release quickly. The automatic chuck is forged solid on the end of the spindle.

Provision is made for gripping and releasing the work by a standard collet, operated by a lever in conjunction with the stock feed, so that a bar may be released and advanced to the desired position and regripped, without stopping the spindle. Master collets and collets of greater capacity than those regularly furnished, can be supplied as special equipments. A hexagonal turret is provided on the machine which indexes automatically and is provided with six large tool holes and binder bushings. Tapped holes are provided on each face for securing large tools in place. Large bearing

surfaces support the slide and saddle, these bearings being scraped and provided with taper gibs to compensate for wear and maintain accurate alignment.

Adjustable independent stops operate automatically with the revolving of the turret and trip the power feed; and a slight amount of over travel can be obtained through manipulating a small lever, without disturbing any adjustment. Four changes of positive power feed are instantly obtainable by shifting a lever, and changes of feed can be made while the machine is running. A screw-feed type of cut-off rest is employed, this rest being fitted with front and rear toolposts and provided with longitudinal adjustment by hand. A pump attached to the back of the machine is driven from the countershaft and operates in either direction. The chip pan is provided with a large reservoir which has a strainer at the top. A double friction countershaft for driving the machine is furnished as part of the regular equipment, which also includes an automatic chuck with one round collet, a feed, two stock supports, a cut-off rest, an oil-pan, pump and piping, a tool tray, and the necessary wrenches for making adjustments.

Principal dimensions of this machine are as follows: Automatic chuck capacity (round, square, or hexagon) 1 5/16 inches; size of hole through spindle, 1 7/8 inches; length that can be turned, 9 inches; swing over bed, 18 inches; swing over cut-off, 8 inches; width of driving belt, 3 inches; power required to drive machine, 2 horsepower; floor space occupied, 28 by 82 inches; and net weight of machine and countershaft, 2925 pounds.

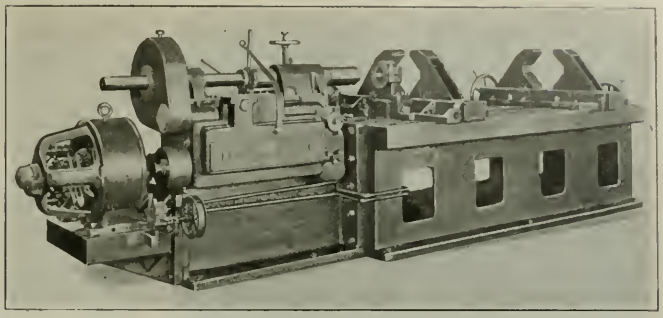


Fig. 1. Heavy-duty Horizontal Drilling Machine built by Baker Bros.

BAKER BROS. HORIZONTAL DRILLING MACHINE

In the accompanying illustrations there are shown front and rear views of a heavy-duty type of horizontal drilling and boring machine which has recently been placed on the market by Baker Bros., Toledo, Ohio. This machine was built for use in a railroad shop for drilling locomotive axles and crankpins, but machines of this type are adapted for many other classes of service besides the work of railroad shops. It is regarded as a standard machine, being built as an addition to the regular line of drilling and boring machines of this company's manufacture.

The spindle is carried by a heavily constructed head allowing the machine to be operated at high speeds and coarse feeds. The spindle construction and the arrangement of speed and feed mechanisms are the same as on the Baker No. 513 high-speed drilling machines, and afford sufficient capacity to drive 5-inch high-speed drills to the limit of their capacity when working in steel. Machines of this type can also be advantageously employed for the performance of boring operations and they have sufficient capacity for boring and enlarging holes in steel and cast iron up to 14 inches in diameter.

Power is transmitted through a train of hardened gears which are carried by annular ball bearings encased in an oil-tight box. The machine is motor driven, the motor being mounted on a bracket and belted directly to the speed-box. A 15-horsepower motor is used, which runs at 1200 revolutions per minute and is equipped with a push-button starter. All operating levers are located in such a way that they may be conveniently handled by the operator when in the working position. Changes of speed are instantly obtained by means of sliding gears, and in working out the design care has been taken to have the minimum number of gears running in mesh at any one time. Eight speeds are secured with a speed ratio of from 11 to 151 revolutions per minute.

The feed mechanism has been designed along simple lines, with all parts liberally proportioned to withstand the stresses incident to severe service. Twelve drilling and twelve reaming feeds are obtainable. The machine is also equipped with a reversing tripping box which gives an automatic back feed, this being a feature that is quite necessary on a machine of this type, as it is often required to bore through work and face or counterbore the back side of the hole. The worktable is designed with an ample working surface and with liberally proportioned oil-grooves to carry away the cutting lubricant after it has flowed over the tools and work. An oil-pump and piping for delivering coolant to the work forms part of the regular equipment of this machine.

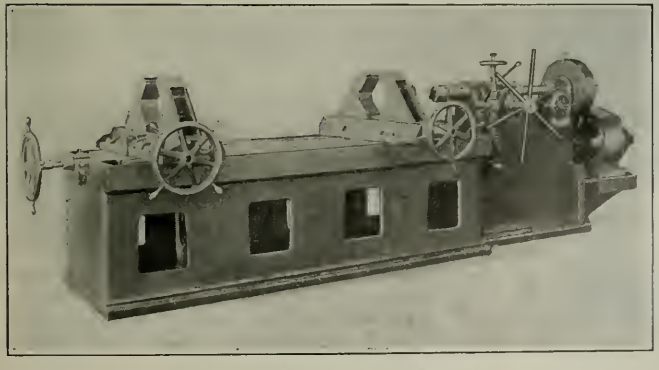
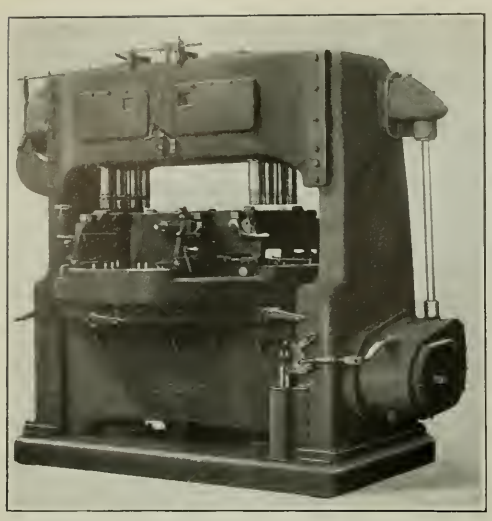


Fig. 2. Opposite Side of the Baker Bros. Drilling Machine shown in Fig. 1

DEFIANCE CYLINDER BORING MACHINE

In the March and May numbers of MACHINERY, descriptions were published of cylinder boring machines developed by the Defiance Machine Works, Defiance, Ohio. This firm has recently developed a third cylinder boring machine which is of somewhat similar design, except that provision is made for rough-boring and finish-reaming two or more blocks at a single operation. This is a single-purpose production tool, and it is built in three different sizes with capacities of 36, 48, and 60 inches between the housings. Each of these sizes can be equipped with either two or three spindles or two or three groups of spindles. When equipped with either three spindles or three groups of spindles, the machine will rough-bore, semi-finish, and ream gas engine cylinders of either single units or a number of units cast en bloc, these three operations being performed simultaneously. The machine is equipped with a circular indexing jig to hold four units, and while the operator is re-

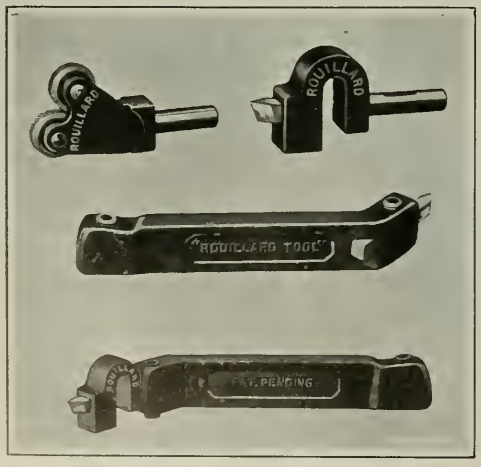


Cylinder Boring Machine built by the Defiance Machine Works

placing the finished unit in the loading position, one unit is being rough-bored, the second is being semi-finished, and the third is being reamed. When the machine is furnished with two spindles, or two groups of spindles, it will rough-bore and ream the work at a single operation. Where either of these methods of machining is employed, the machine is constantly producing, and no time is lost in unloading or reloading the fixture.

"ROUILLARD" COMBINATION TOOL

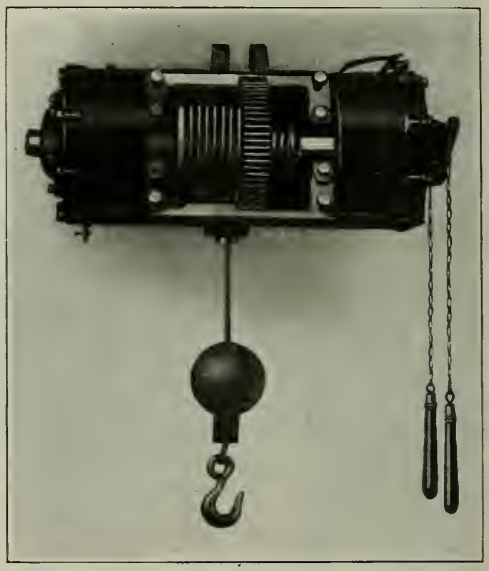
For tool-room service and for use in machine shops handling a general line of work, Montgomery & Co., Inc., 105-107 Fulton St., New York City, have recently placed on the market the "Rouillard" combination lathe tool. It will be apparent from the illustration that this device combines a right-hand, left-hand, and straight lathe tool and a boring tool, and that a gooseneck or a knurling attachment can be mounted in the holder. For shops handling general work, it will be found to give very satisfactory service, but a combination tool of this type is not recommended for use on repetition work in manufacturing plants, as the additional cost of a combination tool would not be justified in cases where the tool is performing the same operation day after day. The tool-holder will take square, round, or octagon cutters, 3/16, 1/4, 5/16, and 3/8 inch in size. Each tool is furnished complete with a wrench, one high-speed steel cutter, and one boring tool. The total length of the holder is 7 inches, and the greatest width at the nose, 9/16 inch. The size of the shank is 1/2 by 1 1/8 inches.



"Rouillard" Combination Lathe Tool made by Montgomery & Co., Inc.

VICTOR R. BROWNING HOIST

Victor R. Browning & Co., Cleveland, Ohio, have recently developed a hoist which has been designed to meet the requirements of industrial service. The general design of this hoist adapts it for use where the head-room is limited, or where available space is otherwise restricted. The main casting which carries all of the moving parts contains individual compartments for the four units, either of which may be removed independently. In one end of this casting there are heat-treated gears and the disk load brake, these members operating in a bath of oil. At the opposite end there are the controller and motor shaft. The entire controller may be quickly removed for inspection or repairs, and the removal of a plate gives access to the gears and load brake.



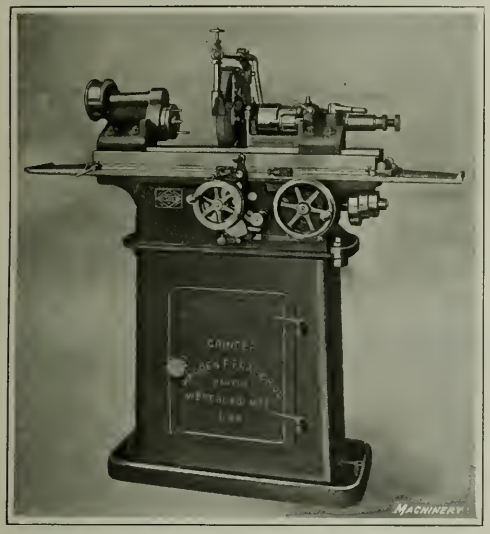
Electric Motor-driven Hoist built by Victor R. Browning & Co.

Between the gear and controller units, there are two long compartments, one of which contains the motor and the other the hoist drum, this drum being carried on a threaded shaft so that it travels longitudinally while rotating. This longitudinal movement feeds the cable through a bushing in the main housing and directly into the drum grooves in rewinding. It is claimed that this adds considerably to the life of the cable, and maintains a perfect balance. Simple but dependable limit attachments are installed at the ends of the drum shaft to prevent over travel of the drum in either direction. All bearings are of large size and bushed with phosphor bronze, with the exception of the motor, the shaft of which revolves on ball bearings. Two of the bearings are provided with grease-cups, while the other four are lubricated by a splash system from the gears. This hoist is furnished with an especially designed motor, either alternating or direct current; and provision may be made for suspending the hoist from an overhead trolley, I-beam, or any kind of fixture.

WARREN F. FRASER PLAIN GRINDER

The No. 21 plain grinding machine shown in the accompanying illustration is a recent product of the Warren F. Fraser Co., Westboro, Mass. It is the first plain grinding machine built by this company to supplement the line of universal grinders of its manufacture. The plain grinder may be equipped for either belt drive or individual motor drive, according to the requirements of the consignee. It has a rated capacity for cylindrical work up to 5 by 18 inches in size, and the maximum capacity is for work up to 6 by 20 inches. The actual swing over the water guards is 5 inches, and over the table 6¼ inches. The grinding wheel spindle is hardened and finished to size by grinding. It runs in bronze-bushed bearings which are furnished with means of adjustment for wear.

Principal dimensions of this machine are as follows: Diameter of headstock and tailstock spindles, 1¼ inches; taper of centers, No. 2 Morse; dimensions of grinding wheel, 12 inches in diameter by 1½ inches face width; diameter of wheel driving pulley, 4½ inches; width of driving belt, 2½

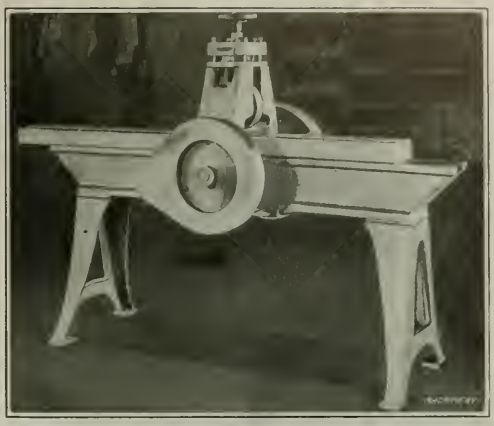


No. 21 Plain Grinding Machine built by the Warren F. Fraser Co.

inches; size of wheel-spindle head bearing, 1½ by 4 inches; size of wheel-spindle back bearing, 1⅜ by 3½ inches; speeds of grinding wheel, 1800 and 2150 revolutions per minute; speeds of work, 30, 50, 75, 107, 150, and 210 revolutions per minute; available table speeds, 3/16, 9/16, and 3/4 inch per revolution of the work; countershaft speed, 450 revolutions per minute; size of tight and loose pulleys, 12 inches in diameter by 3 inches face width; and power required to drive machine, 3 horsepower.

WINTERHOFF SEAM ROLLING MACHINE

For use in rolling seams of lap-jointed brazed tubing, the Winterhoff Tool & Machine Co., Elkhart Ave. and Jackson St., Elkhart, Ind., has recently developed a rolling machine which is here illustrated and described. Seams of the type used in making lap-jointed tubing are produced by notching one edge of the metal and then lapping the notches to hold the seam in place while it is brazed. The tube is then placed on a hardened steel mandrel with the seam at the top, in order that it may be rolled, the tube and mandrel being carried under the roll by a traveling table on the machine, that is driven by a rack and pinion. The machine is stopped when the end of the tube is reached by means of a countershaft equipped with friction clutch pulleys which may be dis-

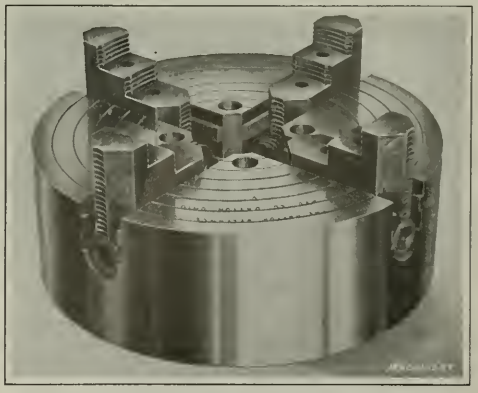


Machine built by Winterhoff Tool & Machine Co. for rolling the Seams of Lap-jointed Brazed Tubing

engaged. After the tube passes through the machine, it is of an even thickness, and the seam is perfectly united. Provision is made for adjusting the roll by a handwheel which manipulates the elevating screws, the handwheel being graduated to indicate movements of the roll to 0.001 inch.

DAYTON QUICK-CHANGE CHUCK

The Dayton quick-change chuck, which is a recent product of the Dayton Reliance Tool & Mfg. Co., Dayton, Ohio, derives its name from the fact that provision is made for quickly changing the jaws from their position for holding internal work to a position for holding external work, or vice versa. The lateral hole in which the screw operates is a little larger than the body diameter of the screw; and therefore, when the locking plug is released, the screw and jaw which are still in mesh may be slid out of the chuck body. In changing the position of the jaws, this arrangement is the means of saving a lot of time. Also this means for removing both the jaw and screw simultaneously, effectually prevents danger of stripping the threads on the screws or jaws. To reverse the jaws on this chuck, it is simply necessary to pull out a locking plug that holds the screw in place, and remove the jaw and screw. After replacing the jaw and screw in the proper position, the locking plug is again pushed back into place to secure the screw. A square socket for the operating wrench is provided in both ends of each screw. Four-jaw independent chucks of this type are made in seven sizes having capacities for handling work 8, 9, 10, 12, 14, 16, and 18 inches in diameter.



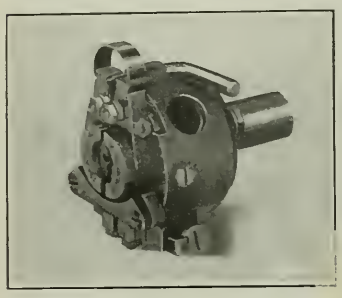
Quick-change Chuck made by the Dayton Reliance Tool & Mfg. Co.

DEMCO DRILLING, TAPPING, AND MILLING MACHINE

In the December, 1917 number of MACHINERY, an illustrated description was published of bench and pedestal types of sensitive drilling machines which had just been placed on the market at that time by the Demco Machine Tool Co., 706 Frankfort Ave., N. W., Cleveland, Ohio. Recently this firm has added to its line a drilling, tapping, and milling machine which is of quite similar design, except that it is furnished with a milling machine table to provide the necessary feed movements. A machine of this type will be found very useful for handling tool-room and general shop work, where it is desired to perform a variety of different operations on a single machine.

FEDERAL SELF-OPENING DIE-HOLDER

The Federal Products Corporation, 393 Harris Ave., Providence, R. I., is now manufacturing a simple type of automatic self-opening die-holder which uses standard button dies. It is claimed that these tools combine the advantages of self-opening die-heads with those derived from the use of solid button dies. Also, the mechanism is so simply designed that it is claimed these Federal die-holders can be cleaned in ninety seconds without disturbing their adjustment.



Self-opening Die-holder made by the Federal Products Corporation

The self-opening feature of this tool eliminates time lost in backing the die off the work, and it clears the thread on the reverse operation, thus obviating the possibility of damaging the finished [illegible]s. An or[illegible] button die [illegible]ed in the [illegible]older, which is [illegible] two parts, the two die sections being firmly held [illegible]rs and substantially supported around their enti[illegible]rence. The rough edges of the split die are groun[illegible]angle, after which the two halves are ready for [illegible]n the die-holder. This whole operation takes but a few minutes to complete. Standard button dies are available in almost any supply shop, and the split dies can be easily sharpened until they are used up.

Heat-treated alloy steel is used in making parts of the Federal die-holder which are subject to wear, thus assuring adequate durability. Provision is made for closing the die before starting a thread by simply pressing a button at the top of the holder, or closing may be automatically accomplished by a lever device adapted to the turret of the machine on which the holder is used. This die-holder is suitable for use on hand screw machines, automatic screw machines, and lathes; and closing attachments can be obtained for use on standard screw machines. The holder will cut any thread that can be produced with a button die, and it is claimed that the full accuracy of the button die is obtained. Where exceptional accuracy is desired, an attachment may be provided to permit the operator to take a roughing and finishing cut

CINCINNATI 28-INCH LATHE

The Cincinnati Lathe & Tool Co., 3207-3211 North St., Oakley, Cincinnati, Ohio, has recently added to its line a 28-inch engine lathe which is equipped with a three-step cone pulley and double back-gears. This machine has the features of design which have become familiar to the trade through their application in 16- and 18-inch lathes built by the Cincinnati Lathe & Tool Co. for the past fifteen years; but all dimensions have been substantially increased to afford the necessary strength and rigidity that are required on a 28-inch lathe. In addition to the cone type of machine, this 28-inch Cincinnati lathe is also built with a geared head for the application of either belt or individual motor drive.

BECKER CHERRYING ATTACHMENT

For use on vertical milling machines the Becker Milling Machine Co., Hyde Park, Boston, Mass., has recently developed an improved type of cherrying attachment. This device is clamped to the outside barrel, or head, of the milling machine and is driven by bevel gears, with an especially constructed bevel gear threaded to the spindle, which drives through spur gears to the milling cutter arbor. The minimum diameter of cutter that can be used is 1 inch, from which the size of cutters that can be employed on the attachment extends up to 6 inches in diameter. The attachment is arranged with a graduated plate so that it can be swiveled through 360 degrees.

F. M. C. LATHE

In the August number of MACHINERY, on pages 1189 and 1190, a description of a 7-inch lathe built by the Flather Mfg. Co., of Nashua, N. H., was published under the title "Flather Manufacturing Lathe." This title should have been "F. M. C. Manufacturing Lathe," as the initials of the company's name have been adopted to distinguish its 7-inch lathes from the larger sized Flather lathes built by Flather & Co., Inc., Nashua, N. H. As the sizes of lathes built by these two companies do not overlap, their lines of manufacture do not conflict in any way.

NEW MACHINERY AND TOOLS NOTES

Machine Vise: Miller & Crowningshield, Greenfield, Mass. A machine vise which is made in two sizes, known as Nos. 4 and 5½. These vises are of the swivel type, and they are designed to facilitate setting to any desired angle or position, after which locking is accomplished by two screws.

Gage Standards: Coats Machine Tool Co., Inc., 110-112 W. 40th St., New York City. These gage standards are made in small sets to meet the requirements of shops which do not need the usual complete set of gage standards. Each plug is guaranteed to be within 0.00001 inch at a temperature of 65 degrees F.

Expansion Reamer: New Britain Tool & Mfg. Co., New Britain, Conn. A line of expansion reamers that are made in sizes ranging from 15/32 inch to 4 1/8 inches, inclusive. Simplicity of design is a feature of these tools. They consist of three parts; namely, the body, adjusting nuts, and blades. The largest sized reamer of this line has an expansion range of 9/16 inch.

Expansion Reamer: Davis Boring Tool Co., 3722 Forest Park Blvd., St. Louis, Mo. An expansion reamer that is provided with renewable blades which may be replaced when worn out, although provision is made to expand the plates to compensate for wear. All parts of this tool that are subjected to severe service are hardened, and all threaded parts are carefully protected from damage.

Disk-grinding Machine: Badger Tool Co., Beloit, Wis. A disk grinding machine which has a lever-feed work-table with an adjustably attached wheel-truing device, a back stop, and a micrometer screw. Leverage is obtained from a toggle joint action which requires a minimum of exertion from the operator. The spindle is mounted in ball bearings, which are thoroughly protected from grit and dirt.

Crank Shaper: Hendey Machine Co., Torrington, Conn. A 16-inch crank shaper which has the base, column and bearing for the bull gear cast in a single piece, and an oil-pan placed on the inside to catch the oil which escapes from the bearings and keep the floor clean. This machine has an actual stroke of 16½ inches, a horizontal table travel of 24 inches, and a vertical table travel of 15 inches.

Set-up Appliances: Standard Shop Equipment Co., Inc., 802-803 Real Estate Trust Bldg., Philadelphia, Pa. A standardized line of set-up appliances for use in holding pieces of work on the tables of machine tools. This line includes such devices as bolts and nuts, single- and double-end clamps, packing blocks, etc. The tools included in this line are made in various sizes to meet the requirements of different classes of work.

Emery Wheel Dresser: Otto A. Miller, 169 Edgervale Ave., Detroit, Mich. This tool consists of a holder mounted on a swivel base, with a cross-slide enabling the operator to set the diamond to form any desired radius on the wheel. The radial distance is measured from a measuring post which is set 3 inches from the center of the base. This tool is sold by the J. R. Stone Tool & Supply Co., 997 Woodward Ave., Detroit, Mich.

Hexagonal and Square Hole Drill: Detroit Hexagon Drill Co., Detroit, Mich. A drill which is adapted for use in cutting square or hexagonal holes and for countersinking bolt heads. Drills of this type fit in standard drilling machines, without requiring the use of a special head or chuck. They work like ordinary twist drills, and it is claimed that they will drill holes as accurately and at about the same speed as a twist drill cuts a round hole.

Die-sinkers Grinding Machine: R. G. Haskins Co., 547 W. Washington Blvd., Chicago, Ill. A grinding outfit which consists of an electric motor for connection to an incandescent light socket, and a flexible shaft for driving various grinding wheels, etc., which are used for the performance of die-sinking operations. The electric motor develops 1/8 horsepower, and it is mounted on an adjustable base, so that it may be raised, lowered, or swung around into any convenient position.

Counterboring and Facing Tool: Chapin & Baker Mfg. Co., 143 Edison St., Syracuse, N. Y. A combination counterboring and spot facing tool in which the holder is made of nickel steel and the cutter of high-speed steel. An internal shoulder on the holder has the pilot of the cutter drawn up against it to provide for holding the cutter in place. The cutter teeth are ground with a slight hook which causes the chips to roll out freely, instead of being broken up into small pieces.

Baling Press: Chicago Baling Press Mfg. Co., 305 S. La Salle St., Chicago, Ill. A scrap metal baling press which is equipped with an end door that permits the operator to draw out the bale instead of lifting it over the top of the compression chamber. This arrangement greatly facilitates the operation of the press. The machine is equipped with a geared motor drive, and presses of this type are made in three different sizes. In addition to the motor drive, they may also be equipped for a belt drive.

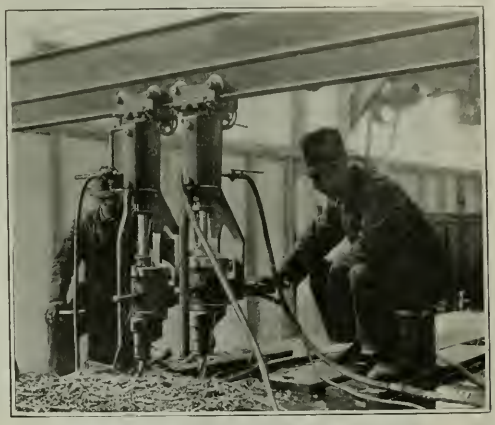
Oil Strainer: Griscom-Russell Co., 90 West St., New York City. A duplex strainer which is adapted for installation in suction or discharge lines of lubricating or fuel oil systems, to provide for removing solid foreign matter from the oil. This device is also suitable for use in straining water drawn from such sources as lakes or rivers to prevent solid impurities from entering the pipe lines. The strainer consists of a cast-iron body containing two perforated steel or brass baskets and valves which permit the removal of either basket for cleaning.

Indicating Calipers: Indicating Calipers Co., 506 E. 19th St., New York City. In the March number of MACHINERY, an illustrated description was published of the indicating calipers which had just been placed on the market by this company. These instruments were made in two styles, one of which had a scale graduated in intervals of 0.010 inch, with a capacity of 2 inches, while the other had a scale graduated in sixty-fourths, with a range of 3 inches. Recently this firm has introduced two other indicating calipers with scales graduated in the metric system. One of these is graduated in intervals of 0.2 millimeter with a capacity of 50 millimeters, while the other is graduated in 0.5 millimeter, with a capacity of 75 millimeters.

Vise: Germanow-Simon Machine Works, 58 Mill St., Rochester, N. Y. A tool for holding work on drilling and milling machines, planers, etc. It is so designed that provision has been made for holding work of almost any form. Flat pieces are held between the vise jaws, and cylindrical or similarly shaped work is secured in V-grooves, in either a horizontal or vertical position. The operating screw has a heavy square thread and is located at the center of the sliding jaw which is the means of avoiding excessive wear of the bearings. Overhanging jaws are provided, which enable many classes of work to be held in the vise which could not otherwise be secured for the performance of machining operations. Duplicate pieces of round work which require a definite location can be placed in the vees of this vise, thus making the vise serve as a jig. Two standard 5/8-inch slots are cut in the base for use in setting the tool up on the milling machine or planer.

PORTABLE ELECTRIC DRILL EQUIPMENT

At the Puget Sound Machinery Depot, Seattle, Wash., a novel equipment is employed in connection with portable electric drills for drilling boiler plates. The accompanying illustration shows two of these drills in operation. It will be noticed that the machines are hung on a track, consisting



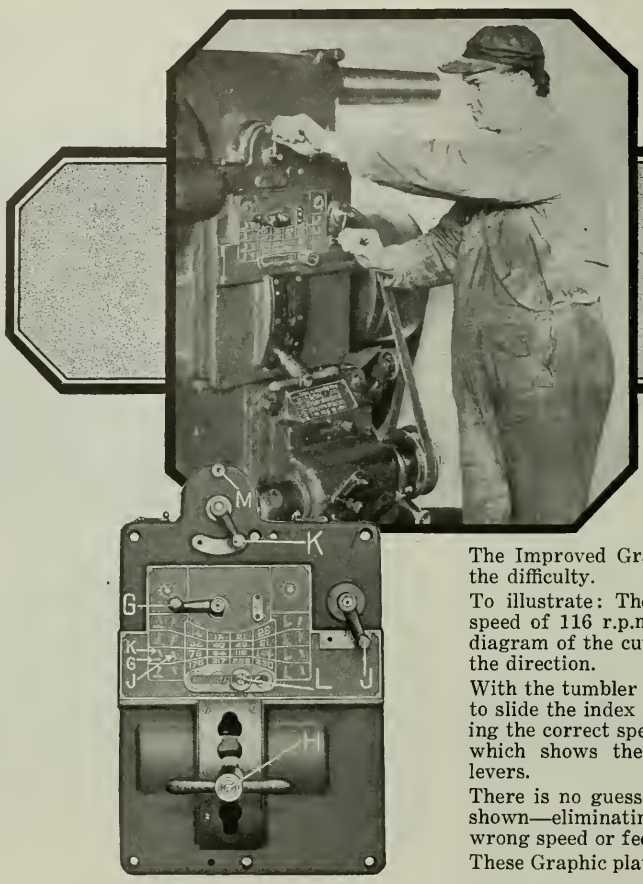
Portable Electric Drills with Overhead Track Support

of an extra truss supported on the top of the span, an arrangement which allows the use of four machines simultaneously on the same plate. The machines, which are made by the Van Dorn Electric Tool Co., Cleveland, Ohio, have been in operation for several months and have proved both satisfactory and economical. The feed is provided by hydraulic cylinders controlled by a four-way valve, which is operated under city water pressure of about eighty-five pounds. The boiler shell plate upon which the drills are used is 1 9/16 inches thick, three thicknesses being drilled at a time, making a total of 4 11/16 inches of metal. High-speed drills are used, the diameter of the hole being 1 9/16 inches, and the average time per hole is eight minutes, including all shifting and changing.

* * *

SAFETY CONGRESS TO BE HELD IN CLEVELAND

The Eighth Annual Safety Congress will be held in Cleveland, October 1 to 4, by the National Safety Council. The program includes special sessions for the metals section to be held in the morning, October 2, 3 and 4. At the session of the first day, a paper on Accident Prevention in a Malleable Iron Foundry will be read by H. L. Church, Rockford Malleable Iron Works, Rockford, Ill., and another on Personal Element in a Safety Program for the Foundry by H. F. Grantland, Marion Grey Iron Foundry, Marion, Ind. At the second session, October 3, the following papers will be read: "Consider the Crane," by C. C. Reusch, assistant director, Safety Institute of America, New York City; "New Ways to Put Safety Across in a Steel Plant," by H. P. Hoyne, United Alloy Steel Corporation, Canton, Ohio; and "Practical Demonstration of Investigating Accidents," a court of inquiry staged by H. J. Weeks, with employes of the American Steel & Wire Co. At the session on the morning of October 4 papers will be presented as follows: "How the Foremen Cut Lost-time Accidents," by James F. Belford, acting secretary of labor-safety and welfare, American Smelting & Refining Co., New York City; "Humanizing a Steel Plant," by Philip Stremmel, superintendent hot mills, National Enameling & Stamping Co., Granite City, Ill.; and "Practical Demonstration of Welding and Cutting," by J. Schleicher, of the Alexander Milburn Co., Baltimore, Md.



In order to illustrate more clearly the simplicity of the index plates we have lettered the illustration showing the relation of the levers on the index plates to those on the machine.

Getting The Correct

He Can't Go Wrong When It's Pictured

The Improved Graphic Index Plates have solved the difficulty.

To illustrate: The operator desires to obtain a speed of 116 r.p.m. spindle running direct. The diagram of the cutters in the upper corner shows the direction.

With the tumbler gear out all that is necessary is to slide the index knob under the column containing the correct speed and then follow the diagram which shows the relative positions of all the levers.

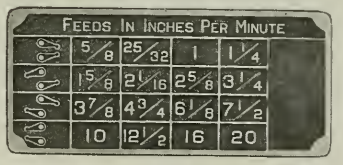
There is no guesswork—everything is pictorially shown—eliminating all chances of obtaining the wrong speed or feed.

These Graphic plates are aiding many operators of

BROWN & SHARPE MILLING MACHINES

The feeds are obtained by the same method as the speeds with the exception that there are only two levers to change on the feed plate.

This added feature is worthy of your consideration when purchasing.



Representatives in U. S. A.

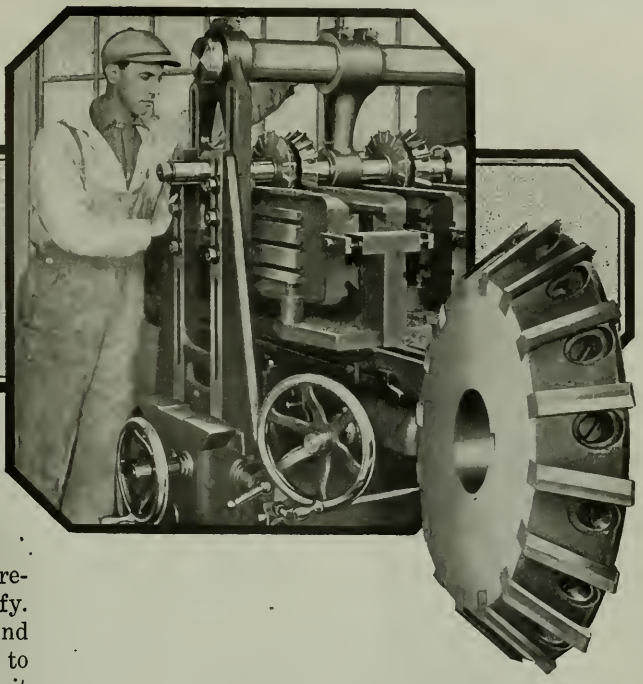
Baltimore, Md.....Carey Machinery & Supply Co.
Cincinnati, O., Indianapolis, Ind., The E. A. Kinsey Co.
San Francisco, Cal.....Pacific Tool & Supply Co.
Cleveland, O., Detroit, Mich., The Strong, Carlisle & Hammond Co.
St. Louis, Mo., Colcord-Wright Machinery & Supply Co.
Seattle, Wash.....Perine Machinery Co.
Portland, Ore.....Portland Machinery Co.
St. Paul, Minn.....Savage & Winter Co.
Atlanta, Ga.....Seeger-Walraven Co.

Brown & Sharpe Mfg. Co.

BRANCH OFFICES:

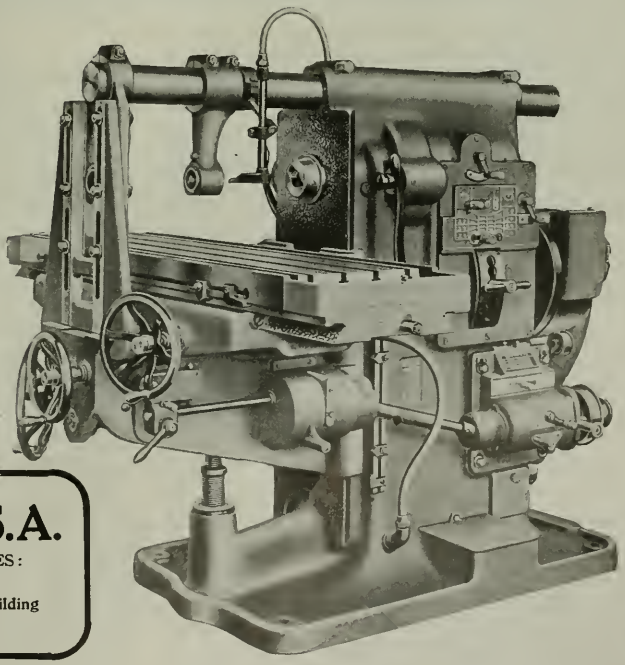
CHICAGO, ILL., 626-630 Washington Boulevard
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Speed And Feed



Satisfying Results

Milling Cutters that bring results are those that satisfy. The one big thought behind Brown & Sharpe Cutters is to make every cutter so that it will give the best possible results for the work it is intended. Each cutter receives individual thought and attention and is rigidly inspected before leaving our works. That's the reason they satisfy.



BROWN & SHARPE MILLING CUTTERS

Our Book on Milling Machines and our Cutter Catalog will be gladly sent on request

Providence, R.I., U.S.A.

BROWN & SHARPE OF N. Y., Inc., OFFICES:
NEW YORK, 20 Vesey Street
ROCHESTER, 415 Chamber of Commerce Building
SYRACUSE, Room 419 University Block

PERSONALS

E. O. Floyd has been appointed general sales manager of the Rossendale-Reddaway Belting & Hose Co., Newark, N. J.

Charles A. Swan has become associated with the Crucible Steel Forge Co. of Cleveland, Ohio, in the capacity of general superintendent.

Charles O'Connor Sloane has resigned from the Allied Machinery Co. of America, and is now connected with the Betts Machine Co., Rochester, N. Y.

Tell Berna, formerly district manager for the Cutler-Hammer Mfg. Co., Cincinnati, Ohio, has become associated with the G. A. Gray Co., of Cincinnati, manufacturer of metal planers, as sales engineer.

Arno W. Gaebelein, who has the rank of Major in the Ordnance Reserve Corps Department of the United States Army, is now in charge of the new office of the New Britain Machine Co. at 50 Church St., New York City.

Byron F. Stowell, for many years connected with the Hendee Mfg. Co. of Springfield, Mass., as master mechanic and mechanical engineer, is now associated with the Napier Saw Works, Inc., Springfield, Mass., as mechanical engineer.

Horace S. Baker, late colonel of the 111th Engineers, has recently returned from active service in France, and is now associated with Frank D. Chase, Inc., 645 N. Michigan Ave., Chicago, Ill., in the capacity of engineer in charge of work for the General Motors Corporation, at Janesville, Wis.

George R. Woods has resigned from the Allied Machinery Co. of America, and sailed on August 2 for Europe to study industrial conditions. He expects to return to New York in November, when he will again become interested in the exportation of American metal-working machinery and small tools.

N. S. Braden, formerly sales manager of the Canadian Westinghouse Co., Ltd., Hamilton, Ontario, Canada, has recently been elected vice-president of the company. H. M. Bostwick, assistant sales manager, has been appointed sales manager to fill the vacancy created by Mr. Braden's promotion.

Edward R. Cardinal has been appointed district sales manager of the Tacony Steel Co., Tacony, Philadelphia, Pa. Mr. Cardinal is well-known in the steel trade, having formerly been district sales manager for the Carpenter Steel Co., and until recently president of the Cardinal Tool Co., Philadelphia, Pa.

George T. Trundle, Jr., who has been connected with the American Multigraph Co. for twelve years as chief engineer, has opened a consulting engineering office at 241 Engineers Bldg., Cleveland, Ohio. Mr. Trundle will specialize in management, production, machine design, and the building of special machines.

J. H. Jackson, formerly production engineer with the Sharples Separator Co., West Chester, Pa., was recently discharged from the United States Army after eighteen months' service as a lieutenant, and has been made sales manager of the Pittsburg Gear & Machine Co., Pittsburg, Pa., succeeding W. H. Thompson.

C. E. Hildreth, president of the Whitcomb-Blaisdell Machine Tool Co., Worcester, Mass., has resigned as director of the Machine Tool Section of the Department of Sales of the War Department, and has returned to his duties in Worcester. V. C. Kylberg, the assistant director, is temporarily in charge of the section.

Sergeant Paul Mitchell of the Provisional Supply Depot, American Expeditionary Forces, France, has just returned to Chicago and resumed his duties as traveling representative for the Independent Pneumatic Tool Co., 600 W. Jackson Blvd., Chicago, Ill., manufacturer of "Thor" air and electric tools. Mr. Mitchell will travel from the Chicago sales office as heretofore.

E. D. Westrip, for about fifteen years general manager of the Rockford Machine Tool Co., Rockford, Ill., has resigned his position with this company and expects to settle permanently in Los Angeles, Cal., but details as to his future business plans have not yet been announced. Before becoming connected with the Rockford Machine Tool Co., Mr. Westrip was engaged in the selling or manufacturing of machine tools for many years, and was for several years with Hill, Clarke & Co. of Chicago, and with the Treadwell Engineering Co. of Easton, Pa.

Arthur B. Reynders, former director of production of the Westinghouse Electric & Mfg. Co., at East Pittsburg, Pa., has recently been made works manager of the East Springfield plant of the company. Mr. Reynders has been with the Westinghouse Electric & Mfg. Co. since 1899, when he started work as a draftsman. A. E. Kaiser, who has been assistant to the director of production since 1912, will fill the vacancy made by Mr. Reynder's new appointment. The new East Springfield works will manufacture small-power motors, and automobile starting, lighting, and ignition equipment.

OBITUARIES

B. F. BARNES

B. F. Barnes, president of the Barnes Drill Co., Rockford, Ill., died on July 29 after a brief illness, aged sixty-six years. Mr. Barnes was born in Mount Morris, N. Y., and came to Rockford when a boy. After attending school there, he went to work at the machinist trade. For twenty-five years prior to 1899 he was superintendent of the W. F. & John Barnes plants on South Water St. In 1899 he organized the B. F. Barnes Co. and was president until about June, 1907, when he sold out his interests. The name of the business was then changed to the Rockford Drilling Machine Co. The Barnes Drill Co. was organized in July, 1907, by Mr. Barnes, who was president of the company from that time until his death. The business which Mr. Barnes started in a small way and which has grown to considerable proportions will be continued along the same lines as in the past on the foundation that he has laid. Mr. Barnes was widely known for his improvements in upright drilling machines, and he was prominent in local industrial circles for many years. He is survived by his wife.



* * *

NEW BOOK ON IRON AND STEEL

Iron and Steel. By Erik Oberg and Franklin D. Jones. 328 pages, 6 by 9 inches; 137 illustrations. Published by The Industrial Press, publishers of Machinery, 140-148 Lafayette St., New York City. Price, $2.50.

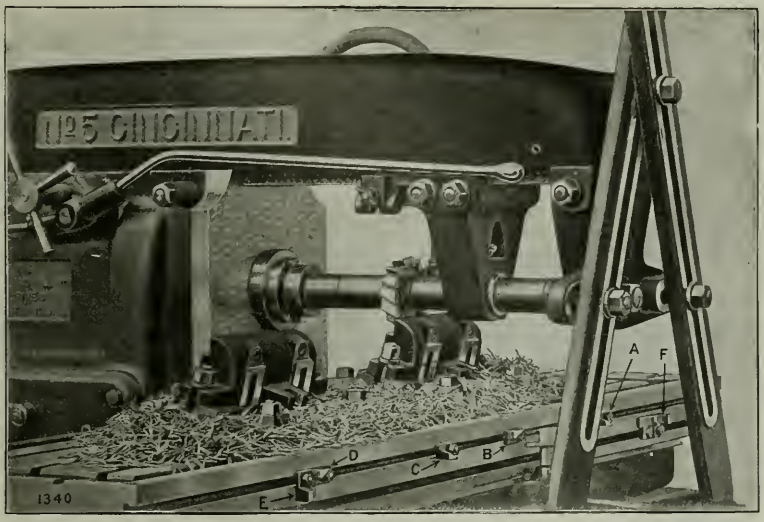
While there are a great number of books devoted to the subject of iron and steel, there are few that deal with this subject in such a manner as to convey the information that is required by the man who is primarily a user of steel. The transformation of crude iron ore into the various classes or grades of iron and steel requires the knowledge of the chemist, the experience and skill of the iron and steel maker, and a great variety of mechanical and electrical equipment; many volumes of the size of the one here reviewed would be required to cover the subject completely from the metallurgist's and steel maker's point of view. No attempt has been made to prepare such a treatise for metallurgists and other specialists; instead, this is a practical book for steel users that may be considered much in the light of a text-book intended for men in the machine building and mechanical engineering fields who want a broad, general survey of the iron and steel industry, with definite, practical information pertaining to the various commercial forms and grades of iron and steel products, and the particular classes of service for which the different grades are applicable.

The book is of particular value in that it points out the uses to which different steels can be most advantageously put. Expensive materials are often employed where cheaper grades would meet every requirement, and sometimes low-grade products are used where the best and most costly materials would ultimately prove more economical. Because of these facts, it is highly important that the characteristics, properties, and limitations of the different grades of iron and steel be properly understood, and this phase of the subject has been emphasized in this book.

The various refining and mechanical processes of the iron and steel industry have been described quite completely in some instances, because of the close relationship between the manufacturing methods and the properties and charac-

THE INTERMITTENT FEED *on the*

New Cincinnati No. 5 Miller



This is the feature that has made our Automatics so successful. You simply set dogs to give the cycle of movement suited to the work. There is nothing complicated about it. It is merely an extension of the application of the usual dogs used on all millers for limiting the table travel. When you want it, you set the dogs. When you don't want it, you omit the dogs and control the machine just as you control a machine that does not have intermittent feed.

Assume the machine ready to start. The operator engages the feed. The table advances at 100″ per minute to the work; dog "A" trips to the feed rate; dog "B" engages the forward quick traverse between the pieces; dog "C" again trips to the feed rate and dog "D" engages the forward quick traverse, while immediately behind it dog "E" automatically reverses the quick traverse movement, which brings the machine back to the starting point and it is stopped by dog "F."

This is only one of some twenty different cycles obtainable by different settings of the dogs.

The Cincinnati Milling Machine Company

CINCINNATI **OHIO, U. S. A.**

teristics of the product. The book is divided into fourteen chapters as follows: Classification of Iron and Steel; Iron Ore and its Preparation for Smelting; Pig Iron and its Production; Wrought Iron and its Manufacture; Classification and Characteristics of Steel; Crucible Steel; Bessemer Process; Open-hearth Steel; Electric Steel; Rolling and Drawing Bars, Rails, Plates, Shafting, and Wire; Structural Carbon and Alloy Steels; High-speed Steel; Cast Iron; Steel Castings. Under each of these main chapter headings there are numerous sub-headings, and as the book is carefully indexed, it is very easy to locate exactly the information that is required on any particular subject.

It is believed that the treatment of these different subjects will be appreciated by designers of machinery and tools as well as by manufacturers and workers in metal, who realize that the knowledge of the materials which are so closely related to their work is not only of great value and interest to all of them, but absolutely essential in many instances, especially at the present time when so many different grades of iron and steel are used in the industries.

COMING EVENTS

September 16-19—Annual meeting of the Traveling Engineers' Association in Chicago, Ill.; headquarters, Hotel Sherman. Secretary, W. O. Thompson, General Offices, N. Y. C. R. R., Cleveland, Ohio.

September 22-27—Meeting of the American Institute of Mining and Metallurgical Engineers in Chicago, Ill.; headquarters, Congress Hotel.

September 22-27—First annual convention and exhibit of the American Steel Treaters' Society in Chicago, Ill. Business manager, W. H. Eisenman, 154 E. Erie St., Chicago, Ill.

September 23-25—Fall meetiog of the American Electrochemical Society in Chicago, Ill.; headquarters, Congress Hotel.

September 25—Monthly meeting of the Rochester Society of Technical Draftsmen, in Rooms 131-137 Sibley Block, 328 Main St., E., Rochester, N. Y. Secretary, O. L. Angevine, Jr., 547 Arnett Blvd., Rochester, N. Y.

September 29-October 4—Eighth annual congresa of the National Safety Council at Cleveland, Ohio.

September 29-October 4—Twenty-fourth annual meeting of the American Foundrymen's Association and fourteenth annual exhibit of foundry and machine shop equipment and supplies in Philadelphia, Pa. Secretary, C. E. Hoyt, 111 W. Monroe St., Chicago, Ill.

October 1-4—Eighth annual safety congress of the National Safety Council in Cleveland, Ohio. Offices of the council, 168 N. Michigan Ave., Chicago, Ill.

February 2-6, 1920—First annual mechanical inspection equipment exposition and convention of the American Society of Mechanical Inspectors at the Hotel Astor, New York City. Secretary, Henry F. Winter, 35 W. 39th St., New York City.

May 12-15, 1920—Seventh national foreign trade convention in San Francisco, Cal. Secretary of the National Foreign Trade Council, O. K. Davis, 1 Hanover Square, New York City.

SOCIETIES, SCHOOLS AND COLLEGES

University of Notre Dame, Notre Dame, Ind. Circular entitled "How Notre Dame Prepares the Trade Ambassador," containing the curriculum for the course in foreign commerce offered by the university, and also an article entitled "Cultural Equipment for Foreign Trade" an address delivered at the Sixth National Foreign Trade Convention in Chicago.

BOOKS AND PAMPHLETS

Official Report of the Sixth National Foreign Trade Convention. 650 pages, 6 by 9 inches. Issued by the Secretary, National Foreign Trade Council, 1 Hanover Square, New York City. Price, $2.

Effect of Rate of Temperature Change on the Transformation in an Alloy Steel. By Howard Scott, assistant physicist of the Bureau of Standards. 12 pages, 7 by 10 inches. Published by the Department of Commerce, Washington, D. C., as Scientific Paper No. 335 of the Bureau of Standards. Price, 5 cents.

The Spacing and Depth of Laterals in Iowa Underdrainage Systems and the Rate of Run-off from them with Data from Investigations. By W. J. Schlick. 119 pages, 6 by 9 inches. Published by the Engineering Experiment Station of the Iowa State College of Agriculture and Mechanic Arts, Ames, Iowa, as Bulletin No. 52.

Constitution and Microstructure of Silica Brick and Changes Involved through Repeated Burnings at High Temperatures. By Herbert Insley, laboratory assistant, and A. A. Klein, assistant physicist of the Bureau of Standards. 31 pages, 7 by 10 inches. Published by the Department of Commerce, Washington, D. C., as Technologic Paper No. 124. Price, 10 cents.

Location of Starting and Lighting System Troubles Made Easy. Chart arranged by Victor W. Page. 23 by 38 inches. Published by the Norman W. Henley Publishing Co., 2 W. 45th St., New York City. Price, 50 cents.

This chart comprises a comprehensive treatment of the common derangements of automobile starting and lighting systems, and contains instructions for locating and remedying the trouble. A typical automobile starting, lighting and ignition system is shown, illustrating all of the important components, and wiring diagrams are included showing other popular systems.

One Thousand Technical Books. Compiled by Herbert L. Cowing. 123 pages, 6 by 9 inches. Published by the American Library Association, Library War Service, Washington, D. C.

This pamphlet contains a selected list of all the important technical books, with annotations, arranged by broad subjects, with an index by smaller subjects—giving the title of the book, author, publisher, and price. It is intended primarily for the use of libraries desiring to purchase books of this class, but should also prove of great value to all those who have occasion to look up books on engineering subjects.

Airplane Design and Construction. By Ottorino Pomilio. 399 pages, 6 by 9 inches. Published by the McGraw-Hill Book Co., Inc., 239 W. 39th St., New York City. Price, $5, net.

This book presents in detail the application of aerodynamic research conducted abroad to practical airplane design, the intention being to enable the designer to replace the cut-and-try methods of airplane construction with scientific methods of procedure. The subject matter has been arranged with a view to making the book applicable for use as a text-book in technical schools and colleges. The first three parts of the book deal with the structure of the airplane, and the fourth part with the design.

Readjustment and Reconstruction Information. 188 pages, 6 by 9 inches. Published by the Reconstruction Research Division of the United States Council of National Defense, Washington, D. C.

This pamphlet contains an account of reconstruction activities in foreign countries, and is made up of extracts and digests of articles which have appeared in recent publications. The material consists mainly of accounts of governmental activities in the administration of reconstruction work, and of similar activities of important national, industrial, commercial, and welfare organizations. The report covers all countries which have been affected by the war.

Metal Workers Handy-Book of Receipts and Processes. By William T. Brannt. 582 pages, 4¾ by 7¼ inches. Published by Henry Carey Baird & Co., Inc., 116 Nassau St., New York City. Price, $3, net.

This is a new and enlarged edition of a volume originally prepared as a reference book for those engaged in the various branches of the metal-working trades, presenting a large amount of information on alloys; annealing, hardening, and tempering; bronzing and coloring; casting and founding; electro-deposition of metals; cements; welding; wire manufacture, etc. Several new chapters have been added on flame welding and cutting; thermit welding; electric welding; galvanizing; Schoop's spray process; and die-casting.

Induction Coils in Theory and Practice. By Professor F. E. Austin. 64 pages, 6 by 9 inches; 45 diagrams. Published by the author, Box 441, Hanover, N. H. Price, $1.

This book aims to present the fundamental principles underlying the operation of the induction coil, and to explain these principles in such a way as to enable anyone to construct induction coils to meet a variety of demands as well as for specific requirements. Those who desire to construct coils to operate wireless outfits will find specific instruction for building such coils for large and small ranges. The subject matter presented resulted largely from the writer's experience in directing the courses in radio and buzzer training, Dartmouth Training Detachment, National Army. The book would be more readable and its typographical appearance would be considerably improved if the matter were set leaded instead of solid.

Abrasives and Abrasive Wheels. By Fred B. Jacobs. 340 pages, 6 by 9 inches. Published by the Norman W. Henley Publishing Co., 2 W. 45th St., New York City. Price, $3.

The fact that abrasives and abrasive wheels are used in practically every line of metal-working should make this book of interest to engineers, foremen, foundrymen, mechanics, and superintendents. The author has avoided theory in his treatment as far as possible and has attempted to present only practical information that will be of value in the everyday work of the shop. The scope of the work is indicated by the followiog chapter heads: Natural Abrasive Substances; Artificial Abrasives; The Manufacture of Grinding Wheels; Artificial Sharpening Stones; Grits and Grades; Testing Wheels for Efficiency; Laoratory Tests; Grinding Wheel va. Grindstones; The Economic Advantage of Using Large Wheels; Truing Devices for Grinding Wheels; Rebushing Grinding Wheels; Suggestions to Follow in Ordering Grinding Wheels; Design of Dust-collecting Systems; Safeguarding Grinding Wheels; Abrasive Papers and Cloths; Surface Grinding Operations; Cutter Sharpening; and Saw Sharpening.

NEW CATALOGUES AND CIRCULARS

Ingersoll Milling Machine Co., Rockford, Ill. Circular illustrating the application of Ingersoll adjustable-rail milling machines for rapid production milling.

Firth-Sterling Steel Co., 310-314 Hudson St., New York City. Folder entitled, "A Keen Edge on a Chisel is More Important than a Keen Edge on a Lathe Tool."

Allied Machinery Co. of America, 51 Chambers St., New York City. Circular descriptive of the Landis Tool Co.'s horizontal boring, milling, and drilling machines.

Franklin Specialty Mfg. Co., 540 W. 58th St., New York City. Loose-leaf pamphlet of Anderson adjustable electric light holders and adjustable unit lighting systems.

Earle Gear & Machine Co., 4705 Stenton Ave., Philadelphia, Pa. Catalogue illustrating and describing Earle double-suction single- and multi-stage centrifugal pumps.

Sterling Grinding Wheel Co., Tiffin, Ohio. Booklet giving information concerning the manufacture, grades, grains, operating speeds, etc., of Sterling grinding wheels.

Salter Motor Mfg. Co., 1516 Oakland Ave., Kansas City, Mo. Circular of clamps for the use of oxy-acetylene welders in welding plants, garages, and machine shops.

Morse Chain Co., Ithaca, N. Y. Catalogue 14 (revised edition) showing the application of Morse silent chain for large power drives ranging from 100 up to 5000 horsepower.

Gwilliam Co., 253 W. 58th St., New York City. Bulletin 2 showing details of the S. A. E. standard ball thrust bearings and giving dimensions of the bearings and ball retainers.

Alfred Herbert, Ltd., 54 Dey St., New York City. Circular illustrating and describing the Lumsden periphery grinder, ball-bearing cup-wheel grinder, and oscillating tool grioders.

National Machinery Co., Tiffin, Ohio. National Forging Machine Talk No. 36, describing the operation of forming the "eyes" on brake hangers on a National forging machine.

Cooper Hewitt Electric Co., Eighth and Grand Sts., Hoboken, N. J. Catalogue of Cooper Hewitt electric lamps (direct- and alternating-current outfits) for photographic processes.

Van Dorn Electric Tool Co., Cleveland, Ohio. Catalogue No. 19 of portable electric drills and grinders, illustrating and describing the line built by the company.

Peter A. Frasse & Co., Inc., 417-421 Canal St., New York City. Price list of Frasse polished drill rods for taps, drills, punches, reamers and mechanical tools requiring great accuracy.

Sprague Electric Works of General Electric Co., 527-531 W. 34th St., New York City. Circulars B-3505 and B-3506 descriptive of Sprague electric portable ozonators for deodorization purposes.

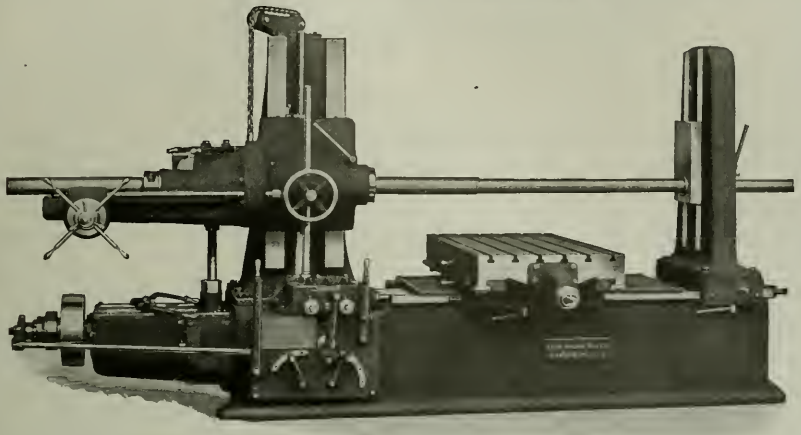
Efficiency Device Corporation, 199-203, 8th St., Long Island City, N. Y. Circular entitled, "Efficiency Dogs and Dog Efficiency," illustrating and describing improved lathe dogs manufactured by the company.

Westinghouse Electric & Mfg. Co., East Pittsburg, Pa. Circular 7375 entitled "Electrical Precipitation," describing the recovery of valuable material from smoke and gases by means of electrical equipment.

C. W. Meade Mfg. Co., Industrial Bldg., Syracuse, N. Y. Circular descriptive of the Kelly ball bearing lubricator and centrifugal or eccentric oiler, designed for connecting-rods, engine work, or centrifugal motion.

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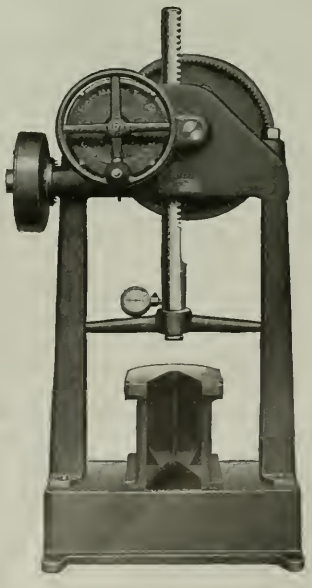
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(And it was only the 4th day of the month).

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Brazo Mfg. Co., Newark, N. J. Catalogue covering flexible metal hose, tubing, and accessories, dealing in detail with the subject of flexible metal hose and describing every type—method of winding, application, and use.

T. P. Walls Tool & Supply Co., Inc., 75-77 Walker St., New York City, is distributing upon request a catalogue illustrating and describing the company's complete line of simplex and duplex emery band and disk grinders.

Ingersoll Milling Machine Co., Rockford, Ill. Circular illustrating and describing Ingersoll drum type continuous milling machines as built especially for Henry Ford & Son to mill the ends of Fordson tractor cylinder castings.

Mehl Machine Tool & Die Co., Roselle, N. J. Circular describing the tool service which this company offers, and showing examples of the classes of jigs, fixtures, dies, gages, and special machines which it is equipped to produce.

Schatz Mfg. Co., Poughkeepsie, N. Y. Catalogue 4, illustrating and describing "Commercial" annular ball bearings. The catalogue also contains illustrated instructions for mounting different classes of ball bearings made by the company.

New Departure Mfg. Co., Bristol, Conn. Circulars Nos. 110 FE, 112 FE, and 113 FE, describing the application of ball bearings to centrifugal basket drive mounting, locomotive headlight generator unit, and motor-driven grinder, respectively.

Davis-Bournonville Co., Jersey City, N. J. Bulletin illustrating and describing the Pyrograph, a boiler shop cutting machine for trimming and beveling boiler sheets to the correct flange height and calking angle in one operation, with the oxy-acetylene torch.

Michigan Machine Co., Detroit, Mich. Circular of "Rollway" lubricant pumps for use in connection with machine tools, made in sizes ranging from ⅛ inch to 2 inches intake and outlet, with capacities ranging from 2 quarts per minute to 150 gallons per minute.

Precision Truing Machine & Tool Co., Cincinnati, Ohio. Circular entitled "Better Grinding and More of It," describing the precision truing tool made by this company, for truing and sharpening grinding wheels, and showing how production can be increased through its use.

Dauber-Kratsch Co., Oshkosh, Wis. Circular illustrating and describing the "Wisconsin" all-gear-driven 20-inch drill press, having four spindle speeds and four changes of feed for each spindle speed. By the use of a two-speed countershaft, eight spindle speeds may be obtained.

Kales Stamping Co., W. Lafayette Blvd., Detroit, Mich. Catalogue illustrating samples of the stamped metal parts produced by the company, and views in the plant. The book also contains a list of sizes of special washer dies and gang dies, as well as tables of weights of steel gages, sheet brass, copper sheets, and cold-rolled strip, band, and hoop steel.

Cleveland Milling Machine Co., Cleveland, Ohio. Catalogue B containing a list of the standard sizes of milling cutters made by this company, and giving dimensions, prices, etc. The catalogue also contains tables giving tap drill sizes for U. S. standard threads and A. S. M. E. standard machine screws, decimal equivalent tables, tables of cutting speeds, and weights of round bars of high-speed and carbon steel.

A. P. Munning & Co., manufacturers of electroplating and buffing apparatus and supplies, 50 Church St., New York City. Bulletin 1000, entitled "Buffing and Polishing Composition," giving authoritative data useful to those who employ such compositions in their work. The bulletin covers abrasives, greases, and compositions employed in buffing and polishing, including the compositions known as "Zucker's Acme" brands.

Smalley-General Co., Inc., Bay City, Mich. Circular illustrating and describing the Smalley-General No. 1 thread-milling machine, which is made in two sizes having capacities for milling threads up to 5 or 6 inches in length by 16 inches in diameter. Circular describing the application of thread milling to oil and gas well supplies and fittings, and showing illustrations of Smalley-General thread milling machines especially adapted for this class of work.

Metalwood Mfg. Co., Detroit, Mich. Circular B 23 descriptive of Metalwood "A" type universal hydraulic arbor and forcing presses, which are made in three sizes having capacities of 35, 60 and 100 tons, respectively. Circular B 47 of Metalwood 20-ton hydro-pneumatic assembly presses. Circular describing hydraulic accumulators of different types made by the company, including multiple weight type, yoke suspension guided; case weighted type, yoke suspension guided; moving ram type with three-point suspension; and moving cylinder type with center suspension.

TRADE NOTES

Camden Forge Co., Camden, N. J., has established a New York district sales office at 2 Rector St., with Samuel W. Hilt in charge as manager.

Lanham Cotton Cultivator Co., 425 Empire Bldg., Atlanta, Ga., has purchased ground for the erection of a factory for manufacturing a cotton chopper-cultivator. Plans for the factory building and equipment are now being prepared.

Chatham Die-Casting Co., Inc., 128 Mott St., New York City, has taken over all the assets and liabilities of the Chatham Machine & Tool Works, and all business will be conducted under the name of Chatham Die-Casting Co., Inc. The officers will remain the same as heretofore.

Hathaway Machinery Co., N. Water and Elm Sts., New Bedford, Mass., has succeeded to the business that has been conducted by Chester F. Hathaway since 1910. The concern will be continued under the same management and organization as in the past.

Electric Furnace Co., Alliance, Ohio, has recently shipped to the Dayton Engineering Laboratories, Dayton, Ohio, an electric furnace for melting and refining aluminum in the "Delco" plant. The furnace has a hearth capacity of 500 pounds and a melting rate of 200 pounds of aluminum per hour.

Van Dorn Electric Tool Co., Cleveland, Ohio, manufacturer of portable electric drills and grinders, announces that the company's Chicago office has been moved to new and larger quarters at 727 S. Dearborn St., where an extensive stock of Van Dorn portable electric drills and grinders and a complete stock of spare parts will be carried.

Timken Roller Bearing Co. has awarded contracts for the erection of a new plant at Columbus, Ohio. It is stated that the main building will be 482 by 282 feet, and in addition there will be a building 160 by 61 feet devoted to heat-treatment, a boiler house, and a storage building, each of brick with steel sash and of saw-tooth construction.

Alemite Metals Co., Chicago, Ill., will hereafter be known as the Alemite Die-Casting & Mfg. Co. The new name has been selected in order to cover more fully the scope of the activities of the company, which have changed from exclusive die-casting to die-casting and manufacturing. The personnel of the company will remain the same.

Machinery Merchants, Inc., 50 Church St., New York City, announces that in order to eliminate the confusion which the present name of the company invites and in order to establish the more personal relation the new name of the company suggests, it will hereafter be known as Morey & Co., Inc. There has been no change in the personnel of the company.

Detroit Reamer Salvage Co., 818-820 W. Warren Ave., Detroit, Mich., has changed its name to the Grinding Process Tool Co. The capital of the company has been increased to provide for a larger organization, equipped to remanufacture all types of precision metal-cutting tools. The president of the company is S. A. Cogsdill, and the secretary-treasurer, W. W. Blakely.

Onondaga Steel Co., Syracuse, N. Y., has increased its capitalization from $150,000 to $1,000,000, to permit of expanding its plant in order to take care of its rapidly increasing business. It is planned to erect several new buildings, including an annealing plant, 160 by 40 feet, an 80-foot extension to the present mill building, and several smaller service buildings.

Duff Mfg. Co., Pittsburg, Pa., has constructed an addition, 160 by 80 feet, to its works. The new building is of brick and steel and designed to accommodate the forge shop and heat-treating department of the company. Provision has been made for installing sixteen steam hammers, with an equal number of trimming presses. The completion of the new forge shop about October 1 will enable the company to largely increase its production of Duff jacks.

Samson Tractor Co., Janesville, Wis., announces that contracts have been let for the erection of a foundry which will be one of the largest foundries in the state of Wisconsin. The engineering contract has been awarded to the Frank D. Chase Co. The building will cover a total ground space of 322 by 500 feet, and it is expected that it will be completed January 1, 1920. Nearly 1000 persons will be employed when the foundry starts operation.

Charles H. Higgins and Delano & Aldrich, associated architects and engineers, have discontinued the association of the two firms made during the war, and each firm will now continue its practice independently. The firm of Delano & Aldrich will remain in their offices at 126 E. 38th St., New York City, and the firm of Charles H. Higgins will remove to offices at 19 W. 44th St., where it will continue its practice in planning and supervising the construction of buildings and manufacturing plants.

Sommer-Adams Co., has recently been organized in Cleveland, Ohio, with a capitalization of $100,000, to engage in the manufacture of special machinery, gages, tools, and fixtures, for the metal-working industries. The officers of the company are W. H. Reedy, president, L. A. Sommer, vice-president and general manager, and Frank H. Adams, secretary and treasurer. L. A. Sommer has been connected with the Allen Motor Co. for more than four years, and will still retain his interest in that company, continuing to serve upon the board of directors.

Page Steel & Wire Co., 30 Church St., New York City, has opened a branch office in Chicago, at 29 S. La Salle St., which will handle all the "Armco" iron products, including welding rods, wires, fencing, etc. The company has opened another new branch office in the Book Bldg., Detroit, Mich. Distribution in Canada is handled by Taylor & Arnold, Ltd., Montreal, Toronto, and Winnipeg. Local distributors for "Armco" iron welding rods are located in all the principal industrial centers. The sales of the "Armco" iron department are under the supervision of W. T. Kyle, sales manager, at 30 Church St., New York City.

Dantzig, Pfeiffer & Ritt is a firm that has recently been formed at 500 W. 116th St., New York City, to engage in work as consulting mathematicians, handling all problems that arise in industry, the solution of which requires the knowledge of a mathematical specialist. Each of the members of the firm has been privately engaged for some time in work of this nature, having taught at Harvard, Princeton, and Columbia. During the war, Dr. Dantzig was in charge of the mathematical work of the Instrument Section of the United States Ordnance Department, and Dr. Ritt was one of the chief ballisticians of the Ordnance Department.

Carborundum Co., Niagara Falls, N. Y., will depart somewhat from its usual exhibit at the forthcoming annual convention of the American Foundrymen's Association at Philadelphia. This year carborundum refractories will be featured in addition to the regular exhibit of carborundum and aloxite wheels for foundry grinding work and the general exhibit of carborundum abrasive products. In the company's section there will be a Gilbert & Parker furnace, in operation, equipped with an entire lining of carborundum refractory material. Another new product to be exhibited and demonstrated is carborundum refractory cements, as well as other carborundum products, such as "Carbofrax" and "Refrax" brick.

D. Nast Machinery Co., Bourse Bldg., Philadelphia, Pa., announces that it has been appointed exclusive representative for the Cleveland Milling Machine Co.'s line of high-power milling machines and profile grinders, the Cleveland Machine Tool Co.'s line of horizontal boring, drilling, and milling machines, and the Cleveland Planer Co.'s line of open-side planers. A complete line of sample machines will be carried in the Philadelphia display rooms. The company has also been appointed exclusive sales agent for the Rivett Lathe & Grinder Co. of Boston, and will carry in the Philadelphia warehouse a complete assortment of Rivett precision lathes and grinders, and attachments, ready for immediate delivery.

James T. Winterling & Co., dealers in mill, mine and contractors supplies, has been organized and opened business in Conestoga Bldg., Pittsburg, Pa. The organization consists of James T. Winterling, president; J. L. McConaghy, vice-president; and C. W. Elton, secretary and treasurer. Mr. Winterling has previously been in the contracting business in Pittsburg; Mr. McConaghy has been with the firm of James H. Matthews & Co., Pittsburg, Pa., for the past three years, previous to which he was engaged in engineering work for the city of Pittsburg; and Mr. Elton has been in the service of James H. Matthews & Co. for the past seven years. The Winterling Co. will represent exclusively the Aborn Steel Co., the Philadelphia Belting Co., the Holyoke Truck Co., the Acme Waste Co., and many other concerns.

Tacony Steel Co., and the **Tacony Ordnance Corporation**, of Tacony, Philadelphia, Pa., announce the purchase of the Ordnance Corporation plant by the Tacony Steel Co., and the consolidation of the respective metallurgical and manufacturing organizations. The Tacony Ordnance Corporation was organized in August, 1917, by J. B. Warren, who was then secretary, and who is now president and general manager of the Tacony Steel Co., and by George Satterthwaite, vice-president and treasurer. With the acquisition of the new plant, the Tacony Steel Co. will control the quality of its product from the melting to the shipment. The consolidation does not affect the officials or management, the same officers and directors being retained. The officers are as follows: President, J. B. Warren; vice-president and treasurer, George Satterthwaite; and secretary, Henry T. Stetson.

Chicago Pneumatic Tool Co., 1060 Fisher Bldg., Chicago, Ill., announces its plans for moving its general offices from Chicago to New York and expects to erect an office building for this purpose at 6-8 E. 44th St., New York City. The structure is of combination steel, brick, and limestone, and will comprise ten stories, all to be occupied by the company. The ground floor is to be a permanent exhibition room and will contain a display of the company's products, including "Boyer" pneumatic hammers, "Little Giant" pneumatic and electric tools, rock and coal drills, "Giant" oil and gas engines, air compressors, etc. In conjunction, a completely equipped service station will be maintained. The operation of the company's six American plants and twenty-six sales and service branches can be directed more economically from New York. There will be continued in Chicago a sales and service organization more extensive than formerly. The new building is to be ready for occupancy early in 1920, at which time the transfer will be effected.

VOLUME 26 **MACHINERY** NUMBER 2

OCTOBER, 1919

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Principal Articles to Appear in November MACHINERY

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USE OF PRECISION BALLS FOR ACCURATE MEASUREMENTS .. *R. L. Rankin*

DESIGNING CHANGE-GEARS ..... *W. C. Steuart*

MAKING DIAMOND WIRE-DRAWING DIES ..... *Edward K. Hammond*

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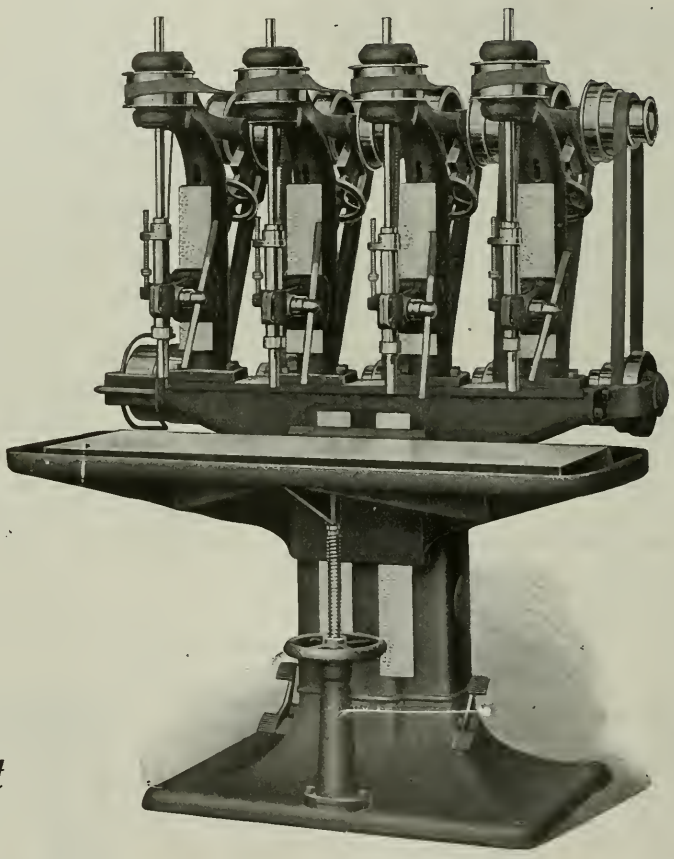
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Turret Lathe Practice

By Erik Oberg

Examples of Turret Lathe Practice Based Upon the Experience and Practice of the Service Department of the Gisholt Machine Co., Madison, Wis.—First of a Series of Four Articles on Turret Lathe Tooling Equipment

THE work that may be performed on turret lathes has been dealt with in the past only by occasional articles in the trade and engineering press. On account of the importance of the turret lathe in the modern machine shop and the possibilities that this machine tool presents for the rapid and accurate production of work that, when performed by other methods, would become much more costly, a more comprehensive treatise on this subject is required.

Because of the character of the work performed on the turret lathe and the very important part that the lay-out of the various operations and the tooling equipment play in successful turret lathe practice, it has been deemed advisable to deal with this subject by presenting actual examples, showing the complete tooling lay-outs, giving detailed descriptions of the order of operations and methods of holding the work, together with photographs showing the machines actually set up with the tooling equipment and the work in place. The examples that have been selected are those for which the turret lathe is especially suited, and where the saving of time is the greatest. The series of articles beginning in this number of MACHINERY, dealing with turret lathe practice, will cover tooling lay-outs and orders of operation for flywheels, truck wheels, automobile engine cylinders, cone clutch parts, motor frames, axle housings, wheel hubs, and valves.

In addition, examples of work will be shown which can be successfully performed on a turret lathe, although the work might also be performed on other machine tools. There are, for example, many instances when a turret lathe will not continually be kept busy on the work for which it is primarily installed and on which the greatest saving is

The Gisholt Machine Co. maintains a service department engaged in the solving of difficult problems in machining work on the turret lathe for its customers. Providing, as this service department does, the solution for between 800 and 900 such problems annually for its customers throughout the industrial world—including the laying out of tooling equipments for performing the various operations, outlining the methods for obtaining maximum production, building and testing all the tooling equipments thus planned and designed, and training operators for the company's customers in a special training school in order to insure the proper maintenance and use of the machines and the equipment—it is evident that a vast amount of accumulated data was available from which the information required to make this series of articles comprehensive and instructive could be drawn. The illustrations have been selected from a file of 4000 photographs kept by the service department as a record of past performances, every tooling equipment, when tested out in the company's plant, being photographed for a permanent record which can be consulted at any future time.

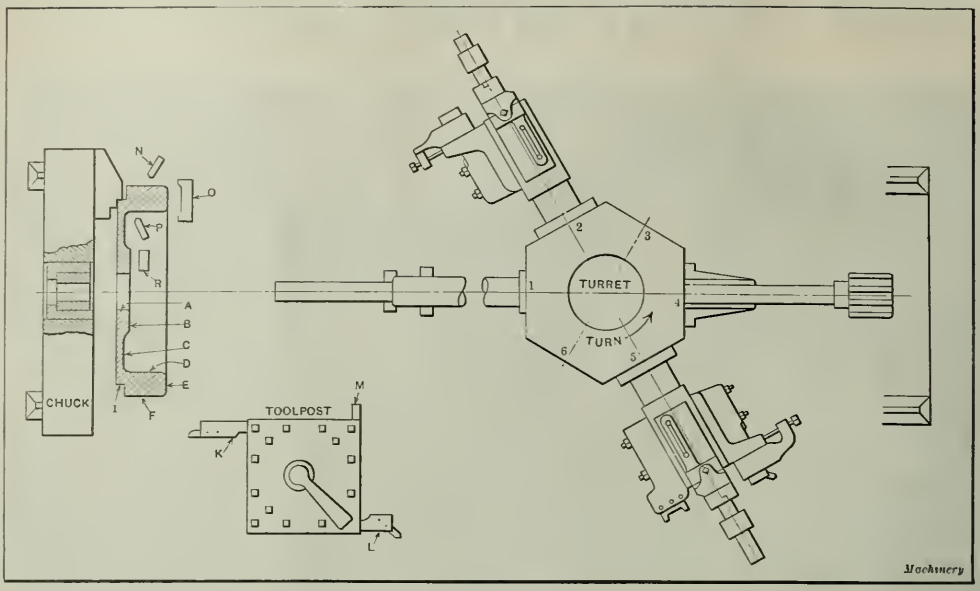


Fig. 1. Tooling Lay-out for First Operation on Flywheel

accomplished. In that case, it is evidently of advantage to fill in the idle time with such work as can be performed satisfactorily on this machine, although the machine would not have been bought for this work exclusively.

In dealing with the examples of turret lathe practice that will be explained in the following, the time for each operation is given; this time is the "floor to floor" time and includes the time required for chucking the work in the machine and for removing the finished part. The material from which the various parts, the machining of which is described, are made is also given, so that all the factors involved may be properly understood. The great detail in which the sequence of operations (or steps in each operation) is given will make it possible to follow thoroughly the methods used in machining. It is believed that a careful study of the sequence of the various steps in performing the machining work will give the reader a comprehensive idea of the principles involved in turret lathe tooling, and enable him to understand the reasons underlying the selection of various tools and the order in which they are used.

Tool Lay-out for Finishing Flywheels

Fig. 3 shows a flywheel used in connection with an electric starter for an automobile. This flywheel is finished all over in two operations, the tooling lay-out for the first operation being shown in Fig. 1, and the lay-out for the second operation in Fig. 2. A photograph showing the tooling for the first operation is shown in Fig. 4, and for the second operation, in Fig. 5. There is a slight modification in the arrangement in Fig. 4 as compared with Fig. 1. Side 2 of the turret in Fig. 1 has the turning tool in the front arm of the facing head, while in Fig. 4 it is shown in the rear. Side 5

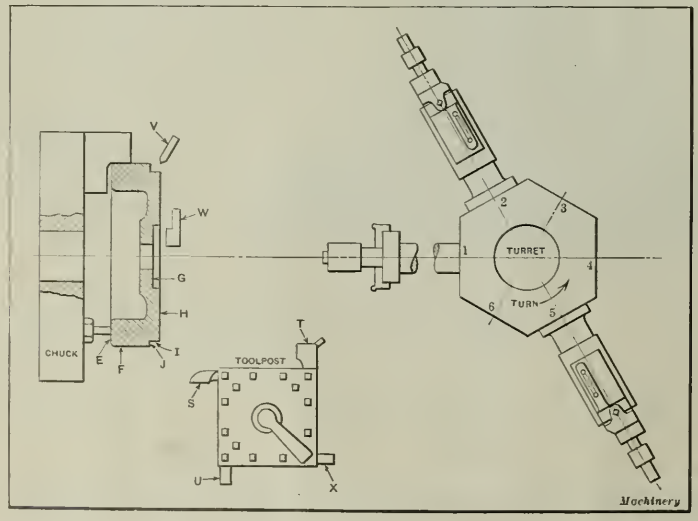


Fig. 2. Tooling Lay-out for Second Operation on Flywheel

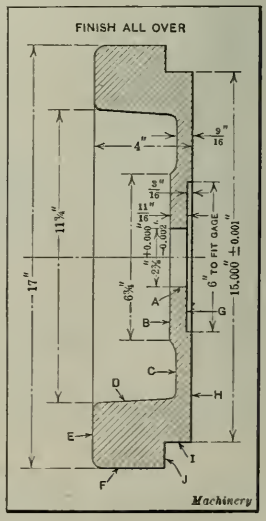


Fig. 3. Drawing of Flywheel

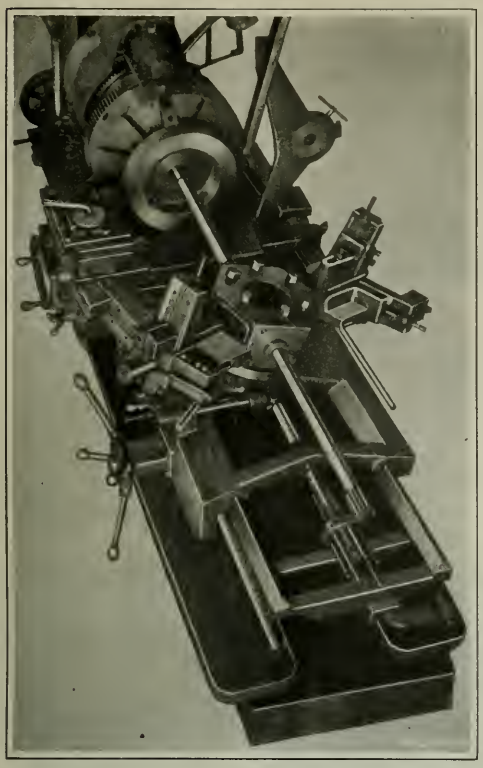


Fig. 4. Machine set up for performing First Operation on Flywheel

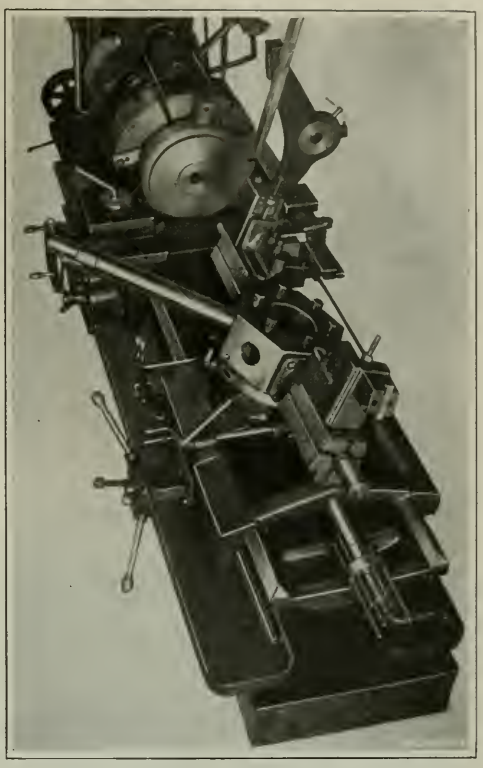


Fig. 5. Machine set up for performing Second Operation on Flywheel

of the turret in Fig. 1 also shows the cutter in the front arm, while in Fig. 4 it is shown in the rear arm. Fig. 6 shows a detail view of the work as held in the first operation with the boring-bar for the hole just entering the work, while Fig. 7 shows a detail view of the work as held for the second operation, the bar and tool for finishing the counterbore being shown as it is being withdrawn from the work. These views are so clear as to require but little explanation.

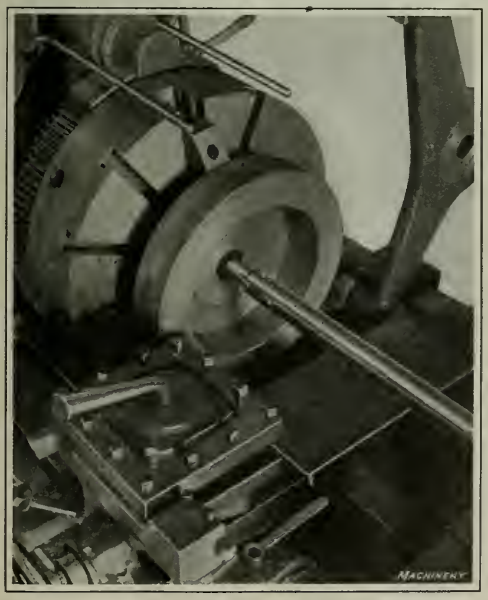


Fig. 6. Detail View of Work as held in First Operation

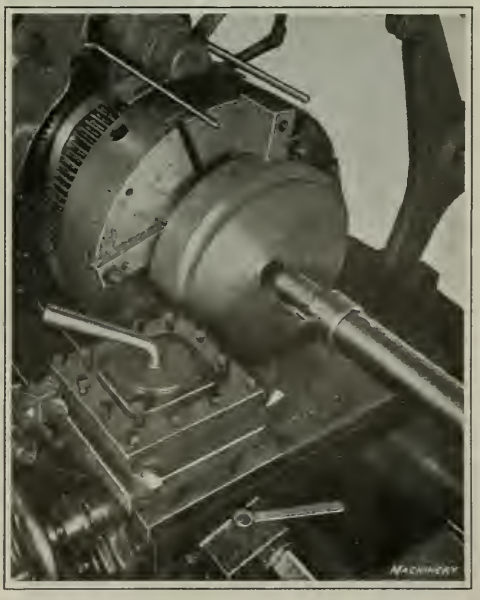


Fig. 7. Detail View of Work as held in Second Operation

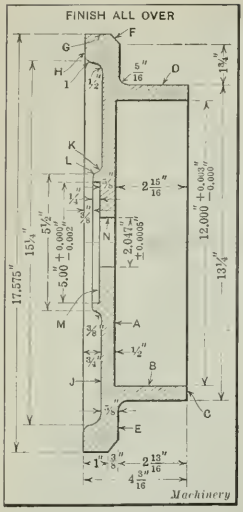


Fig. 8. Automobile Flywheel

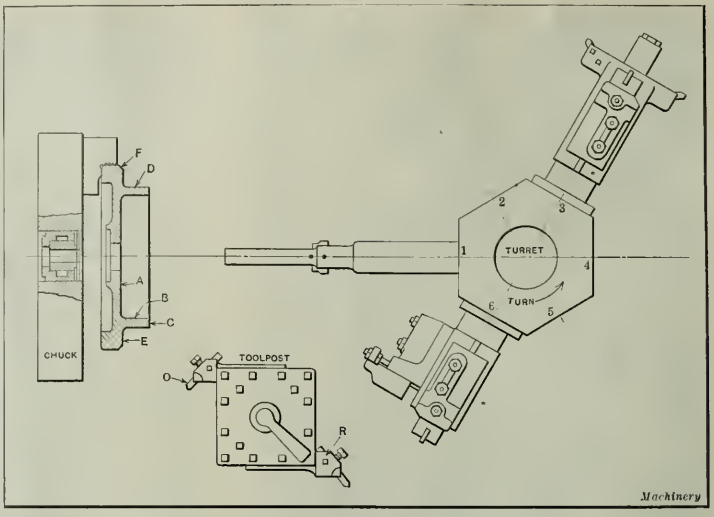


Fig. 9. Tool Lay-out for First Operation on Flywheel in Fig. 8

This work as shown is performed on a 24-inch Gisholt turret lathe. The material of the flywheel is cast iron. The first operation, Fig. 1, consists in finishing surfaces *A*, *B*, *C*, *D*, *E*, and *F*, the order of operations being as follows: (1) The work is held in the chuck by special hard jaws clamping on surface *I*. (2) Hub *B* is rough-faced by tool *K* in the toolpost. (3) Surface *C* is faced by the same tool. (4) Surface *D* is rough-bored by still using tool *K* in the toolpost. (5) Finally, surface *E* is faced by

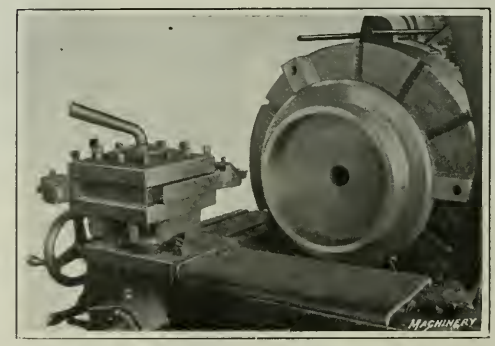


Fig. 10. Method of holding Flywheel in First Operation

tool *K*. (6) Hole *A* is rough- and finish-bored by the boring-bar in Side 1 of the turret. (7) Hole *A* is reamed with the reamer held in Side 4 of the turret. (8) The outside surface *F* of the flywheel is rough-turned with tool *L* held in the toolpost, followed by the facing head mounted in Side 2 of the turret. (9) The outside surface *F* is finish-turned, surface *E* is faced and the corners rounded, and surface *D* is finish-bored with the facing head mounted in Side 5 of the turret. It will be noted that in Operation (6)

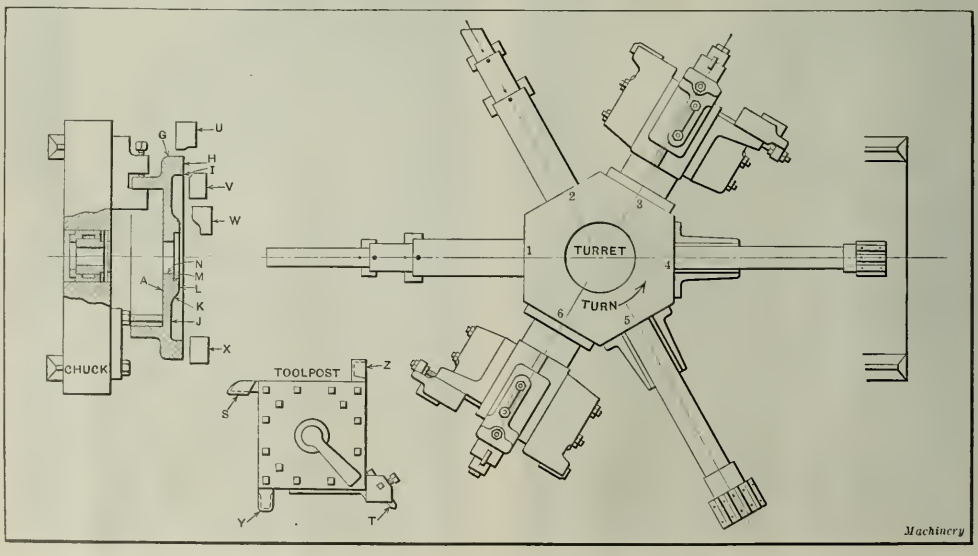


Fig. 11. Tool Lay-out for Second Operation on Automobile Flywheel

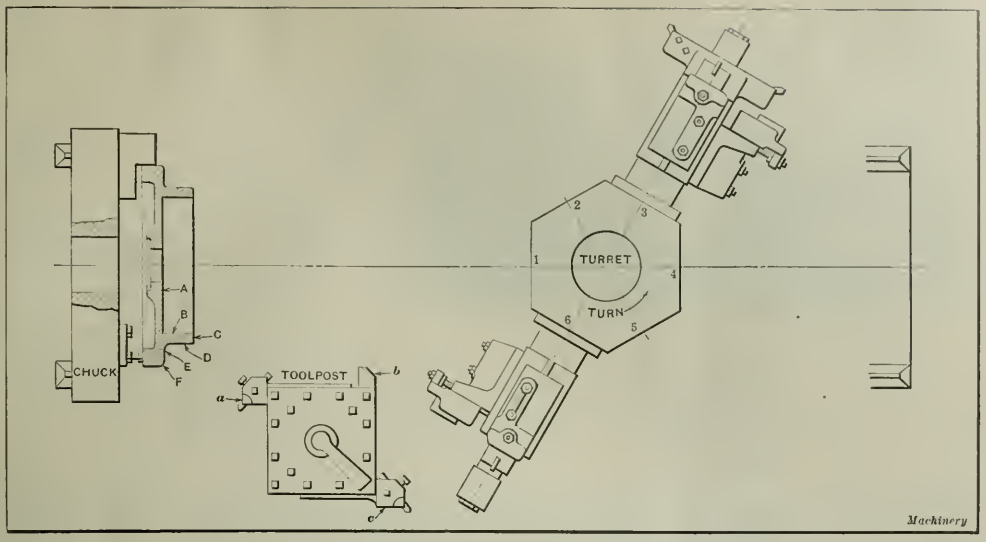


Fig. 12. Tool Lay-out for Third Operation on Automobile Flywheel

a pilot enters a bushing in the chuck, and in Operations (8) and (9) pilots enter bore *A* of the flywheel, thus insuring that outside surface *F* and bore *D* will be turned and bored true with hole *A*. The facing head mounted in Side 5 of the turret has four arms, as will be seen in Fig. 4, each of which carries one tool, the relative positions of these tools being shown diagrammatically at *N*, *O*, *P*, and *R*, Fig. 1. Cutter *N* is mounted in the top arm and finishes the surface *F*; cutter *O* is held in the rear arm and finishes *E*; cutter *P* is mounted in the front arm and finishes bore *D*; and cutter *R* is mounted in the bottom arm and finishes hub *B*. Face *E* is finally finished with tool *M* in the toolpost, face *B* being

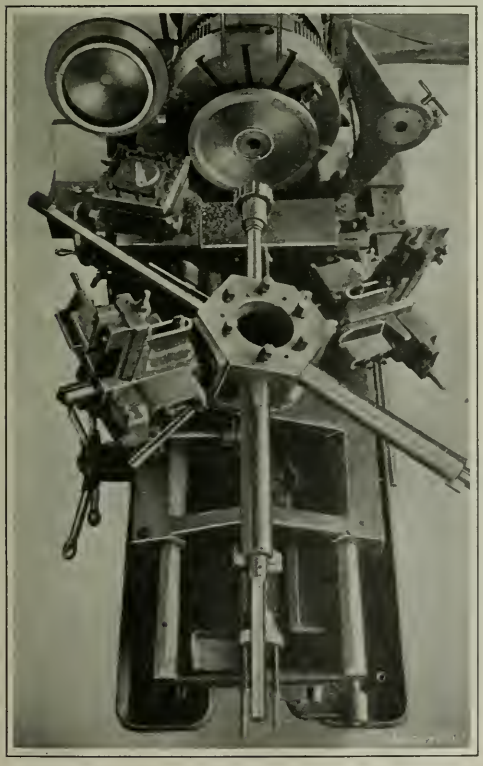


Fig. 13. Machine set up for Second Operation on Antomobile Flywheel

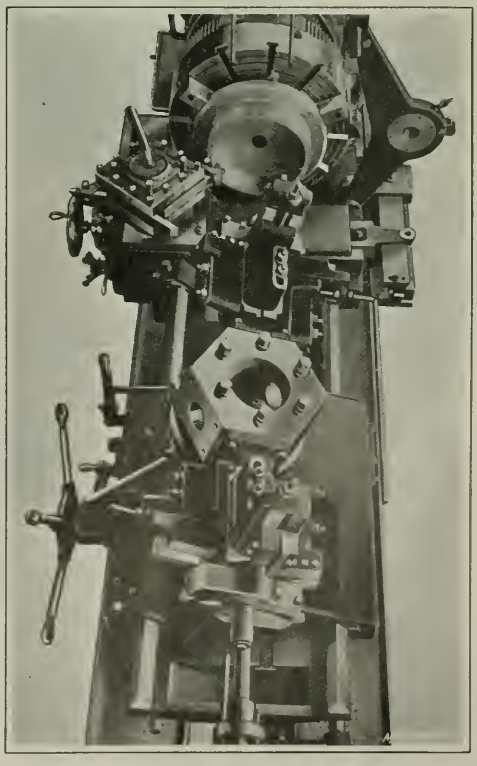


Fig. 14. Machine set up for Third Operation on Automobile Flywheel

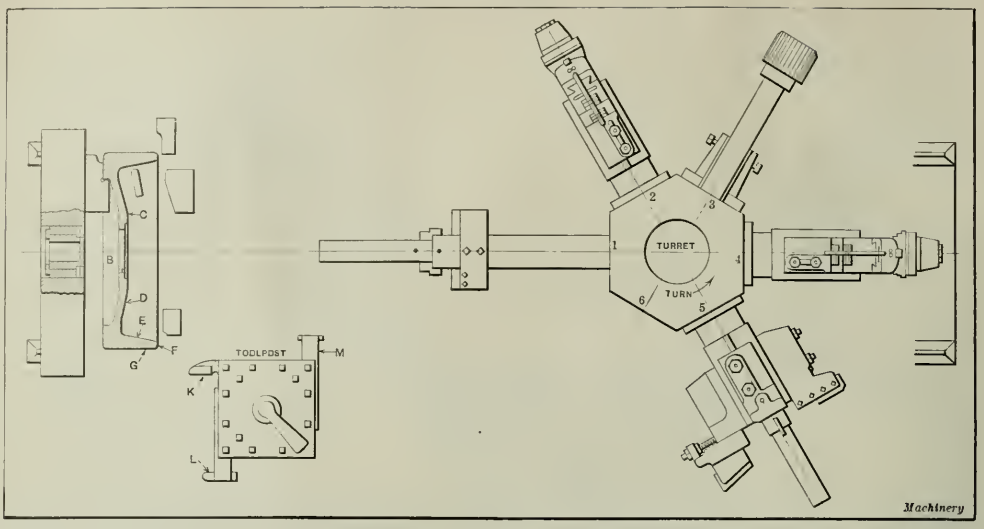


Fig. 15. Tooling Equipment for First Operation on Flywheel in Fig. 16

afterward finished by the same tool. The total time required for the first operation is 25 minutes.

In the second operation, Fig. 2, the work is finished in the following order: (1) The work is held by soft chuck jaws at *F* and supported as shown at *E*. (2) Surfaces *G* and *H* are rough-faced with tool *S* held in the toolpost. (3) Surface *J* is finished with tool *T* in the toolpost. (4) Hub *H* is faced with tool *U* in the toolpost. (5) A second roughing cut is taken on surfaces *G* and *J* and a roughing cut is also taken on surface *I* with cutters held in the facing head mounted in Side 2 of the turret. This head is provided with a pilot which enters the bore in the flywheel, thus insuring the concentricity of the cuts taken. As shown in Fig. 5, the facing head in the turret is provided with a top and a bottom arm, cutter *V*, Fig. 2, which finishes surfaces *J* and *I*, being held in the top arm, and cutter *W*, which finishes surface *G*, being held in the bottom arm. (6) Surfaces *G*, *I*, and *J* are finished with cutters held in the facing head mounted in Side 5 of the turret, this head being identical in construction with that used in the preceding step for roughing. (7) Counterbore *G* is given another finishing cut with the cutter in the head mounted in Side 1 of the turret. (8) Finally, the face of the counterbore is finished with tool *X* in the toolpost. The total time required for the second operation is 15 minutes.

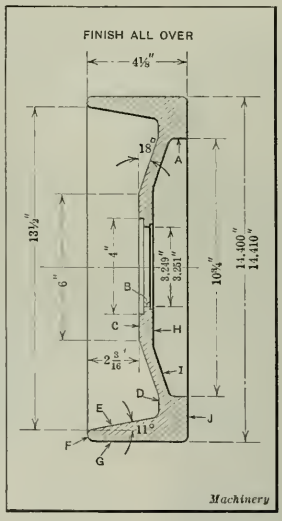


Fig. 16. Flywheel of Unusual Design

Tool Lay-out for an Automobile Flywheel Having Thin Sections

Fig. 8 shows an automobile flywheel made from semi-steel, where the sections are comparatively thin. In finishing this flywheel on the turret lathe, three operations are required instead of two, because there is a great deal of stock to be removed, and as the sections are not heavy, there would be considerable distortion if all the stock were removed at once on each side of the flywheel. In cases of this kind, one or more extra operations may be found necessary in order to overcome the difficulty caused by distortion. The first operation is simply the roughing of one side; then the other side is roughed and finished

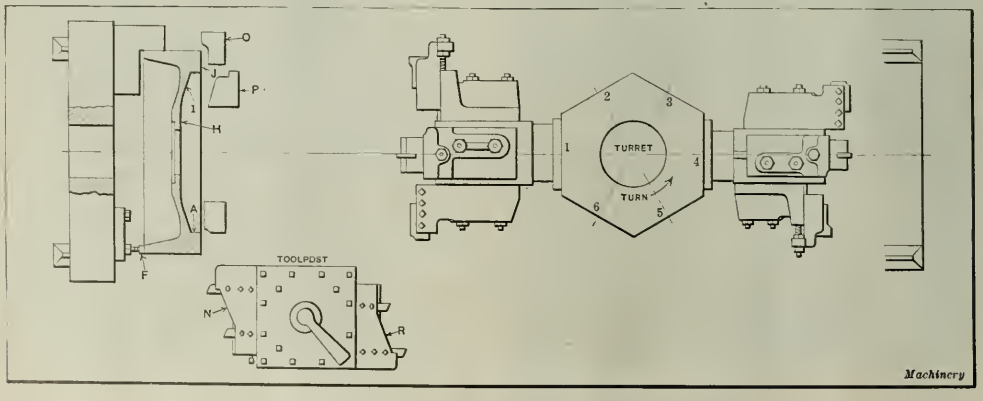


Fig. 17. Tooling Equipment for Second Operation on Flywheel in Fig. 16

in the second operation; and, finally, the flywheel is rechucked and the first side, which was roughed only, is now finished. Fig. 9 shows the tool lay-out for the first operation; Fig. 11, for the second operation; and Fig. 12, for the third operation. The rough-turned flywheel and the method by which it is held in the first operation are shown in Fig. 10. Fig. 13 shows the complete tool outfit for the second operation with the flywheel in position in the machine, while Fig. 14 shows the tooling arrangement for the third operation, this view corresponding to the line illustration, Fig. 12.

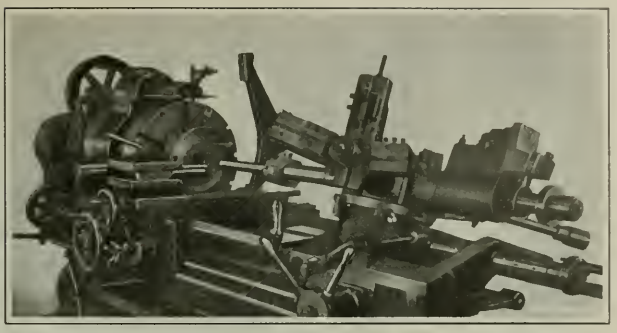


Fig. 18. Front View of Machine set up for First Operation on Flywheel in Fig. 16

The first operation, which consists in roughing one side of the flywheel, as shown in Fig. 9, is performed as follows: (1) The work is held with special hard chuck jaws, as indicated. (2) The bottom *A* is rough-faced with tool *O* in the toolpost, and the hole is bored with the cutter mounted in the bar in Side 1 of the turret. (3) The inside and outside cylindrical surfaces *B* and *D* are bored and turned, respectively, with the facing head mounted in Side 3 of the turret. The head shown mounted in Side 6 of the turret is not used, but is mounted in position simply to balance the turret. (4) Surfaces *C*, *E*, and *F* are rough-faced with tool *R* in the toolpost. The first operation is completed in 8 minutes.

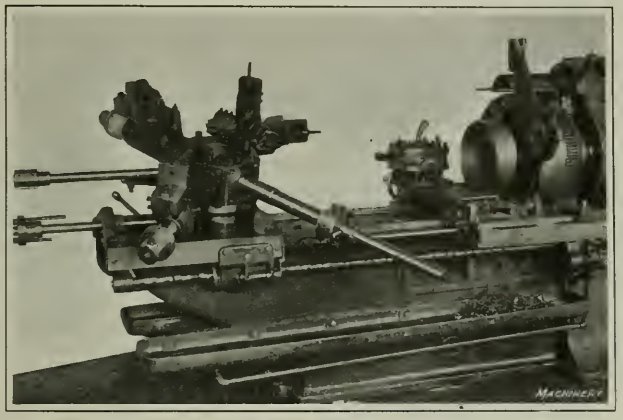


Fig. 19. Rear View of Machine set up for First Operation on Flywheel in Fig. 16

In the second operation, the work is held as shown in Fig. 11, and one side of the flywheel is both roughed and finished complete. The work is accomplished in the following order: (1) The work is held by special jaws, as indicated, and chuck jacks are used to support it against surface *A*. (2) Surfaces *H*, *I*, *J*, *K*, *L*, and the bottom of counterbore *M* are rough-faced by tool *S* in the toolpost. (3) Bore *N* and counterbore *M* are rough-bored with cutters in the bar mounted in Side 1 of the turret. (4) Bore *N* and counterbore *M* are finished with cutters in the bar mounted in Side 2 of the turret. The bars used in the last two steps are provided with pilots which enter a bushing in the chuck. (5) Bore *N* is reamed with the reamer mounted in Side 4 of the turret. (6) The outside surface *G* is rough-turned with tool *T* mounted in the toolpost, this tool being followed by the facing head mounted in Side 3 of the turret, which roughs surfaces *G*, *H*, *I*, and *L*. This facing head is provided with a pilot entering the bore of the flywheel. The tool *U*, turning surface *G*, is held in the top arm, cutter *V* is held in the front arm, cutter *W* is held in the bottom arm, and cutter *X*, in the rear arm of the facing head. (7) Surfaces *G*, *H*, *I*, and *L* are now finished by the tools held in the facing head mounted in Side 6 of the turret, the arrangement of the tools being the same as for Step (6), and the head being piloted in the bore of the flywheel in the same manner. (8) Surfaces *J* and *H* are finally finished with tool *Y* held in the toolpost. (9) The bottom of the counterbore *M* is finished by tool *Z* held in the toolpost. (10) The cylindrical surface of the counterbore *M* is finished by a reamer held in Side 5 of the turret. The total time required for the second operation is 10 minutes.

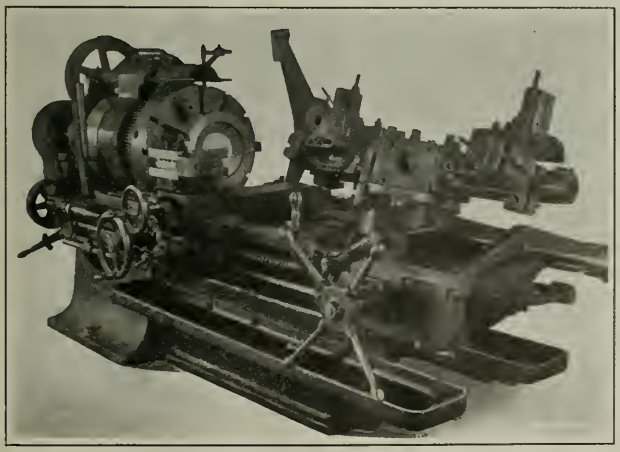


Fig. 20. Front View of Machine set up for Second Operation on Flywheel in Fig. 16

Fig. 12 shows the tooling arrangement for the third operation, which consists in finishing the side of the flywheel which was rough-machined in the first operation, the work being carried out in the following order: (1) The flywheel is held with soft jaws and supported by chuck jacks. (2) The outside of the cylindrical surface *D* and face *E* are roughed by tool *c* in the toolpost. (3) Surfaces *B* and *C* are rough-machined and surfaces *D* and *E* are finished with tools mounted in the facing head in Side 3 of the turret; this facing head is piloted in the bore of the flywheel. (4) The bottom *A* of the counterbore is finish-faced with tool *a* in the toolpost. (5) Surfaces *B*

and *C* are finished with cutters held in the facing head mounted in Side 6 of the turret. (6) The chamfer at *F* is finished with tool *b* held in the toolpost. The total time for the third operation is 10 minutes, or for all three operations, 28 minutes.

Tooling Equipment for Flywheel having an Angular Web

Fig. 16 shows a flywheel which is of unusual design in that it has a central web, part of which is at an angle with the axis of the flywheel. The material from which the wheel is made is cast iron. It is finished all over on a 24-inch Gisholt turret lathe in two operations, Fig. 15 showing the tooling equipment for the first operation, and Fig. 17, the equipment for the second operation. Fig. 18 shows a front view and Fig. 19 a rear view of the machine as set up for the first operation. Figs. 20 and 21 show front and rear views, respectively, of the machine as set up for the second operation. An additional head is shown in the photographs for counterbalance only.

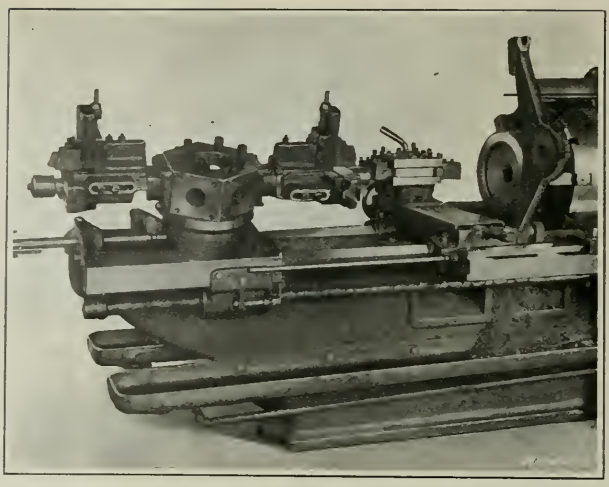


Fig. 21. Rear View of Machine set up for Second Operation on Flywheel in Fig. 16

The first operation consists of roughing and finishing the convex side of the web, the beveled inside surface, and the outside of the rim; this is accomplished as follows (see Fig. 15): (1) The work is held by the inside of the rim by special chuck jaws. (2) Surfaces *C*, *D*, and *F* are roughed with tool *K* in the toolpost. (3) The hole *B* in the flywheel is bored and the surface *C* is finish-faced with tools in the bar mounted in Side 1 of the turret. In this operation, the tool is guided by a pilot entering the bushing in the chuck. (4) Hole *B* is reamed with the reamer held in Side 3 of the turret. (5) Beveled surface *E* is rough-bored with the tool in the facing head mounted in Side 4 of the turret. Simultaneously with this operation, the outside *G* of the flywheel is rough-turned with tool *L* held in the toolpost. (6) Beveled surface *E* is finished with the tool held in the facing head mounted in Side 2 of the turret. (7) Surfaces *F* and *D* are machined and the corners of surfaces *F* are chamfered with the tools in the head mounted in Side 5 of the turret. The facing head used for this operation, more clearly shown to the right in Fig. 18, is especially designed for finishing the tapered surface *E* with a single-point tool, thus insuring the correct angle. A pilot enters the bore of the flywheel, and a flange is provided with a ball thrust bearing which bears against the web of the wheel at *C*, thereby accurately locating the tool and preventing the pilot from entering beyond a certain point. The head then slides over the pilot, and as the head is provided with a pin which rests against a tapered surface immediately beyond the thrust bearing shown in Fig. 18, the tool in the facing head is lowered as it slides forward and the tool mounted in the facing head will finish the tapered surface accurately. (8) Finally, the outside *G* of the flywheel is finished with tool *M* held in the toolpost.

The second operation, shown in Fig. 17, consists in roughing and finishing the concave side of the flywheel. The step-by-step method of performing the work is as follows: (1)

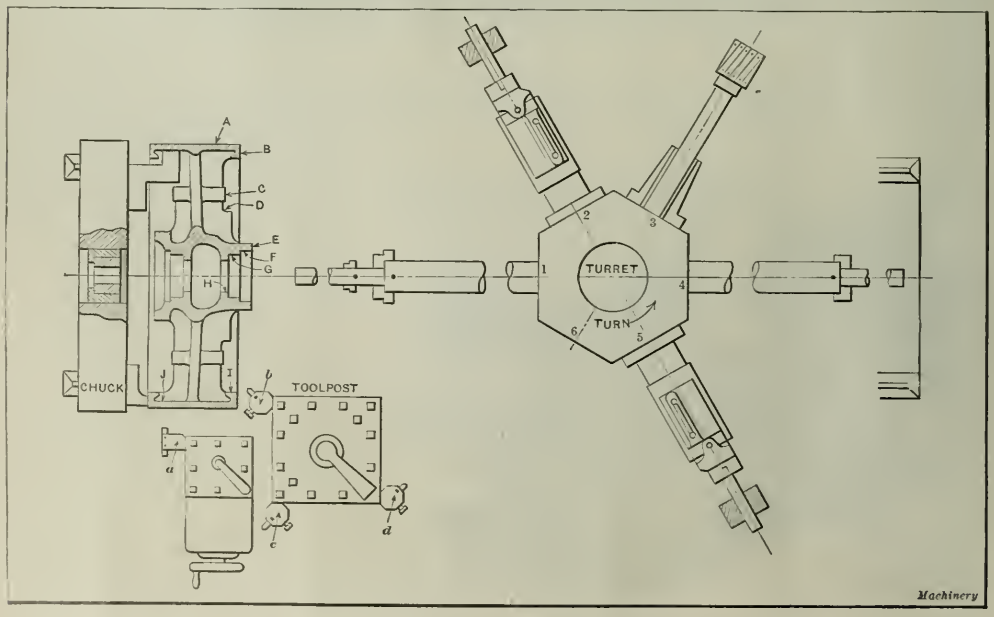


Fig. 22. Tool Lay-out for First Operation on Truck Wheel in Fig. 24

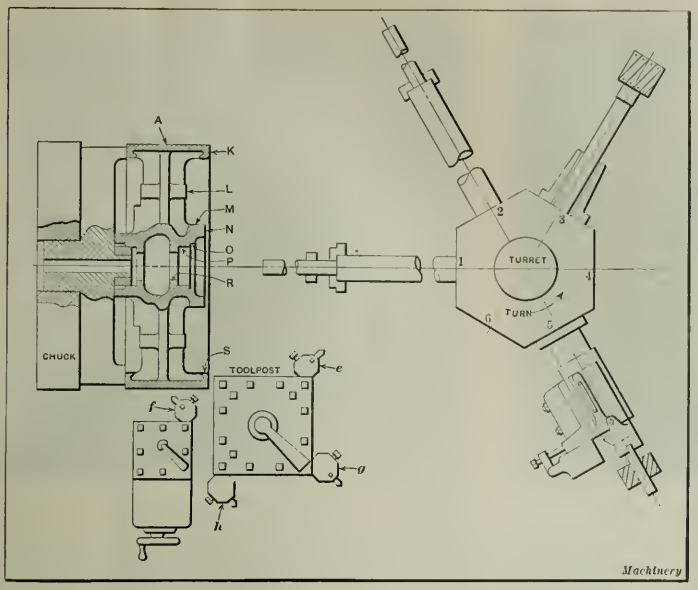


Fig. 23. Tooling Equipment for Second Operation on Truck Wheel illustrated in Fig. 24

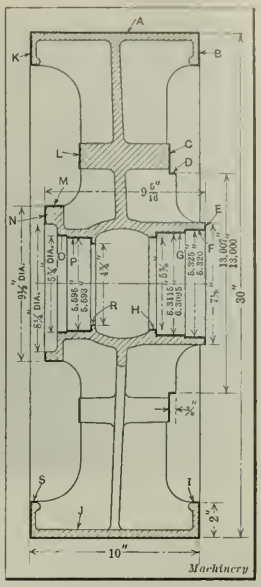


Fig. 24. Truck Wheel finished in Two Operations

The work is held with soft jaws bearing against the finished outside of the flywheel and supported with chuck jacks bearing against the rim at *F*. (2) Surfaces *H*, *I*, and *J* are rough-faced with tools held at *N* in the toolpost. (3) Surface *A* is rough-bored and surface *I* is rough-faced, and the outside corner at *A* rounded with tools held in the facing head mounted in Side 1 of the turret. (4) Surfaces *A* and *I* are finished and the inside corner at *A* is rounded with tools held in the facing head mounted in Side 4 of the turret. In both Steps (3) and (4) the facing head is piloted in the bore of the flywheel, and tool *O* is held in the rear arm, while tool *P* is held in the top arm. (5) Surfaces *H* and *J* are finished with tools held at *R* in the toolpost.

Tooling Equipment for Auto Truck Wheels

Fig. 24 shows the design of a rear wheel for an automobile truck. The heavy lines indicate the surfaces that are finished in the turret lathe. This example of turret lathe practice is of especial interest in that the complete tooling equipment that can be arranged for on the turret lathe is brought into action, including the auxiliary toolpost, also known as the "wing-rest" toolpost, which is best shown in Fig. 25 where it is being operated as indicated. All the Gisholt turret lathes have an extension on the carriage for this auxiliary toolpost so that it may be used, if required, for turning diameters which are too large for the regular toolpost. At the same time, this auxiliary toolpost provides for an addition to the number of permanently set tools that may be used. The auxiliary toolpost is also well illustrated in Fig. 29. The percentage of turret lathe jobs where the auxiliary toolpost is required is small, it seldom being necessary to use it, either on account of the size of the work or because all the tooling facilities on the machine are employed, as in the present case.

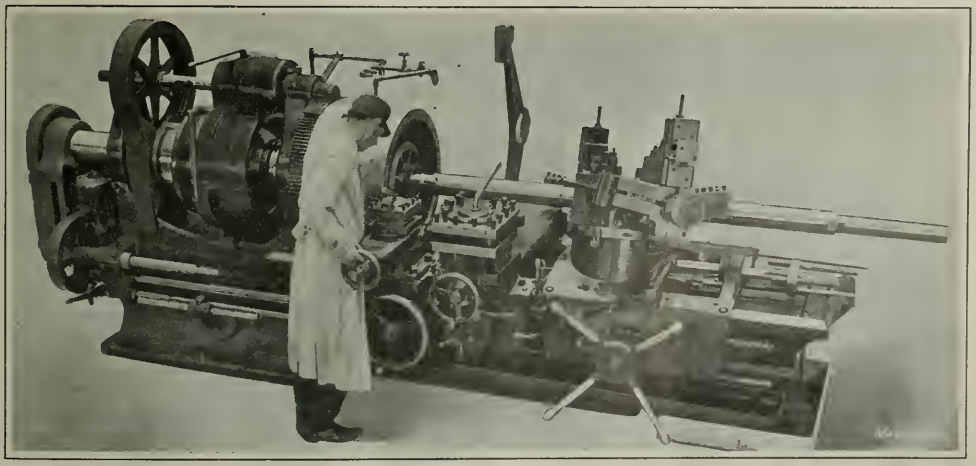


Fig. 25. Front View of Machine set up for First Operation on Truck Wheel

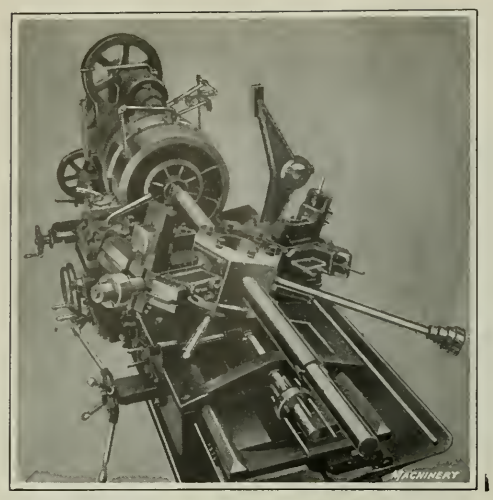


Fig. 26. Top View showing Tooling Equipment of Machine set up for First Operation on Truck Wheel

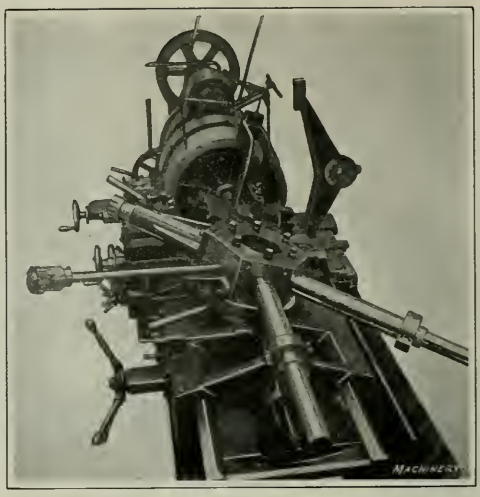


Fig. 27. Top View showing Tooling Equipment of Machine set up for Second Operation on Truck Wheel

The truck wheel is finished in two operations, the lay-out for the first operation being shown in Fig. 22, and for the second operation, in Fig. 23. The halftone illustrations, Figs. 25, 26, and 29 show different views of the first operation, while Figs. 27, 28, and 30 show views pertaining to the second operation. Fig. 25, as mentioned, shows the auxiliary toolpost in operation and a general view of the machine setup. Fig. 26 gives a better view of the tooling equipment, as it shows the machine from the top, while Fig. 29, being a detail view, shows more clearly the work in place on the machine. The halftone illustrations showing the second operation are arranged in the same manner, with a general view (Fig. 28), a top view showing the tools in the turret (Fig. 27), and a detail view showing the work in place on the machine on a larger scale (Fig. 30). The material from which the truck wheels are made is cast steel.

The step-by-step method for the first operation, Fig. 22, is as follows: (1) The wheel is held from the inside of the rim by means of special hard jaws at *J*, and is located by special blocks on the chuck. (2) The outside *A* of the wheel is rough-turned with tool *a* held in the auxiliary toolpost or wing-rest. (3) Surfaces *B*, *C*, *D*, and *E* are rough-faced with tool *b* in the toolpost. (4) Holes *F*, *G*, and *H* are bored with cutters held in the boring-bar mounted in Side 1 of the turret. This bar is provided with a pilot guided by a bushing in the chuck of the machine. (5) Surface *G* is finish-bored with a cutter held in the bar mounted in Side 4 of the turret, this bar being guided in the same manner as the roughing bar. (6) Hole *G* is reamed with a reamer mounted in Side 3 of the turret. (7) Surfaces *D* and *E* are rough-turned with cutters held in the facing head mounted in Side 2 of the turret, the tool operating upon surface *D* being held in the top arm and the tool operating upon surface *E*, in the bottom arm of the facing head. (8) Surfaces *D* and *E* are finished with tools held in the facing head mounted in Side 5 of the turret. This facing head and the tooling arrangement is identical with that used for the roughing operation on the same surfaces. (9) Surfaces *B* and *C* are finished with the tool *c* held in the toolpost. (10) The inside of the rim at *I* is bored with tool *d* in the toolpost. The total time required for the various steps in the first operation is 50 minutes.

The second operation, Fig. 23, also makes use of the auxiliary toolpost or wing-rest, the various steps being as follows: (1) The work is held on a special chuck plate by

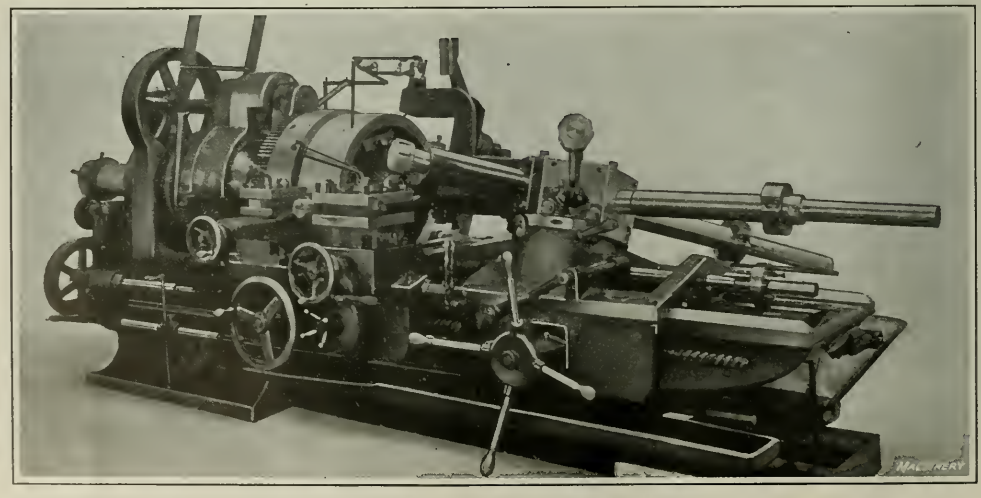


Fig. 28. Front View of Machine set up for Second Operation on Truck Wheel

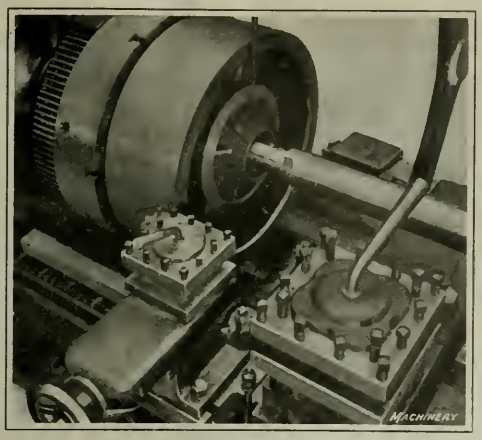


Fig. 29. Detail View of First Operation on Truck Wheel

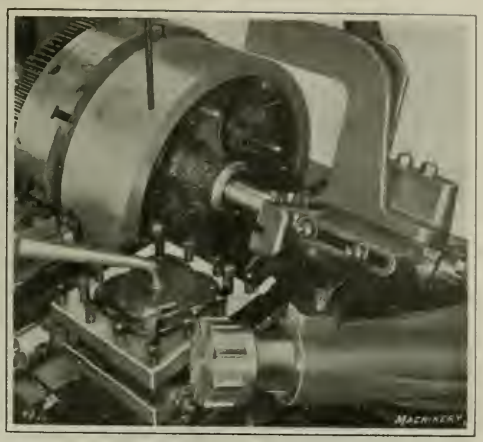


Fig. 30. Detail View of Second Operation on Truck Wheel

clamps. (2) Surfaces *K*, *L*, *M*, and *N* are rough-machined with tool *e* held in the toolpost. (3) Holes *O*, *P*, and *R* are rough-bored with cutters held in the boring-bar mounted in Side 1 of the turret. This bar has a pilot which is guided in a bushing mounted in the chuck plate. (4) Hole *P* is finish-bored with a cutter held in the boring-bar mounted in Side 2 of the turret, this bar being piloted in the same manner as that used for the roughing cut. (5) Hole *P* is reamed with a reamer mounted in Side 3 of the turret. (6) A second roughing cut is taken on the outside *A* of the wheel with the tool held in the auxiliary toolpost or wing-rest, this cut being followed by the advance of the facing head mounted in Side 5 of the turret, which finishes the outside of the rim *A* and also the surfaces *M* and *N*, the three tools required being mounted in the top arm, rear arm, and the bottom arm of the head, respectively. While this operation takes place, the facing head is guided by a bushing on its pilot which enters into hole *P*. (7) Surfaces *K* and *L* are finished with tool *g* in the toolpost. (8) The inside of the rim at *S* is bored with tool *h* in the toolpost. The total time required for the second operation is 45 minutes.

An interesting feature in connection with the work just described is that the truck wheels shown in Fig. 31, while differing considerably in design from that shown in Fig. 24, were finished with practically the same tooling equipment as that used for the truck wheel in Fig. 24, except that different sizes of cutting tools, boring-bars, and reamers were used to suit the different sizes of holes and counterbores required. Each of these truck wheels is finished in two operations, the same as that shown in Fig. 24, and the step-by-step methods in each case are quite similar, so that it is not necessary to repeat the complete procedure. It may be of interest to note, however, that the front wheel shown at *A*, Fig. 31, is finished complete in 47 minutes, the first operation requiring 25 minutes, and the second, 22 minutes. The rear wheel shown at *B* requires a total time of 55 minutes, the first operation taking 33 minutes and the second, 22 minutes. The front wheel shown at *C*, Fig. 31, is finished in 65 minutes, the first operation requiring 32 minutes and the second operation requiring 33 minutes.

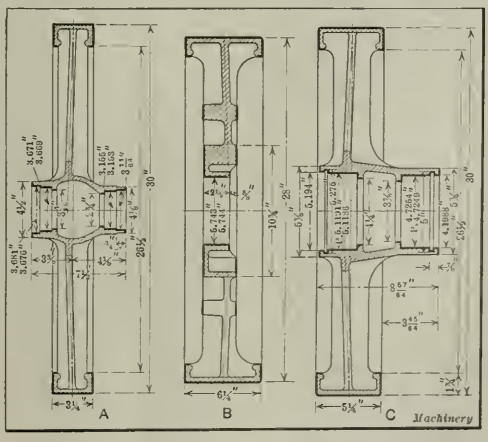


Fig. 31. Truck Wheels finished by practically the Same Tooling Equipment as shown in Figs. 22 to 30, Inclusive

The following articles in this series will deal with the machining of cylinders, piston ring castings, tractor axle housings, motor frames, clutch drums, valves, etc., and in addition there will be an article dealing with the system and methods of the service department of the Gisholt Machine Co., by which the customer's needs are studied so that he may not only buy machines and tools, but will also be assured of actual production on those machines and tools in his own plant.

* * *

AIR MAIL SERVICE RECORD

It is stated in the *Journal of the Society of Automotive Engineers* that a record of 99 per cent was made by the Air Mail Service between Washington and New York for the month of June. The total mileage covered was 11,118, and the total weight of mail carried 15,643 pounds. On the Cleveland-Chicago division, a perfect score of 100 per cent was obtained. In this division, the total mileage was 19,825 miles, and the weight of the mail carried 19,603 pounds. The average speed on that route for the month was 97.8 miles per hour. The operation of the Cleveland-Chicago route is without parallel in the history of aviation. Since May 15, seventy consecutive daily non-stop flights of 325 miles each were made without a forced landing. On the next trip a gas-line connection sprung a leak, causing a forced landing on the Emergency Air Mail Landing Field at Bryan, Ohio. The route from New York to Cleveland, across the Allegheny Mountains, has been operating with the same degree of perfection as the Cleveland-Chicago route since July 1.

* * *

Much interest is being shown in China in motorcycles, due to the fact that they can travel on the paths used by foot passengers, as there are but few roads suitable for automobiles. If these paths were improved, commercial travelers could penetrate with ease, by the use of motorcycles, to places which are now practically inaccessible.

Design and Calculation of Williams Internal Gearing

By REGINALD TRAUTSCHOLD

A new system of internal gearing has been devised by Harvey D. Williams, a man recognized as a gear designer of considerable ability and knowledge. Mr. Williams was formerly professor of kinematics at Cornell University and subsequently entered the Government service. In this capacity he designed a great number of special gears and he is also the inventor of a new type of bevel gear. His internal gear, with which the present article deals, is now being introduced to the public, although Mr. Williams has himself employed the construction for some years past. A water wheel driving a motor for lighting and power purposes has been equipped with a Williams large internal gear for the past four or five years and the transmission has proved unusually efficient. The gearing shows practically no sign of wear despite the fact that it has run continually since its installation. At the present time a number of important users of internal gears are considering adopting this system, and prominent gear manufacturers are showing considerable interest in the development. But, so far, little publicity has been given to the system, and what publicity there has been has dealt with general principles only. The present article is the first one that deals with the design in detail, showing working formulas and complete lay-outs necessary for proper design and will, therefore, prove of great interest.

THE Williams system of internal gearing possesses those elements of simplicity and low cost of manufacture which distinguish the Williams system of bevel gearing, and decided mechanical efficiencies are realized by virtue of the simpler construction. In the new system, the profiles of the internal gear teeth are straight lines, so that the tooth spaces are similar to those of an involute rack, while the teeth of the mating pinion have curved profiles of conjugate form. This radical departure from the involute and other systems of gearing secures a number of inherent advantages for the new system which give a much longer arc of tooth contact, improve the operating action, reduce wear, and increase the strength of the pinion teeth. Gear combinations in which the pinion has considerably fewer teeth than are feasible in the involute system of internal gearing are practicable with Williams gearing, and the compactness thus attainable makes possible higher speed ratios for simple combinations without the diameter of the internal gear exceeding practical dimensions.

All the advantages possessed by the internal form of gearing are not only retained in the Williams construction, but in nearly every instance are materially accentuated. Not only are production costs much less, but also the accuracy with which the teeth may be finished to approved profile is far greater than in the involute system. No modification of tooth profiles is necessary, such as is so generally resorted to for the greater part of the depth of teeth of involute form, particularly in the case of internal gears.

Lay-out of Williams Internal Gears

The distinctive form of the Williams internal gear teeth is well illustrated in the diagrammatic lay-out shown in Fig. 2. The profile planes of the gear teeth are all tangent to a circle concentric with the gear, the radius L of which is equal to the pitch radius of the internal gear multiplied by the sine of the sum of one-half the tooth space angle c and one-fourth the pitch angle. The path of point of contact—the distinguishing feature of the system—lies in a curve passing through the instant axis m of the meshing gears. The section of this curve which constitutes the maximum or usable path of point of contact (that is, arc st) may be considered as the arc of a circle having its center S half way between the instant axis and the foot of a normal radiant of the circle of profile plane tangency.

The longest possible path of point of contact is from s to t, these being points at the intersection of radiant lines of the describing circle of the path of point of contact. Point s, at the approach end lies in a radiant line passing through the center of the describing circle and the center of the mating pinion, while point t at the recession end lies in a straight line passing through the center of the describing circle and that of the internal gear. These points connected by radiant lines to the center of the pinion and of the internal gear, fix the usable angles of contact for the pinion and for the gear. The usable angle of approach u for the pinion is apparently much greater than could be secured for an involute gear of the same size and pressure angle. Similarly, the usable angle of approach U for the internal gear is greater than could be secured for an involute gear of the same size and pressure angle.

The angles of recession for Williams gears are finite, it is true, while in the involute system they are theoretically infinite. However, in the involute system very definite limitations are placed on the lengths of the arc of recession by the practical limits to the flank depth of the internal gear and the addendum of the pinion teeth. These limitations make the usable recession angles (v in the Williams pinion, and V for the internal gear) appreciably greater than in the involute system.

Arcs of Contact

The entire arc of contact, particularly the recession section, is rarely made use of in the Williams system, but such arc of contact as is employed is invariably greater than that for corresponding internal gear combinations proportioned according to the involute system—that is, greater than when the angularity of the contact planes of the teeth is the same. In many instances this is so, even if the pressure angle for the involute teeth is much greater than that for the Williams teeth. In the involute system, the length of the arc of contact that is possible with the Williams system may be secured only by materially increasing the pressure angle and adopting the stub form of tooth. This modification, now so generally resorted to for commercial gear combinations, has the decided disadvantage of reducing the mechanical efficiency of the transmission by increasing the axial component of the transmitted force, thereby decreasing the effective component.

The large diagram in Fig. 1 illustrates the Williams gear combination shown in Fig. 2. Contact between meshing

teeth commences at the point p, the intersection of the inner circle of the gear with the path of point of contact, and ends at the point r, the intersection of the outer circle of the pinion with the path of point of contact, so the actual arc of pinion contact is measured by the angle g. This angle, it will be noted, is much smaller than the usable angle of contact w.

The derivation of the simple equation for the actual angle of approach e entails the solution of the triangle pSO, while evolving an equation for the actual angle of recession f, requires the solution of the triangle rSo. These two triangles are duplicated at reduced scales in the lower left- and right-hand corners, respectively, of the illustration. The sum of these two angles measures the actual arc of contact

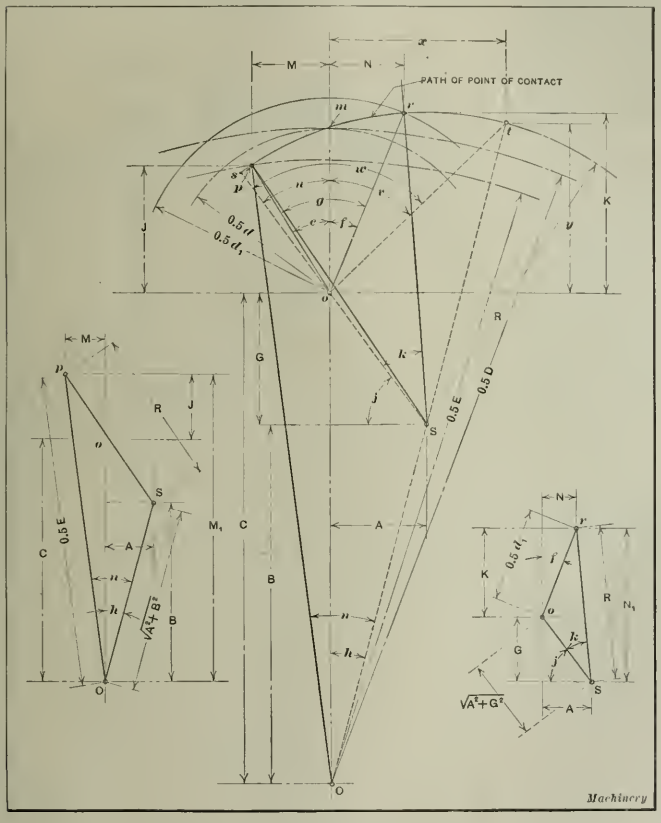


Fig. 1. Diagrams used in Williams System of Gear Formula Calculations

for the pinion in a combination of Williams gears.

The diagram shown in Fig. 3 depicts an internal gear combination of involute form, the path of point of contact of which is a straight line passing through the instant axis and normal to the advancing profile of the pinion tooth at the moment the pitch line of the pinion is at the instant axis. The commencement of contact occurs at p_1, the foot of the radial which is normal to the path of point of contact; the termination of contact occurs at the point r_1, the intersection of the outer circle of the pinion with the path of point of contact. The angle of approach e_1, which is the maximum for the involute form of tooth with the pressure angle shown, is no greater than the pressure angle of the teeth will allow, while the angle of recession f_1 also appears quite limited.

The angle of recession can be increased by increasing the inner diameter of the gear and adopting the stub form of gear tooth. This modification can be carried to such a point, without sacrifice of angle of approach, that the diameter E of the internal gear becomes equal to F. Sacrifices result, however, in a certain reduction in the recession angle, due to the increased pressure angle, and a reduction in the effectiveness of power transmission, due to the increase in the axial thrust incidental to the use of the heavier pressure angle. It can readily be seen that the departure from the involute tooth of standard proportions entails weaknesses which are compensated for only in part by the increased strength of the teeth and the reduction in seriousness of tooth interference.

In the Williams system of internal gearing, on the other hand, an increase in the obliquity of the profile planes of the teeth is seldom called for, since interference is largely avoided by the design, and a stub tooth is rarely necessary. The angle of approach and the recession angle, are usually considerably larger in the Williams construction than in equivalent involute gear combinations.

Comparison of Arcs of Contact of Williams and Involute Internal Gearing

A comparison of the respective arcs of contact for the two systems of gearing, by a concrete example, will emphasize the superiority of the Williams construction; but for the comparison to be convincing, a gear combination should be selected of proved suitability to the involute system of internal gearing. A combination of a 20-tooth internal gear and a 12-tooth pinion is one frequently employed, and when such involute gears have 20-degree stub teeth the pinion is free from any marked under-cutting.

Though the stub tooth is adopted in the involute system to secure adequate tooth strength and to avoid interference, a tooth of less obliquity may be used in the Williams system without reducing the height. In this system, as the path of the point of contact is a curve, the angularity of the direction of pressure, in reference to the plane of tangency at the instant axis, varies throughout the path of point of contact, being greater during approach and less during recession than it is at the instant axis. If a logical comparison of the two systems is to be made some common obliquity of teeth must be selected.

Since the profiles of involute gear and pinion teeth are tangent when in full mesh, and since the flat profiles of the Williams internal gear teeth are likewise tangent to the profiles of the mating pinion teeth when they are in full mesh, the inclination of the flat gear tooth profiles relative to the center line of the tooth space is comparable to the pressure angle of the involute teeth. In the Williams system, when the line of contact between meshing teeth is at the instant axis, the direction of pressure is inclined to the common tangent plane of the gear and pinion at an angle a, equal to the sum of one-half the tooth space angle and one-fourth the pitch angle of the gear. This angle, which may be termed the "instant pressure angle," will, of course, vary with the number of teeth in the gear regardless of the tooth space angle. The instant pressure angle for a 20 to 12 Williams internal gear combination with a 29-degree tooth space angle is 19 degrees, while for a 40 to 12 combination with the same tooth space angle the instant pressure angle is 16¾ degrees. The instant pressure angle will always be greater than half the tooth space angle.

The actual angle of approach for a 20 to 12 Williams gear

combination, with a tooth space angle of 29 degrees and teeth of standard depth, is 21 degrees, 18 minutes, and the angle of recession (both measured by the pinion) is 24 degrees, 45 minutes; or the actual angle of contact as measured by the pinion is 46 degrees, 3 minutes. (See accompanying example for computations). A 20 to 12 combination of involute gears would necessitate a 20-degree pressure angle and a 4/5 pitch; the angle of approach, in such case, would be 20 degrees, and the angle of recession would be 14 degrees, making a total angle of contact, measured by the pinion, of 34 degrees. (See accompanying example for computations).

As far as the length of arc of contact is concerned, the superiority of the Williams gearing (which, for convenience, may be termed a 14½-degree combination) is thus seen to be about 36 per cent. If the inclination of the Williams gear teeth profiles, in this particular combination, is increased, making the tooth space angle 40 degrees—a 20-degree combination—and at the same time, if the depth of tooth remains constant, the angle of contact, as measured by the pinion, is about 44½ degrees instead of 46 degrees, 3 minutes. This reduction is due to the fact that a smaller proportion of the usable path of point of contact is capable of being employed, owing to the limitations established by the depth of the pinion teeth. Such limitations would be more marked if the stub tooth were employed, so that the length of the arc of contact for a 20 to 12, 4/5-pitch Williams 20-degree combination would become about the same as that of the stub tooth involute gear combination. However, as the best combination of the respective systems should logically be employed, the relative merits of the two systems in respect to arc of contact for the particular combination may be taken as favoring the Williams construction at a ratio of about 136 to 100. Such superiority becomes greater as the speed ratio of the internal gearing increases, if the gears are suitably proportioned as to pitch, etc.

Definitions of Notation Used in Equations and Formulas (Williams System)

a = instant pressure angle (gear)
b = ¼ pitch angle (gear)
c = ½ tooth space angle (gear)
d = pitch diameter (pinion)
d_1 = outer diameter (pinion)
e = actual approach angle (pinion)
f = actual recession angle (pinion)
g = actual contact angle (pinion)
h = angular offset of generating circle
j = angularity from center of generating circle to center of pinion
k = construction angle
m = instant axis
n = construction angle
o = pinion center
p = commencement of tooth contact
r = end of tooth contact
s = commencement of usable path of point of contact
t = termination of usable path of point of contact
u = usable approach angle (pinion)
v = usable recession angle (pinion)
w = usable contact angle (pinion)
x, y = coordinates of usable path of point of contact about pinion center
A = abscissa of center of generating circle
B = ordinate of center of generating circle
C = center distance
D = pitch diameter (gear)
G = difference between ordinate of center of generating circle and the center distance
J = ordinate of commencement of tooth contact (pinion)
K = ordinate of termination of tooth contact (pinion)
L = radius of circle of profile plane tangency
M = abscissa of point of first contact
M_1 = ordinate of point of first contact
N = abscissa of point of last contact
N_1 = ordinate of point of last contact
O = gear center
R = radius of generating circle
S = center of generating circle
T = number of teeth (gear)
U = usable approach angle (gear)
V = usable recession angle (gear)
W = usable contact angle (gear)

Definitions of Notation Used in Equations and Formulas (Involute System)

a_1 = pressure angle (gear and pinion)
d = pitch diameter (pinion)
d_1 = outer diameter (pinion)
e_1 = usable approach angle (pinion)
f_1 = actual recession angle (pinion)
g_1 = actual contact angle (pinion)
l = angle between path of point of contact and limiting pinion radius of recession angle
m = instant axis
o = pinion center
p_1 = commencement of tooth contact
r_1 = end of tooth contact
C = center distance
D = pitch diameter (gear)
E = inner diameter (gear)
F = limiting inner gear dia.
O = gear center

Equations and Formulas for Williams Gear System (Figs. 1 and 2)

$$b = \frac{90 \text{ degrees}}{T}$$

$$a = b + c$$

$$L = 0.5D \sin a$$

$$R = 0.25D \cos a \quad (1)$$

$$A = R \sin a \quad (2)$$

$$B = 0.5D - R \cos a \quad (3)$$

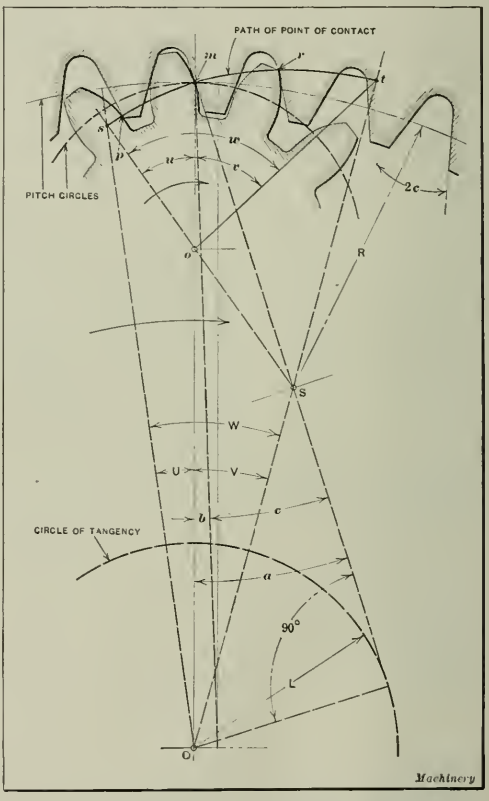


Fig. 2. Diagrammatic Lay-out of Williams Internal Gearing

$$\tan h = \frac{A}{B} \quad (4)$$

$$\cos n = \frac{A^2 + B^2 + 0.25E^2 - R^2}{E\sqrt{A^2 + B^2}} \quad (5)$$

$$M = 0.5E \sin (n - h) \quad (6)$$

$$M_1 = 0.5E \cos (n - h) \quad (7)$$

$$J = M_1 - C \quad (8)$$

$$\tan e = \frac{M}{J} \quad (9)$$

$$\tan j = \frac{G}{A} \quad (10)$$

$$\cos k = \frac{R^2 + A^2 + G^2 - 0.25d_1^2}{2R\sqrt{A^2 + G^2}} \quad (11)$$

Some complications arise in evolving a suitable equation for the recession angle f of the arc of contact in the Williams system. This is due to two facts: First, the ordinate B of the center of the generating circle in reference to the axial plane of the internal gear which is normal to the common axes plane of the gear and pinion, may be greater or less than the center distance of the gears, so that when C is greater than B

$$K = N_1 - G$$

and when B is greater than C

$$K = N_1 + G$$

The second factor which causes complications in deriving the equations for the angle of recession is that the distance N from the point of termination of tooth contact to the com-

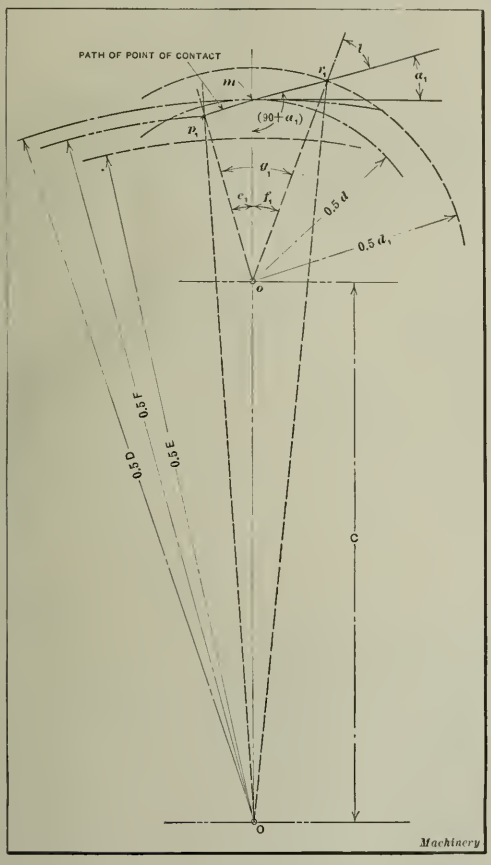


Fig. 3. Diagram used in Involute System of Internal Gearing Formulas

mon axes plane may either equal, be greater than or less than the distance A from the center of the generating circle to the common axes plane. If either the sum of angles j and k or their difference is equal to 90 degrees, then

$$N = A$$

and

$$N_1 = R \pm G$$

The distance N may be sufficiently greater than distance A to employ the full usable section of the recession path of point of contact. From the foregoing it will be apparent that there are six sets of equations necessary for determining the rectangular coordinates N and N_1 of the point of tooth contact termination about the center of the pinion, in order to take care of all possible conditions. When the conditions of the problem are governed by any of the first five cases, the following equation applies for the recession angle.

$$\tan f = \frac{N}{K}$$

while the equation employed when the conditions of the problem are satisfied by the sixth case is:

$$\tan f = \frac{x}{y - C}$$

The selection of the suitable set of equations (or case) for any given conditions is definitely set by plainly established limits. In measuring the angle of recession for the pinion of the Williams system, it is first necessary to note the location of the center of the generating circle in reference to the center of the pinion and then to ascertain the inclination of the straight line connecting these two center points, with a plane normal to the common axes plane of the gear and pinion. With such relations established, the selection of the proper set of equations for the rectangular coordinates of the point of tooth contact termination is apparent.

Case 1

When $C > B$ and $j + k <$ 90 degrees.

$$N = A - R \cos (j + k) \quad (12)$$

$$N_1 = R \sin (j + k) \quad (13)$$

Case 2

When $C > B$ and $j + k >$ 90 degrees but $<$ (90 degrees + h).

$$N = A + R \cos (180 \text{ degrees} - j - k) \quad (12a)$$

$$N_1 = R \sin (180 \text{ degrees} - j - k) \quad (13a)$$

Case 3

When $B > C$ and $k - j <$ 90 degrees.

$$N = A - R \cos (k - j) \quad (12b)$$

$$N_1 = R \sin (k - j) \quad (13b)$$

Case 4

When $B > C$ and $k - j >$ 90 degrees but $<$ (90 degrees + h).

$$N = A + R \cos (180 \text{ degrees} - k + j) \quad (12c)$$

$$N_1 = R \sin (180 \text{ degrees} - k + j) \quad (13c)$$

Case 5

When $C > B$ and $j + k =$ 90 degrees + h, or when $B > C$ and $k - j =$ 90 degrees + h

$$N = A + R \sin h \quad (12d)$$

$$N_1 = R \cos h \quad (13d)$$

Case 6

When $C > B$ and $j + k >$ 90 degrees + h, or when $B > C$ and $k - j >$ 90 degrees + h

$$x = (R + \sqrt{A^2 + B^2}) \sin h \quad (12e)$$

$$y = (R + \sqrt{A^2 + B^2}) \cos h \quad (13e)$$

$$\tan f = \frac{N}{K} \quad \text{(Cases 1 to 5 inclusive)} \quad (14)$$

$$\tan f = \frac{x}{y - C} \quad \text{(Case 6)} \quad (14a)$$

$$g = e + f \quad (15)$$

Equations and Formulas for Involute Gear System
(Reference Fig. 3)

$$a_1 = e_1$$

$$\sin l = \frac{0.5d \cos e_1}{0.5d_1} \quad (16)$$

$$f_1 = 90 \text{ degrees} - a_1 - l \quad (17)$$

$$g_1 = e_1 + f_1 \quad (18)$$

Examples Showing Graphic Comparison of Arc of Contact of Involute and Williams Internal Gear Systems

Williams System—In a 4-pitch internal gear combination, having a 20-tooth gear and a 12-tooth pinion, find the angle which measures the arc of contact of the pinion when the tooth space angle of the internal gear is 29 degrees, and when the center distance is 1 inch.

By the conditions of the problem $D = 5$ inches; $d = 3$ inches; $c = 14\frac{1}{2}$ degrees; $d_1 = 3.5$ inches; $E = 4.5$ inches.

$$a = 14.5 + \frac{90}{20} = 19 \text{ degrees}$$

$$R = 0.25 \times 5 \times 0.94552 = 1.182 \text{ inches} \quad (1)$$

$$A = 1.182 \times 0.32557 = 0.385 \text{ inch} \quad (2)$$

$$B = 0.5 \times 5 - (1.182 \times 0.94552) = 1.3824 \quad (3)$$

$$\tan h = \frac{0.385}{1.3824} = 0.2785 \quad (4)$$

whence

$$h = 15 \text{ degrees } 34 \text{ minutes}$$

$$\cos n = \frac{0.385^2 + 1.3824^2 + (0.25 \times 4.5^2) - 1.182^2}{4.5\sqrt{0.385^2 + 1.3824^2}} = 0.8865 \quad (5)$$

whence

$$n = 27 \text{ degrees } 34 \text{ minutes}$$

$$n - h = 12 \text{ degrees}$$

$$M = 0.5 \times 4.5 \times 0.20791 = 0.468 \text{ inch} \quad (6)$$

$$M_1 = 0.5 \times 4.5 \times 0.97815 = 2.201 \text{ inches} \quad (7)$$

$$J = 2.201 - 1 = 1.201 \text{ inches} \quad (8)$$

$$\tan c = \frac{0.468}{1.201} = 0.3897 \quad (9)$$

whence

$$c = 21 \text{ degrees } 18 \text{ minutes}$$

$$G = B - C = 1.3824 - 1.00 = 0.3824 \text{ inch}$$

$$y = 21 \text{ degrees } 18 \text{ minutes} + 24 \text{ degrees } 45 \text{ minutes} = 46 \text{ degrees } 3 \text{ minutes} \quad (15)$$

Involute System—In a 4/5-pitch internal gear combination having a 20-tooth gear and a 12-tooth pinion, find the angle which measures the arc of contact of the pinion when the pressure angle of the gear teeth is 20 degrees and the center distance 1 inch.

By the conditions of the problem $D = 5$ inches; $d = 3$ inches; $d_1 = 3.4$ inches; $E = 4.6$ inches.

$$c_1 = a_1 = 20 \text{ degrees}$$

$$\sin l = \frac{0.5 \times 3 \times 0.93969}{0.5 \times 3.4} = 0.8291 \quad (16)$$

whence

$$l = 56 \text{ degrees}$$

$$f_1 = 90 \text{ degrees} - 20 \text{ degrees} - 56 \text{ degrees} = 14 \text{ degrees} \quad (17)$$

and

$$y_1 = 20 \text{ degrees} + 14 \text{ degrees} = 34 \text{ degrees} \quad (18)$$

Reduction of Wear

The lengths of the arcs of contact for the respective systems also indicate the relative wearing qualities of the gears, though not exactly. In both systems, the wear is more pronounced on the pinion than on the internal gear, but in the case of the involute pinion the wear is considerably

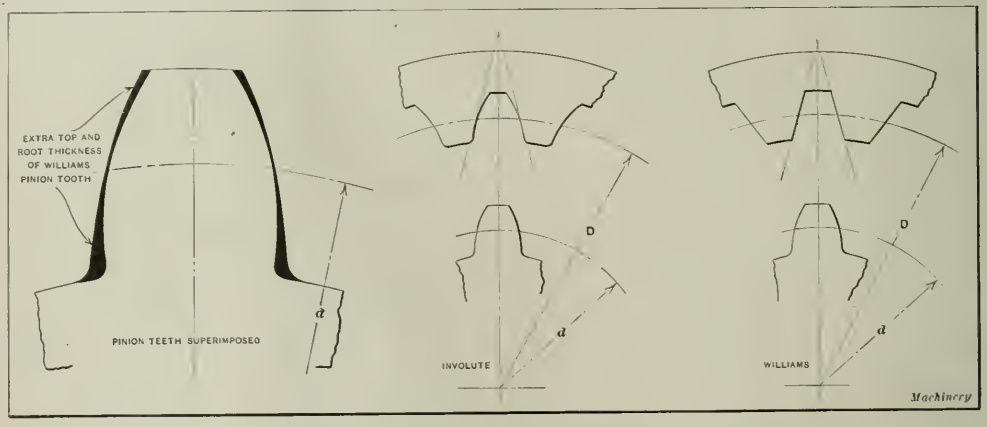


Fig. 4. Diagrammatic Comparison of Williams and Involute Internal Gear Teeth Forms

$$\tan j = \frac{0.3824}{0.385} = 0.99325 \quad (10)$$

whence

$$j = 44 \text{ degrees } 48 \text{ minutes}$$

$$\cos k = \frac{1.182^2 + 0.385^2 + 0.3824^2 - (0.25 \times 3.5^2)}{2 \times 1.182\sqrt{0.385^2 + 0.3824^2}} = -1.07 \quad (11)$$

The above value (—1.07) is an impossible cosine and indicates that the last point of tooth contact lies on the path of point of contact somewhere before the outer diameter of the pinion intersects this contact arc. This means that in this particular example, the conditions are such that the side *ro*, Fig. 1, which is opposite angle *k*, is less than the radius $0.5d_1$. It is evident then, that although *B* is greater than *C*, $j - k$ must be as great as, but cannot be greater than the angle 90 degrees + *h*. It also follows that the conditions of the problem are not satisfied by either Cases 3, 4, or 6 but by Case 5; therefore

$$N = 0.385 + (1.182 \times 0.26836) = 0.7022 \text{ inch} \quad (12d)$$

$$N_1 = 1.182 \times 0.96332 = 1.1386 \text{ inches} \quad (13d)$$

$$\tan f = \frac{0.7022}{1.1386 + 0.3824} = 0.46101 \quad (14)$$

whence

$$f = 24 \text{ degrees } 45 \text{ minutes}$$

greater. In the more familiar construction, there is a concentration of wear upon the shank of the pinion, with an easing off on the shank of the internal gear teeth.

The result of the concentration of wear in the involute system, even in a minor degree, is the objectionable backlash which tends to make the gears noisy in operation by increasing the shock of contact. In the Williams construction, however, the wear is more evenly and effectively distributed over the tooth profiles on account of the longer arc of contact; also the wear which is concentrated to some slight degree on the shanks of the pinion teeth, is similarly concentrated on the shanks of the internal gear teeth, so that a slight wear tends to relieve the shock of contact without developing backlash. In the involute system, the backlash accelerates the wear, while the "relief" in the Williams system tends to transfer the wear to mid-tooth sections without "knock" or tendency to cause abrasive action between engaging teeth.

Strength

In all tooth gearing the pinion, being invariably the weaker member, governs the strength of the combination. The Williams system is no exception to this rule, but the strength of the pinion teeth is considerably greater than in the involute system, in which the strength of the pinion teeth is reduced by under-cutting. This objectionable feature is much less marked in the Williams pinion than in an

involute pinion, for the reason that the tooth space across the tops of adjacent teeth is greater in the former type. For a similar reason, the top thickness of Williams pinion teeth is greater than that of teeth of corresponding involute pinions—the tooth space width at the roots of the gear teeth consequently being greater in the Williams system. This distinctive superiority of the Williams construction is brought out clearly in the comparison of pinion teeth shown in Fig. 4. The smaller diagrams in the illustration depict tooth spaces of the respective systems and demonstrate the cause of the difference in the form of the mating pinion teeth. The curved profiles of the involute gear teeth are concave and recede from the contact planes tangent on the pitch line,

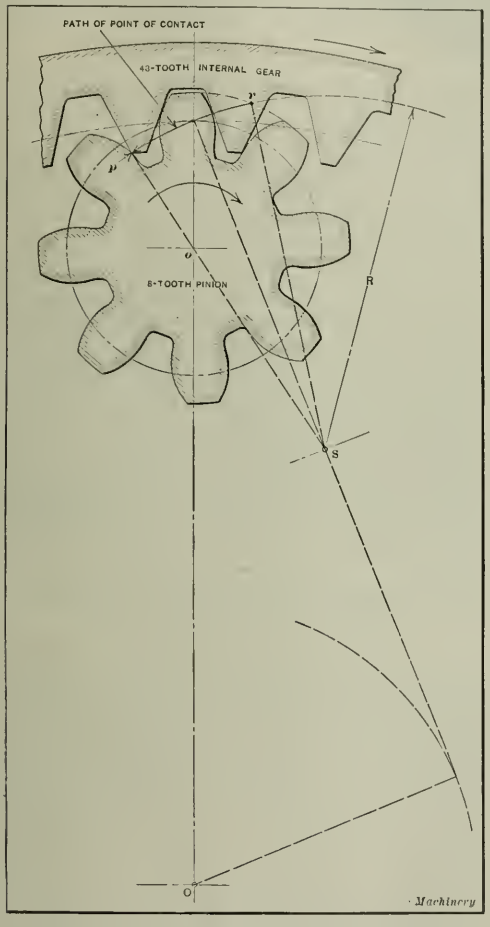


Fig. 5. Special Combination of Williams Internal Gearing, Ratio 6 to 1

while the profiles of the Williams internal gear teeth lie in the contact planes. As previously referred to, the larger diagram, showing the pinion teeth superimposed, illustrates the extra top and root thickness of the Williams pinion tooth.

The pinion tooth forms selected for comparison are chosen so as to favor the involute form, that is, the involute pinion tooth is one free from serious under-cutting. It is a 20-degree tooth of 80 per cent stub form—proportions which materially increase the strength of the involute tooth. Such a tooth is approximately 40 per cent stronger than a 14½-degree involute tooth of standard proportions and the same pitch. The Williams form of pinion compared with the 20-degree stub involute tooth illustrated is about 36 per cent stronger, the strength of the teeth varying with the square of their respective root thicknesses. Thus it is evident that, if the increased arc of contact for the Williams system is taken into account, a Williams "14½-degree combination" is actually stronger than a similar gear combination with 20-degree involute teeth of stub form.

An interesting combination of Williams gears is shown in Fig. 5, in which the strength of the gearing, measured by the strength of the 8-tooth pinion, is materially increased by making the pinion teeth as strong as the gear teeth. This is accomplished by increasing the thickness of the pinion teeth and correspondingly decreasing the thickness of the internal gear teeth, so that the root thicknesses of the respective teeth are the same. The circular pitch of the gears is not altered, the thickness of the pinion tooth simply being increased and the space between adjacent gear teeth widened by reducing the thickness of the gear teeth.

Reduction in Size of Pinion

This method of securing a high speed ratio with a pinion of few and unusually strong teeth cannot be resorted to as effectively with gears proportioned according to the involute system, as in such designs the under-cutting of a pinion having less than 10 or 12 teeth would be excessive. On the other hand, a Williams pinion with a considerably smaller number of teeth is a feasible and practical construction, for the pinion teeth are of generated conjugate form for operation with an internal gear of specific size. If the pinion tooth can be so generated, it can be produced with assurance that it will operate successfully with its "master" gear, without developing interference of teeth. An involute pinion with a small number of teeth can be generated, of course, provided the under-cutting is not too pronounced, but it will not operate in combination with an involute gear. Radical modifications of the involute profiles might enable a so-called involute combination to function, but the under-cutting of the pinion teeth would be so marked as to make them unduly weak.

The Demand for Internal Gearing

Any further enlargement upon the advantages of the Williams system of internal gearing, the more obvious of which have been pointed out, would seem unnecessary, but a word or two in respect to the importance of the development at this time will not be amiss. In other words, what is the present demand for internal gearing?

The advantages of the internal form of gearing are well known and generally conceded, but the demand for a system of efficient internal gears that can be produced at comparatively low cost may not be as well appreciated. However, there are one or two industries that even now realize the advantages of the construction. In the motor truck field, almost 25 per cent of all models of trucks are now being constructed with internal gears for the final drive reduction, and nearly 33 1/3 per cent of all farm tractors are propelled through some form of internal gear mechanism. One manufacturer of rear axle drives for motor trucks has alone placed in service nearly 100,000 internal gear combinations.

* * *

A brief account of the history, organization, and procedure of the United States Patent Office has been prepared by William I. Wyman, member of the Examining Corps, U. S. Patent Office, and has been published by the Patent Office Society, Washington, D. C. This historical review points out that the first patent granted on this continent was to Samuel Winslow by the General Court of Massachusetts in 1641. This patent was for a novel method of making salt. Connecticut also was active early in encouraging inventions, and required, as the basis of a patent grant, that the invention "shall be judged profitable to the country." The first legislative enactment of the Government of the United States establishing a protection for inventors was the law of 1790. The present system of patents was established in 1836.

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THE ECONOMIC PRINCIPLE OF WAGES

Employers everywhere are beginning to realize that they must do some educational work among their employes in order to give them a correct understanding of the true relation between production and wages. The war furnished an object lesson that may be used in this connection. While wages rose, the cost of living rose, in some instances, in even greater proportion; so it is quite evident that an increase of wages alone is of no benefit unless production keeps pace with the increase in wages, or so exceeds it that the cost of commodities, which means the cost of living, is not also raised quite as much as the wage rate.

In some of the neutral European countries, this object lesson was so clearly and so forcibly impressed that the workers began to understand the relation between wages and production. It became evident to them that no matter how high their wages were—and in some instances there was an increase of several hundred per cent—they were not benefited thereby when goods were so scarce that they were either not obtainable at all, or so expensive that even the increased wage was not sufficient to buy a reasonable amount of the necessities of life. This condition is not altogether a war condition; the same economic law is at work in peace times as well. There is but one way in which prices can be brought down, and that is by the production of *more* commodities at the *same* expenditure of time and money, so that the first cost may thereby be reduced.

Any effort, therefore, to prevent the application of efficient methods in factories, or to reduce production by other means, is a direct effort to increase the cost of the product and thus increase the cost of living; and the wage earner will suffer directly from any curtailment in production, no matter what his wages may be in dollars and cents. It is not a question of whether a man earns $3 or $6 a day, but how much will the money he earns buy in actual products; it is the exchange value of wages that counts. Therefore, to decrease the cost of living is equally as important to the wage earner as to increase his wages, and the only way in which the cost of living can be decreased is by increased efficiency and increased production, so that more commodities, more cheaply produced, will be offered for sale.

* * *

SKETCHING IN TOOL AND JIG DESIGN

The value of accurately made free-hand sketches is not as well understood as it should be. Both machine and tool designers will, therefore, find the article "Mechanical Sketching" in this number of MACHINERY, of considerable interest and value. Tool designers may use carefully made sketches to advantage for the preliminary lay-out of tools, jigs, and fixtures; for example, in connection with turret lathe practice, rough sketches may be made to show the possible arrangements of the tools, so as to determine as quickly as possible the most efficient method of machining. Special chucks and work-holding fixtures may also be shown in these sketches. In many cases, these rapidly drawn lay-outs, especially if fairly accurate, will serve the same purpose as drawings made to scale.

When developing the design of a jig or fixture, sketches are particularly valuable. Often a sketch which is made in a few minutes shows that an idea which seemed at first thought to be good, is entirely impracticable. On the contrary, if the design appears to be satisfactory, a scale drawing showing the exact arrangement of the different parts can be made from the sketch by a draftsman who has not had the experience or training to develop original designs. As the design of many special tools and of jigs and fixtures depends upon the shape of the work, the preliminary sketches should be made around a drawing of whatever part the tool or jig is intended for. Ink or a colored pencil may be used for this outline drawing of the work to secure greater contrast with the sketch of the tool or jig itself. It may be advisable to make a fairly accurate drawing of the work. Sometimes cross-sectioned paper is especially useful when developing the designs of new tool equipment, in order to insure greater accuracy in sketching. The squares on the paper serve as units of measurement, and the sketch may be drawn almost as accurately as when instruments are used.

* * *

WHAT THE "SAFETY FIRST" CAMPAIGN HAS ACCOMPLISHED

It is less than fifteen years ago since the effort to reduce accidents in the industries took definite form. As MACHINERY was one of the first journals to actively enlist in the campaign then started, it is all the more gratifying to record here the official figures recently published by the Bureau of Labor Statistics. These show to what an extent industrial accidents have been reduced through the methods developed and the safeguards provided as a result of the Safety First Campaign. The reports show that accidents in the iron and steel industries were decreased more than two-thirds from 1907 to 1917. While in 1907, 245 men were either killed or injured for a certain number of men employed, this rate was reduced to 81 for the same number of men in 1917.

It is stated that a further reduction would have been recorded in 1917 but for the changes in industrial processes made necessary in order to meet the war demands. Machinery and apparatus could not be kept up in good condition and a great many unskilled and inexperienced men were employed during the war. A great many of the accidents must be charged to these conditions, because it is stated that among the most prominent causes of accidents during 1917 were defective machinery and the employment of inexperienced men. The present tendency toward more thorough training of men in the mechanical industries will aid in still further decreasing the number of accidents caused by inexperience; and the number caused by defective machinery will be materially reduced in peace time because of the less strenuous service to which machines and shop equipment will be put.

Can Germany Regain Her Russian Trade?

Cecil B. Harmsworth, Under Secretary of State for Foreign Affairs of Great Britain, recently stated in the House of Commons that the German Government is believed to be trying to establish trade relations with Soviet Russia and that a German Industrial and Commercial Mission has visited or is about to visit Russia with this purpose in view. This statement gives added interest to the present article, giving information concerning the volume of trade of Russia previous to the war and the trade centers that —when normal conditions once more return—are likely to regain their former importance. Manufacturers in the United States who make their foreign trade plans far in advance have expressed interest in Russian conditions because they believe that, after all, the trade with Russia will be one of the most important outlets for American machinery and metal products, even though it may be some time before the Russian trade channels will be reopened. Acknowledgment is made to R. Martens & Co., 6 Hanover St., New York City, for the specific data presented both in the tables and in the text of this article.

FOR over half a century before the war stopped commercial intercourse between the two countries, manufacturers in Germany were systematically establishing trade connections in Russia. This work was conducted with all of the well-known Teutonic efficiency, and immediately before the outbreak of war in 1914, German business men had a virtual monopoly upon many classes of Russian trade. Both European Russia and Siberia are included among the territories of the world still possessing vast natural wealth which has not been exploited; and for several reasons it is to be expected that these great undeveloped resources will lead to a rapid industrial development of the country. Important among these reasons is the fact that both the war and the subsequent revolutions have created what amounts to an intellectual awakening among the Russian people. Many of the old bureaucratic institutions have been abolished, and when a stable form of government is once more set up, there is every reason to feel confidence in the future of the country. Many men of sound judgment believe that war-time conditions have paved the way for a period of rapid industrial expansion, which will create excellent opportunities for the importation of machinery and other factory equipment made in America. But the question is asked by those who are investigating the merits of this potential market, "Can Germany regain her Russian trade?"

Changed Viewpoint of American Business Men

Before the war, there were a large number of manufacturers engaged in making products that could have been profitably sold abroad, who never made any systematic effort to enter foreign markets. This situation has been greatly changed during the last four years. The large volume of profitable European trade which came to our country during the war has shown conclusively the possibilities of foreign markets if they are properly cultivated; and the desire for export business has been further stimulated by the necessity of finding an outlet for the product of manufacturing plants which have, in many cases, been largely increased in order to provide facilities for the execution of government orders.

Those who are now making a study of future Russian trade possibilities recognize the fact that the answer to whether the business men of this country can obtain a share of the future trade with Russia will depend largely upon the question of how successful German manufacturers find themselves in reestablishing their Russian connections. American firms that are planning a sales campaign in Russia are especially cautioned against assuming that the war will have created an insurmountable prejudice against German goods which will make it easy for the American salesman to fill his order books with business that formerly went to Germany. One obstacle to overcome is the fact that most Russian merchants have grown familiar with German business methods, and know the German language. Just as French is recognized as the diplomatic language of Europe, so German is the commercial language of Russia.

Importance of Studying the Customers' Requirements

German business men have not only established offices and made friends in the commercial centers of Russia, but what is more important, they have carefully studied the requirements of their customers and have, in many cases, changed the design of their products in order to make them especially adapted to local conditions. By citing a simple example, this point will be made clear. Some years ago, the files made in Sheffield, England, were used almost exclusively in Russia, but gradually this trade was taken over by the Germans. What was the reason? Sheffield manufacturers were in the habit of delivering files of sufficient thickness so that when the teeth were worn out they could be recut several times before the file was discarded. In Great Britain and other manufacturing countries, where there are shops prepared to recut files at a nominal cost, this form of tool allows a customer to obtain additional service at a relatively low cost. But in most parts of Russia, there is practically no chance of having a file recut, and so the British file with its thick blade represented an additional first cost for steel without any additional service obtained through recutting the teeth.

German file manufacturers were quick to recognize this point, and entered the Russian market with files having very thin blades. These were equally efficient so long as the original teeth lasted, and when the teeth became dull the file was simply discarded. As less steel was required to make such files, they could be sold at a lower first cost, and so they were able to compete on such successful terms that the German file makers soon acquired a virtual monopoly in this line.

The example which has just been cited is a simple one, but there is a big fundamental principle involved, and the manufacturer who hopes to get and to hold business in Russia must be prepared to either send capable men into the field to study local conditions and make trustworthy reports as to the requirements of the trade, or else he must place his product in the hands of an experienced and reliable dealer.

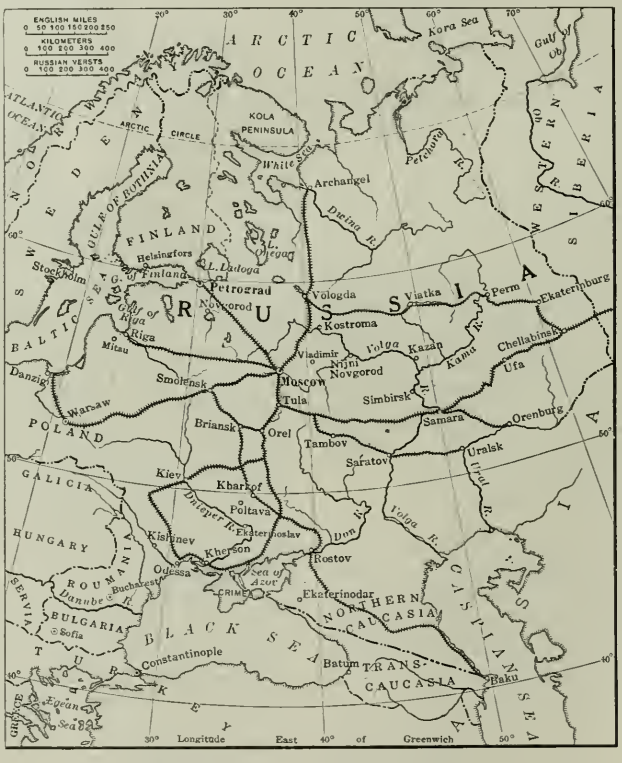
Can the Germans Regain their Trade in Russia?

When the old trade routes are once more open to the commerce of the world, Germany will make a tremendous drive to regain her foreign trade. A special incentive in this direction will be created by the financial burden which has been placed on German business houses through over five years of greatly restricted activity. From the preceding discussion it will be apparent that unless the Russians are prejudiced against German goods as a result of the war, German manufacturers have a considerable advantage in the competition which will arise for Russian trade. Also, there are other special reasons why the Germans will make a most strenuous effort to reestablish themselves in this field. Important among these is the mineral wealth of the country and the losses of territory which the Germans have suffered as a result of their military defeat.

All readers of the daily papers followed the reports of the discussion which occurred in Paris over giving to France

the mineral rights of the Saar Valley to compensate her for the damage which the Germans did to the coal mines in France. Added to this, the loss of Alsace-Lorraine deprives the Germans of practically all of the rich iron ore which supplied the needs of their industry, and leaves them with nothing but relatively poor grades of ore at their disposal. Quite obviously, the electrical, mechanical, and allied industries of the Germans cannot prosper without a supply of ore of a grade which will make good iron and steel, and with their late source of supply cut off, attention of the Germans will naturally be turned to the extremely high grades of ore which are found in large quantities in the Caucasus district of Russia.

A similar situation exists in regard to copper, which is an essential of the electrical industry. Prior to the outbreak of war in 1914, German firms had a virtual monopoly on electrical apparatus sold in Russia, but before they can start upon a campaign to regain any of this trade, it will be necessary to acquire a supply of copper. The best information seems to indicate that Germany has been almost entirely stripped of copper for manufacturing munitions, and it will probably be some time before this supply can be replaced. In the meantime, American manufacturers of electrical equipment and supplies will have an excellent opportunity of entering the Russian field and forming connections which, with proper care, it should be difficult for a competitor to supplant later on. The copper situation and its relation to the electrical trade will, however, offer still another incentive for Germany to regain her hold in Russia, because there are valuable deposits of copper in the Caucasus, the Ural Mountains, and Siberia. Also, virtually all of the world's supply of platinum comes from mines in the Urals.



Map of Russia showing Important Trade Centers

Condition of Russian Industry before the War

In order to form a reliable idea of the probable volume of business that is to be obtained in Russia today, it will be of interest to briefly review industrial conditions of that country prior to the outbreak of war. Agriculture is one of the leading Russian industries, and for that reason there is a large demand for various types of agricultural machinery. Prior to 1914, it was estimated that more than half of the equipment used on farms was of the very crude types which the peasants made for their own use; and that a large part of the remainder was imported from the United States. This fact is of interest because of its probable relation to the changed viewpoint in Russia which has been created by the war. Over 15,000,000 men were enlisted in the army, and a large percentage of this number came from rural communities in which agriculture affords practically the only means of livelihood. Hundreds of thousands of these uneducated peasants were brought into contact with ways of life with which they were formerly unacquainted, and they were taught the use of automobiles, tractors, trench diggers and numerous other mechanical appliances, which has doubtless gone a long way toward giving them an entirely new point of view. Also, there were great numbers of Russian prisoners of war in Germany, who were employed in factories, mines, or on the land, and were taught the use of up-to-date machinery. For these reasons, it is felt that in the future there will be a far better opportunity to sell the Russians improved types of machinery which will enable them to perform their daily tasks with far greater rapidity and with a reduced amount of manual labor.

Management of the Steel Industry—Selling Machinery through Dealers

Continuing with the statement of industrial conditions in Russia it may be mentioned that the steel industry of that country was largely developed by the Belgians, and that an excellent grade of rails and structural shapes were made in sufficient volume so that there was a surplus for export after the domestic requirements had been supplied. The same was not true of plates, however, as these were of poor quality. As regards machine tools, very few were built in Russia and it is estimated that over 75 per cent of those used in the whole country were imported—many from America. The selling of American tools was not done direct, however, as most of the orders passed through German dealers.

It is interesting to note in this connection that just prior to the outbreak of war in 1914, many of these German firms were losing friends in Russia owing to their somewhat arbitrary methods of doing business. The established policy of these firms was to try to obtain nothing but large orders, and where manufacturing plants were in a position to place orders for a large volume of machine tools, but would not give the entire order to one dealer, it was not unusual for him to show very little interest in selling the few machines that were required. Probably some of these little weaknesses of the German dealers will be remembered in years to come, and as a result, American firms who formerly employed these agents to represent them in Russia, should be able to arrange for the direct sale of their machines to the Russian trade.

Made "Out" of Germany

"Made in Germany" is no longer the slogan proudly imprinted upon the manufactured products of that country.

TABLE 1. GENERAL EXPORTS FROM RUSSIA IN 1913

Values given in table are in millions of dollars, based on normal rates of exchange

Country	Millions of Dollars	Country	Millions of Dollars
Germany	226.80	Roumania	10.85
England	133.90	United States	7.10
Holland	88.70	Sweden	5.70
France	50.45	Spain	4.45
Italy	36.90	Egypt	4.35
Austria-Hungary	32.65	Greece	3.45
Belgium	32.35	Norway	3.35
Persia	28.85	Afghanistan	2.95
Finland	27.65	Bulgaria	1.15
Denmark	18.20	Japan	0.70
Turkey	17.90	Other countries	5.90
China	15.75		

Machinery

TABLE 2. GENERAL IMPORTS INTO RUSSIA IN 1913

Values given in table are in millions of dollars, based on normal rates of exchange

Country	Millions of Dollars	Country	Millions of Dollars
Germany	326.10	Denmark	6.45
England	86.50	Norway	4.90
China	42.05	Belgium	4.45
United States	39.55	Afghanistan	3.15
France	28.50	Spain	2.85
Finland	25.50	Egypt	2.95
Persia	21.80	Switzerland	2.60
Austria-Hungary	17.85	Japan	2.40
East Indies	17.25	Greece	0.95
Holland	10.70	Serbia	0.90
Turkey	9.20	Portugal	0.75
Sweden	8.45	Roumania	0.70
Italy	8.40	Other countries	5.00
Ceylon	7.10		

Machinery

It is realized that a wiser course will be to disguise the fact that exports are of German origin, wherever such a course is possible. Among builders of machinery and manufacturers of small tools it is probably a matter of fairly general knowledge that German machinery dealers and manufacturers have established offices and assembling plants in Sweden and Denmark, through which it is proposed to do business in Europe. The idea is, of course, to so camouflage this trade that it has the appearance of emanating from the Scandinavian countries while, as a matter of fact, it is strictly German. Propaganda to expose this system might be employed advantageously in certain cases, where American houses are operating direct in Russia. Men who are most familiar with conditions state that it would be well worth while for large builders of machine tools and manufacturers of machinists' small tools to establish sales offices in Russia. The large manufacturing corporations have grown familiar with the products of the better known American builders of machine tools, and there would be no insurmountable difficulty in arranging for their direct sale from the United States.

Trade Centers of Russia

Manufacturers who consider the establishment of such sales offices would be wise to give careful consideration to the relative merits of the following cities as a location: Petrograd, Moscow, Warsaw, Riga, Baku, Kiev, Kharkoff, Ekaterinburg in the Ural Mountains, and Barnaoul in Siberia. Petrograd is placed at the head of this list because it was the national capital of Russia, but business men who know the affairs of that country express doubt concerning the wisdom of Peter the Great in transferring the capital from Moscow. The latter city is the geographical center of the country, and in many ways it is far better adapted for the national capital than is Petrograd, where it has been found impossible to improve the very poor sanitary conditions of the city caused by the low level of the land. For this and various other reasons it is predicted that the more important business of the country is likely to be done in Moscow in the future.

Machine tool builders and other manufacturers who are considering the institution of direct sales campaigns will naturally be interested in learning of the best way in which to route shipments of goods. These should be sent either via Odessa or one of the Baltic ports, even in cases where the destination is as far east as the western part of Siberia. For shipments to eastern Siberia, it would naturally be more desirable to send goods to San Francisco or one of our Pacific ports for shipment via Vladivostok; but this is unimportant, because for many years to come there is not likely to be much of a demand for machinery or tools in eastern Siberia.

Value of Russian Imports and Exports

Manufacturers who are at present planning to develop their export trade, will naturally wish to give very careful consideration to the probable volume of business that could be done with those countries in which they propose operating. Bearing this fact in mind, tables have been compiled for publication in connection with this article, showing the values of Russian imports and exports. These data are for the year 1913, the latest period for which information is available based upon normal trade conditions. A third table has also been compiled, which presents a partial analysis of the different manufactures and commodities that come under the Russian customs return for the heading of "Ores, Metals, and Metal Manufactures," which includes all classes of machinery and metal goods. There is an interesting point in connection with the items included under this heading; namely, that of a total value of 1,374,000,000 rubles ($687,000,000) for Russian imports, the values of items coming under this group is 353,400,000 rubles ($176,700,000), that is to say, 25.7 per cent of the total. In connection with Tables 1 and 2, which give the values of Russian imports from and exports to various countries, particular attention is called to the great preponderance of this trade which was in the hands of the Germans prior to the war. This naturally suggests the possibility of diverting much of this trade to American firms, if a careful sales campaign is initiated before the Germans are able to reestablish themselves in Russia.

TABLE 3. ANALYSIS OF MACHINERY AND METAL IMPORTS INTO RUSSIA IN 1913

Values given in table are in millions of dollars, based on normal rates of exchange

Classes of Machinery	Germany	England	United States	Sweden	Austria	Denmark	France	Holland	Belgium
Various machinery	33.85	6.85	2.70	0.80	0.80	....	....	....	....
Agricultural machinery	4.95	1.15	2.65	1.10	1.35	0.80	....	....	....
Vehicles	9.00	1.05	....	....	....	....	0.55	....	....
Parts of machinery	6.75	1.15	0.60	....	....	....	....	....	....
Complex agricultural machinery	1.50	1.85	1.75	1.00	....	0.65	....	....	....
Electrical machinery	4.65	0.25	....	....	0.15	....	....	....	....
Cast iron, iron, and steel	3.25	0.80	....	0.35	0.25	0.15	0.10	0.15	0.1
Portable machines	1.25	2.15	....	0.10	0.10	....	....	....	....

Machinery



New National Acme Screw Products Plant

THE National Acme Co., Cleveland, Ohio, has recently completed what is believed to be the largest screw products plant under one roof in the world. This plant is known as the Coit plant, and is located at the junction of E. 131st St., Coit Road, Kirby Ave., and New York Central Railroad, Cleveland, Ohio. Through the completion of this plant, to which the company has moved its entire screw products department, the old plant of the National Acme Co. at Cleveland, Ohio, is released entirely for the manufacture of the company's line of Acme multiple-spindle automatic screw machines and secondary operation equipment, including self-opening dies and taps.

Statistics are dry, but the only adequate way in which to give an idea of the size of this plant is by means of figures. The plant consists of a stock-room and tool-room building of two stories, and a one-story sawtooth main manufacturing building, the total floor space of the whole plant being 8½ acres, of which 335,000 square feet of floor space (about 7½ acres) are covered by the one roof of the sawtooth building. The two-story building is 600 by 52 feet, while the main sawtooth building is 600 by 480 feet. The two-story building is of concrete construction, while the sawtooth building is of brick and steel construction with steel sash. In addition to the shop building, there is an executive office building, 112 by 50 feet, two stories and basement, built from reinforced concrete construction. This building is located in front of the shop building and is connected to it by a covered passageway. The plant employs a total of 1500 people, of which about 350 are women.

Some idea of the size of the building may be obtained from a few figures relating to the amount of material used in building the plant. The amount of structural steel is 2000 tons, and the wood-block flooring required 38,000 square yards of wooden blocks, equivalent to 94 carloads. There are 140,000 square feet of side-wall sash and 105,000 square feet of ventilating sash in the sawtooth roof. Measuring the glass in a 1-foot wide strip, there are 26½ miles of glass in the building, and 70,000 pounds of putty were used in connection with the glazing. In addition, 31 tons of paint were used in the painting of the main building.

Wide aisles, good and evenly distributed light, and provisions for fresh air of the right temperature characterize the plant. An unusually efficient heating and ventilating equipment has been installed. There are four heating and ventilating units, each unit consisting of a supply fan, vento-heaters, air washers, and return fans, vacuum pumps, circulating pumps, etc. The two larger units have a capacity of 90,000 cubic feet of air per minute, at a velocity through the washer of 450 feet per minute. The two smaller units have a capacity of 76,000 cubic feet of air per minute.

General Arrangement of the Plant

The plant is arranged with a view to having the material pass, as far as possible, in one continuous stream through the shop. The stock-rooms for raw materials are at one end of the plant, and from there the material passes to the various machines and departments by a direct route, after which the passage through the hardening and heat-treating

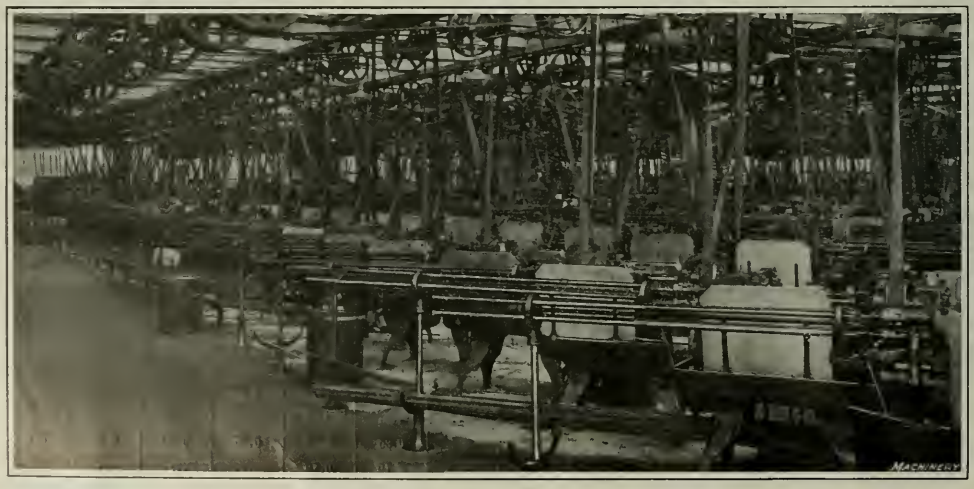


Fig. 1. General View in the Plant, indicating Arrangement of Machines and Broad Aisles provided



Fig. 2. View in the Cleaning Department, showing Pails of Parts and Scrap piled up, Ready for the Oil Extractors

rooms to the shipping room is made to cover a direct line as nearly as possible. In order to eliminate the hauling of finished material an unnecessarily long distance, the rather unusual arrangement of placing the cleaning department almost in the middle of the plant has been adopted. In most plants this department would be located at either end of the plant, requiring a long haul to and from this department. From the cleaning department, the parts pass either to the heat-treating department, to the shipping department—in case they are to go out immediately—or to the finished stock storage room, which is also quite centrally located, although toward one side of the plant.

Along that side of the plant where the raw stock room is located, a railway siding extends for the full length of the plant and an unloading platform is built at this side of a length sufficient for unloading twelve cars at once. As a rule, the outgoing product, except for shipment to branch warehouses, is not sent in carload lots, and hence is hauled by motor trucks to the respective freight stations, a special shipping platform being provided for the accommodation of the motor trucks. In cases where whole carload shipments are made, these are loaded at the unloading platform for raw material just mentioned.

An interesting feature in the management of the plant is that the gross screw machine product is not trucked through the plant during the day, but left until night, when it is brought from the automatic machines to the cleaning department by a night gang ready for the next morning when the material is passed through the oil extractors, where the oil adhering to the work and chips is first recovered. From the oil extractors, the finished material passes into chip removers or separators of special design having perforated sheet-metal screens. These screens permit the chips to pass through, while the screw products pass over the screen, which is oscillated in order to separate the chips from the work. After having passed through the separators, the screw product parts pass to steam washers, where the remaining oil is cleaned from the work as it passes through the cleaning machine in perforated-bottom metal boxes by means of a conveyor. After having passed through these washers, a light oil is poured over the parts to keep them from rusting. Afterward, the parts are sorted, weighed, inspected, and then sent either to the clearing house or to the stock-room. Heat-treated parts are sent to the heat-treatment department, and then returned for sorting and inspection.

The Equipment of the Plant

In order to gain an adequate idea of the size of the plant, a review of the equipment installed is necessary. In all, there are 600 Acme automatics, in addition to 60 milling machines, 46 bolt-threaders, 30 drilling machines, 16 screw-slotters, 29 stud-threaders, 155 nut machines, 65 nut tappers,

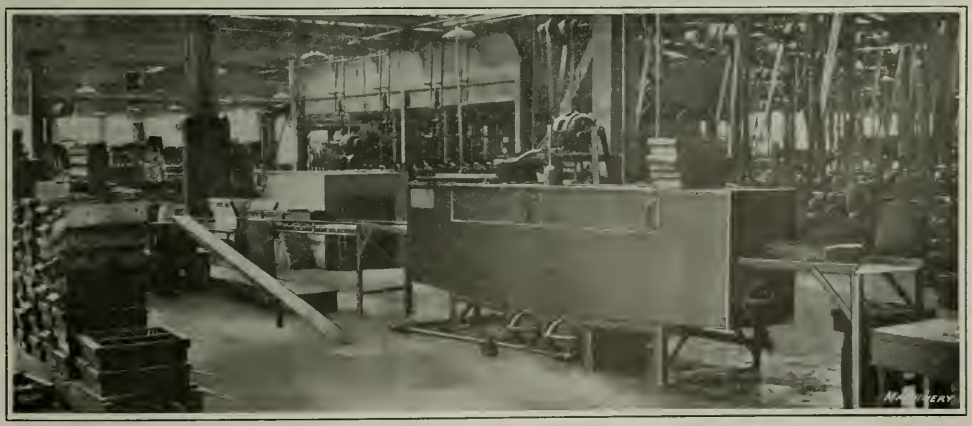


Fig. 3. Another View in the Cleaning Department, showing the Steam Washers



Fig. 4. A View in the Inspection Department, showing Individual Inspection Tables

119 castellating machines, in addition to a great number of other machines employed on secondary operations, the total number of machines in the plant being about 1800. The average production of the plant per month is 50,000,000 pieces. Specifying in detail the capacity of the different machines, it may be of interest to note that the bolt-threaders have a capacity of 500,000 pieces per day, the stud-threaders 100,000 pieces per day, threading both ends; the nut machines 600,000 nuts per day; and the nut tappers, 1,000,000 nuts per day. In addition, the hardening department has a capacity for handling 20,000 pounds of product in twenty-four hours.

In order to maintain this production 17,000,000 pounds of brass, steel, and iron are constantly kept in stock, and 200,000 pounds of stock are daily delivered to the automatic machines. The number of sheet-metal boxes necessary throughout the plant for holding the product while in process of manufacture is about 25,000, an average of 15,000 of which pass through the clearing house at the washing machines daily. About 50 tons of scrap are daily collected from the machines and put into the scrap pit. There are 20,000 gallons of cutting oil used per week, but 90 per cent of this amount is reclaimed.

Provisions Made for the Welfare of Employes

In building this plant, as well as in its management, considerable attention has been given to the comfort, convenience, and welfare of the employes. A hospital is provided where accidents can be quickly and efficiently taken care of, and where a great number of minor injuries are daily taken care of. A nurse is constantly on duty in the hospital and a physician is also there at certain hours every day.

A school has been provided for the women employes, giving them instruction in the English language and hygiene, classes being conducted daily. The course in English has proved to be an important feature, because as many as twenty-nine nationalities are represented among the employes.

Considerable attention has been given to provide a good lunch service for the employes. Space has been provided for a cafeteria seating 350 people. This cafeteria is intended for the office force and the women employes. There are also five additional serving stations provided throughout the plant for the shop men, these serving stations being capable of providing lunches for 850 men. Every feature has been studied with a view to providing maximum service at a minimum cost, so that good meals may be served at a low price, representing only the actual cost to the company.



Fig. 5. One of the Five Serving Stations provided throughout the Plant where the Men obtain their Lunches



Fig. 12. Conveyor System used for carrying the Chassis from a Storage Space in the Basement to the Main Assembling Department on the First Floor of the Plant. This Conveyor carries the Chassis to the Starting Point of the Main Assembling Line

Automobile Factory Transportation Systems

Types of Equipment Used for Transporting Raw Materials and Parts of the Product through the Plant of the Willys-Overland Company in Toledo, Ohio—Second of Two Articles

By EDWARD K. HAMMOND

THE first article on this subject, published in the September number, described the methods and equipment employed by the Willys-Overland Co. in transporting the engine parts and finished engines through the plant, in assembling and upholstering the car bodies, and in handling the wheels, rims, and tires. The present article describes the progressive assembly of the complete cars and the conveyor systems for carrying the chassis, fenders, lamps, etc.



Fig. 13. Opposite End of Conveyor System shown in Fig. 12. The Four Main Assembling Lines will be seen at the Right



Fig. 14. View of Main Assembling Lines at a Point where the Engine and Steering Posts have been mounted on the Chassis

Progressive Assembly of the Complete Cars

The same general method of assembling is applied in the majority of plants engaged in automobile manufacture, although details naturally differ in each plant. In general, the method consists of starting the chassis at one end of a track, down which it is carried between two lines of men, each of whose duty it is to put a specified part on the partially finished car as it passes by the point where he is employed. In the Willys-Overland plant, and in other factories where the assembling department has been carefully organized, it is a practice to have a power-driven conveyor to carry the cars along this assembling track, so that a pace is set at which the men are compelled to work. This pace has been carefully determined, so that by a proper adjustment of the number of men employed at each station, none of those working in the assembling department are required to exert themselves to an extent which would be detrimental to their health. At the same time, the establishment of a uniform rate of working by all of the men protects the employer against the dishonesty of those who might otherwise be inclined to shirk their work. In most places where a power-driven progressive assembling equipment is used, the balance between the speed of the conveyor and the number of men employed has been worked out with such a degree of nicety that it is necessary to have substitutes stationed at intervals along the line for the purpose of taking the place of any man who has to temporarily leave his work. These substitutes have been trained in the performance of

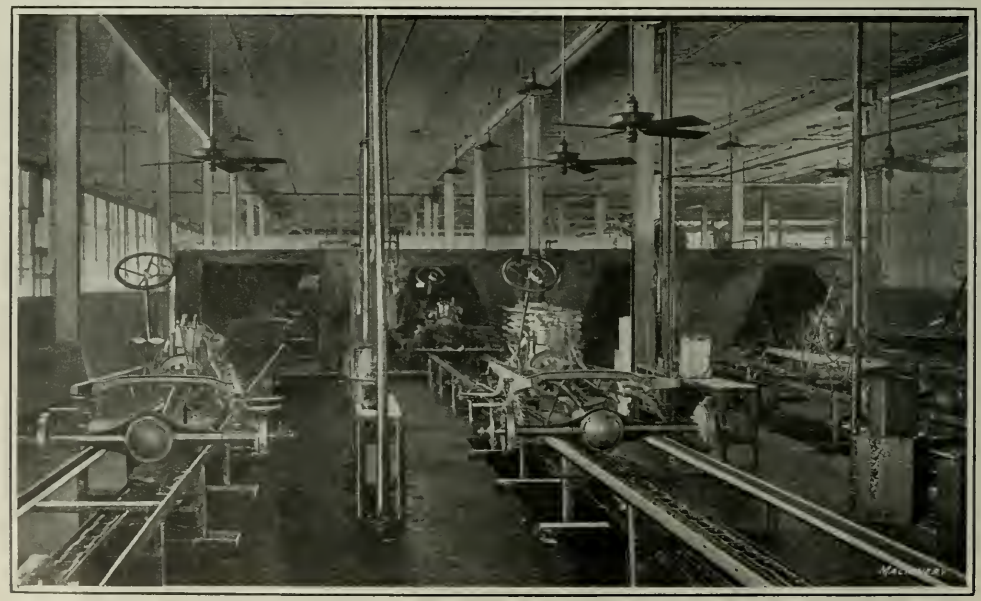


Fig. 15. The Chassis are painted as they pass along the Main Assembling Lines. At the Point shown, Paint is applied and as the Conveyors carry the Work through the Ovens, the Paint is baked to avoid Loss of Time in drying

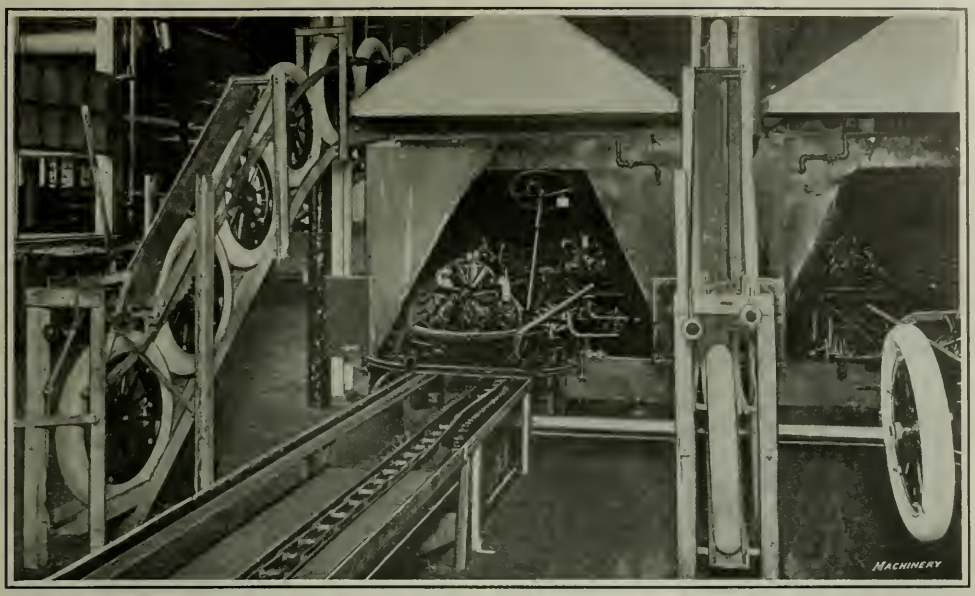


Fig. 16. Opposite End of Drying Oven shown in Fig. 15. The Work is cooled at this Point by Blasts of Cold Air. The Wheels shown in this Illustration descend from the Storage Space to which they are delivered by a Conveyor

various parts of the work of assembling, so that they are able to give efficient service in the performance of a number of these highly specialized tasks without delaying production.

Advantages of the Method of Progressive Assembly

It is coming to be generally recognized by progressive manufacturers that there are few methods which are capable of effecting greater savings in production costs than a properly worked out application of the method of progressive assembly. Although this method was originated in the automobile industry, its field of usefulness is by no means restricted to plants engaged in the production of motor cars. For these reasons, it may be well to call attention at this point to a modification of the power-driven assembling conveyor which has been found to give satisfactory results in several plants. Instead of having the conveyor moving continuously at a predetermined speed, this modification, to which reference is made, consists of having a control station at the end of the assembling line, where means are provided for starting the conveyor to advance all of the work on the assembling line to the next station, after which the conveyor is stopped long enough to allow the next assembling operation to be performed.

As rapidly as the men at each station complete their work, a signal button is pushed, causing a light to flash under a number designating that station on an indicator board, which forms part of the equipment of the control station. As soon as all of these lights have been turned on, it indicates to the man in charge of the control station that the work of



Fig. 17. Passing Transversely across the Four Main Assembling Lines there are Overhead Conveyors that carry a Continuous Stream of Fenders, Running Boards, Radiators, and other Auxiliary Parts to the Men who assemble them on the Cars

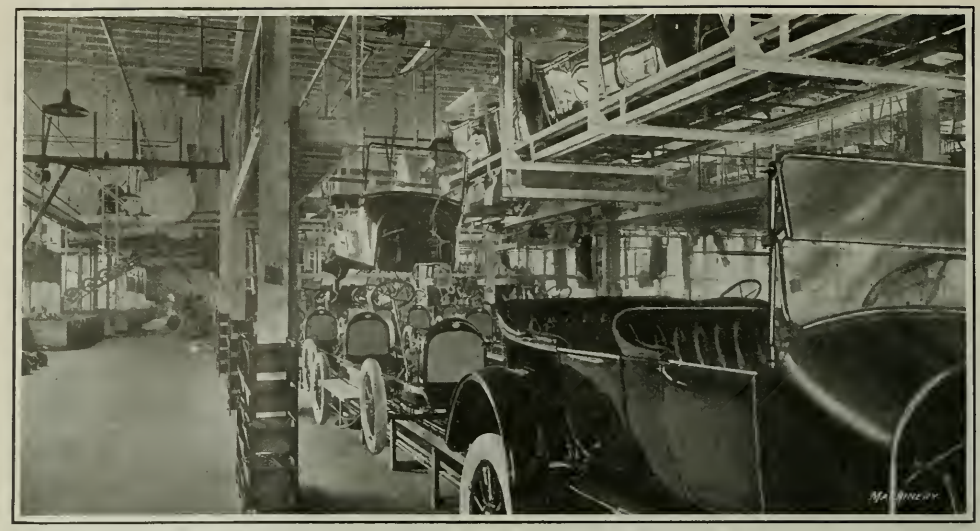


Fig. 18. Assembled Bodies are lowered through the Floor above to the Overhead Conveyor here shown, and carried to a Point over the Four Main Assembling Lines at which the Bodies are assembled on the Chassis

assembling has been completed at every station along the line; and immediately the last signal light appears, he throws over the control lever to move the conveyor sufficiently to advance the work to the next assembling station. A careful record is kept of the order in which each station along the assembling line completes its work. This is an important source of information for the production department, as a study of this record will sometimes show that one station along the line is consistently the last in finishing its work. When the records reveal such a condition, an investigation is immediately started to ascertain whether the men employed at that station are taking too much time over their work, or whether they have too much work to do in a specified time. In either case, the necessary correction will be made to enable this assembling station to complete its work with the required degree of rapidity.

At the Willys-Overland plant in Toledo, the chassis frames are stored in the basement, and delivery is made from this storage space to the starting point of the main assembling line by means of a conveyor system as shown in Fig. 12. It will be seen that this consists of two T-irons on the edges of which the chassis slides. There are hooks on the power-driven Link-Belt chain which provides the source of motive power, these hooks being so arranged that they grip a chassis when it is placed upon the conveyor rails, without requiring any attention from the workmen. Several drilling

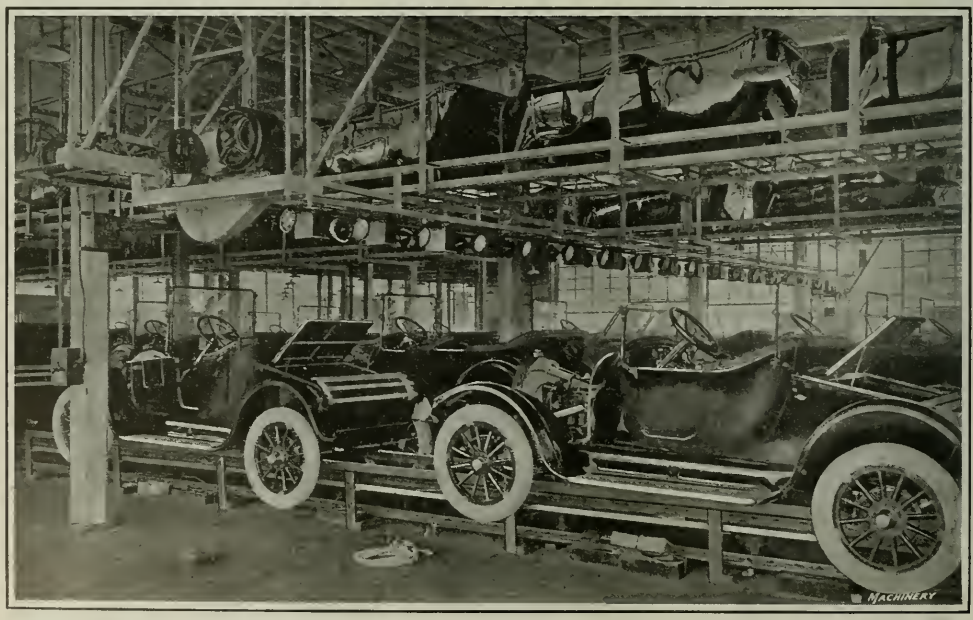


Fig. 19. View of Four Main Assembling Lines where the Work is still further advanced. This Illustration shows Overhead Conveyors carrying Lamps to be assembled on the Cars

operations and similar work is done on the chassis as they are carried along by the conveyor. In the background of this illustration it will be seen that the conveyor track runs up at an angle to carry the work through an opening to the first floor of the plant, on which the main assembling lines are located, the upper end of the chassis conveyor being shown at the left-hand side of Fig. 13. It will be apparent from this illustration that each chassis is delivered from this conveyor to a receiving platform, from which it is slid to a hand truck on which it is pushed across to the starting point of either of four assembling lines, each parallel to the other. As each chassis is pushed off the truck on the assembling track, the rear axle is fastened to the rear springs. Fig. 6, in the September number, showed the apron conveyor which carries the completely assembled engines through a tunnel to the central storage space. From the point where this apron conveyor discharges its load, an overhead conveyor picks up the engines and carries them to a position above the four main assembling tracks, where they are lowered within reach of the men who bolt the engines to the chassis frames. Fig. 14 shows the chassis with the engine in place. From this point onward, the various parts, such as steering wheels, motor controls, fans, lamps, etc., are brought to successive positions over the four main assembling lines, ready to be attached to the cars. Reference to the remaining illustrations will show the car in the various stages of completion, and give a representative idea of the way in which it grows from a bare chassis frame to the complete car that runs off the end of the assembling track under its own power.

When the partial assembly of a Willys-Overland car has reached the stage of development shown in Fig. 15, it is ready to be painted, and in order that this part of the work may be accomplished as rapidly as possible, a practice is made of spraying the paint on those parts which require protection against damage from rust. The paint is sprayed on while the chassis passes over a draining pit that will be seen under each of the four assembling tracks, after which the partial assembly passes on through a drying oven, which hardens the paint sufficiently so that the work of assembling can proceed immediately after each chassis emerges from the opposite end of the drying oven. However, it is necessary to cool the work sufficiently so that it can be handled, and this is done by means of blasts of cold air that are directed on the chassis as they leave the ovens. In Fig. 16 there is shown a view of the assembling tracks coming out at the opposite ends of the ovens, which are shown in the preceding illustration; and leading down from a storage space located above these ovens will be seen tracks which carry a continuous stream of assembled wheels.

In the condition in which the work is shown in Fig. 17, these wheels have been assembled on the axles, and the work has progressed from the drying ovens to a point at which the fenders are secured in place. Coming up through the floor at the right-hand side of this picture there will be seen three elevating conveyors which carry up the fenders, running boards, mud guards and radiators, and transfer them over the four assembling tracks, so that the men employed to bolt these parts in place are kept constantly supplied with the parts which are required for their work. By carefully synchronizing the relative speeds of the four main assembling lines and the elevating conveyors, no trouble is experienced through having a surplus of parts, or through failure of parts to reach the assemblers as rapidly as they are needed. This system of using cross-conveyors to bring work to the four main assembling lines, makes it unnecessary to resort to either of the objectionable practices of carrying the material on trucks or of storing a surplus supply on the assembling floor.



Fig. 20. At this Point, Cars carried on the Assembling Lines receive a Preliminary Running Test to "limber" up the Engine. The Back Wheels run on Idler Rollers mounted beneath the Floor

In connection with the description of the method of procedure in handling the work of the body department (Figs. 7 and 8 in the September number), mention was made of the fact that this section of the plant is located on the second floor, and that finished bodies are lowered through an opening in the floor to an overhead conveyor, which carries them to the four main assembling lines. A view of this overhead conveyor is shown in Fig. 18, which also includes the trolley hoist that is used to take bodies from the conveyor and lower them into place on the chassis, as they travel along the four assembling lines. In the background,

at the left-hand side of this illustration, there will be seen the conveyor line which carries the assembled wheels up to the storage space above the drying ovens; and another view of the fender, running board, and radiator conveyor which serves the four main assembling tracks will also be seen at the extreme right. Fig. 19 shows cars on the assembling track after the bodies have been mounted in place, and at the point at which this picture was taken, there is located a cross-conveyor that carries lamps, batteries, horns, etc., up from the storage space in the basement and over the four assembling lines ready for the men whose duty it is to mount them on the partially finished machines.

During the process of assembling the Willys-Overland cars, a gasoline tank is delivered to the assembling line containing a sufficient supply of fuel to provide for giving the car a brief running test before it leaves the assembling line, and then sending it away from the end of the line under the power of its own engine. In Fig. 20 there is shown a platform on which the engine and transmission of each car is "limbered" up before the finished car leaves the assembling department. For this purpose it will be seen that the floor



Fig. 21. The Gasoline Tank which is assembled on Each Car contains a Sufficient Supply of Fuel so that when the Finished Car reaches the End of the Line, it may run off under its Own Power

is raised at the point where the cars, which were formerly carried by the conveyor with their wheels lifted clear of the floor, are run off the assembling track. Beneath the platform, or raised portion of the floor, there are freely mounted rollers on which the rear or driving wheels are located, after which the engine is started so that the driving wheels may rotate without exerting any tendency to advance the car. During the time that the engine is getting this preliminary running test, the assemblers busy themselves in mounting the cover on the body of the car; and after this work has been accomplished, the machine is driven away, ready for the final running test before shipment. The final illustration, Fig. 21, shows a view taken at the end of the assembling line just as the finished cars are ready to leave.

* * *

Commenting on reports that American-made steel is heavily underbidding British steel in English markets, the counsel for the National Erectors' Association (United States) says that since wages in England are still substantially below those of this country, the real differential which explains our cheaper production cost must be found in the lesser output of the English worker under his union rules.

HOURS OF WORK AS RELATED TO OUTPUT AND HEALTH OF WORKERS

The National Industrial Conference Board, Boston, Mass., has issued a comprehensive report on hours of work as related to output and health of workers, this report relating to the metal manufacturing industries. The investigation upon which this report is based justifies the conclusion that a considerable proportion of metal-working establishments is able to maintain production on a schedule of fifty hours per week, but that such schedule could not be universally adopted by the metal-working industry without some loss in production. In the case of a forty-eight-hour week a smaller proportion of establishments report production as being maintained, but the conclusion of the report states that the weight of the evidence leaves little ground for doubt that the general reduction to a forty-eight-hour week at the present time would mean a serious loss in production. In plants where a very large percentage of the work is performed by automatic machinery, the evidence indicates that, in general, maximum production cannot be obtained on a schedule as low as forty-eight or fifty hours per week. The investigation states that there has been no significant change in the health of metal workers resulting from reduction in working hours.

The report points out the distinction which should be made between what *can* be done in fifty hours and what, as a matter of record, *is* done. If both management and workers would actively cooperate, a forty-eight-hour week might prove practicable in a larger number of establishments than is now the case, but unless such cooperation is secured there can be little question that the general adoption of the forty-eight-hour week in the metal trades would involve a serious economic loss to the nation. If workers would realize, says the report, the indisputable principle that their real interest and their real opportunity for bettering their condition lies in increasing the efficiency of individual production, a great deal would be gained.

The conclusions drawn in the report are based upon an investigation made by sending out two questionnaires to which replies were received from 1252 establishments employing 753,561 workers. Of these, 413 establishments employing 358,336 workers had reduced the hours.

Purpose of Models in Interchangeable Manufacturing

By EARLE BUCKINGHAM, Engineer, Pratt & Whitney Co., Hartford, Conn.

The increase in general mechanical knowledge and the improvements in the language of drawings have, in many cases, rendered the making of models unnecessary, but conditions still exist where their use results in the economical solution of many manufacturing problems. The object of this article is to point out this limited use and to indicate their relative position in the constructive development of a new commodity, which is to be manufactured in large quantities by the use of interchangeable methods.

A MODEL mechanism, constructed personally by the inventor, or by the workmen under his immediate direction, was the original form of making and recording a new design. The introduction and development of mechanical drawings superseded many of the functions previously performed by the model. At the present time, therefore, the practice of developing models has been relegated to a comparatively insignificant place in most lines of manufacturing. They are still employed to a limited degree, however, by several manufacturers for a variety of purposes.

The primary purpose of any model at the present time is to prove—not to originate—a new or improved design that has been developed only on paper. It may be either to prove the possibility of the functional design or to check the manufacturing design. This may be done by a single mechanism in some cases, or several duplicate mechanisms may be required to prove its operation under various service conditions.

Manufacturing models may be used for one or more of the following purposes: First, to check the operation of the manufacturing design against the experimental model; second, to prove the manufacturing design in regard to the service requirements; third, to test the manufacturing tolerances which may be contemplated; and fourth, to create a physical standard of precision for future manufacturing.

Manufacturing Model to Test Functioning

A manufacturing model used to test the functioning of the manufacturing design is merely a sample mechanism constructed in the tool-room or machine shop to detect as many faults as possible in the design or to discover possible errors in the component drawings. It is essentially a precautionary measure. It is more economical to detect and correct a fault on one sample than it is to salvage a large number of parts after production is started, with the additional expense of correcting the manufacturing equipment. After such a model has demonstrated the success of the manufacturing design and the correctness of the component drawings, its purpose has been achieved. Its future disposition is a matter of little moment.

Such a model is seldom necessary on simple mechanisms that are merely new combinations of old and proved mechanical movements, or on minor variations of proved designs, such as standard motors, dynamos, various types of engines, and many machine tools. The actions of such mechanisms under many conditions have been so well established that practically all of the necessary experimental work can be accomplished on paper. On many other mechanisms, however, such as typewriters, adding machines, small arms, watches, etc., the mechanical movements of which are delicate and intricate and not so positive, manufacturing models are a vital necessity. In general, such a model will be constructed when the insurance against the possible errors in the design is worth the expense entailed. For this reason it is often customary to first build a pilot machine before putting through a lot of new or special machines.

If a new commodity is designed, particularly if it is to fill a new demand, it is advisable to determine its action in actual service before extensive productive operations are far advanced. The only sure method of obtaining this information is to have one or more mechanisms built and operated under the conditions with which they are expected to contend. The manufacturing model, which is built to test the manufacturing design, is often used for this purpose. As a matter of fact, the test for functioning should also include the tests for service requirements, inasmuch as this factor of functioning should include the measure of service which the mechanism must render throughout its normal life.

For example, a large plant in the Middle West goes thoroughly into this preliminary work on all new models. Three successive designs are developed and tested. First, the functional or inventive design is made and tested. Second, the manufacturing design is carefully developed and tested by means of a manufacturing model. When this last design seems satisfactory, it is turned over to the tool designing department which goes over it a third time solely to simplify the tooling and mechanical productive operations. The changes made at this time, however, affect minor details only. From twenty-five to fifty mechanisms are built to this design and sent into the field for actual service. These last models must give satisfactory service for from one to two years before further preparations for manufacture are considered. It is of interest to note that the manufacturing equipment provided by this factory is very complete; also that changes here in the process of manufacture or in the product under production are very rare.

Many of the so-called improvements in new commodities which result in frequent modifications of the product under manufacture are only steps taken to correct mistakes, omissions, and other faults due in large measure to neglect of the manufacturing design (both neglect to make and neglect to test it) because of haste to rush into actual production. This has been forcibly brought out by the conditions which developed in the manufacture of many devices during the war.

Models to Test the Tolerances

It is desirable to know at the earliest possible moment whether or not the specified tolerances define the limits of parts that will function properly. The sooner this information is obtained, the sooner we can concentrate our efforts on problems of production alone. Until this matter is settled within a reasonable degree of certainty, each problem in production is complicated by many considerations relating to the design and tolerances. This causes innumerable revisions on the component drawings with the attendant changes in tools, fixtures, and gages, resulting in delays in production and additional expense.

Some concerns try to solve this problem by carefully building several models which represent as closely as practicable the extreme conditions permitted by the component drawings. These model parts are assembled and reassembled,

and tested for operation after each assembly. Necessary alterations of the drawings are made before manufacturing operations are under way. This practice is, naturally, very expensive, as each of these models costs much more to construct than any of the preceding ones. However, if insurance against future changes is worth the expense, the practice is well worth while.

One typewriter manufacturer makes a practice of building from six to ten sets of model parts before any new or revised machine is manufactured. When only one unit assembly is affected, model parts for that mechanism only are made. These parts are then sent to the assembling department for trial. Except on purely experimental models, the men who make the parts are not allowed to assemble them. No effort is made to do anything more than to duplicate the kind of work normally produced in the manufacturing departments. The parts are not cornered nor burred unless that operation is required in manufacture. In other words, the attempt is made to determine how little effort will be required to manufacture the mechanism satisfactorily. The sizes of these parts usually cover the entire range between the specified limits, but no distinct effort is made to have them meet either limit exactly. Any combination of these parts must assemble and operate properly before changes or new models are adopted. This practice has saved the company several times from making unnecessary and improper changes.

Model for Standard of Precision

The component drawings give many dimensions. Strictly speaking, the expressed dimensions represent absolute sizes. Dimensions of elementary surfaces can be produced and reproduced within relatively small limits of error. Often, however, these dimensions define developed and complicated profiles, locations, and other composite surfaces which cannot be reproduced as readily. Yet, they must be reproduced many times over in the course of manufacture to within relatively small limits of error.

We must choose between accuracy and precision at the outset. In the case of elementary surfaces, accuracy is usually the better choice; but for many composite surfaces, precision will often give the quicker, more economical, and more practical results. On the other hand, it must be clearly understood that when precision is choosen, it becomes practically impossible for another plant, working in entire independence of the first, to produce a common interchangeable product. If more than one plant is engaged on the production, they must maintain close relations in almost every detail of the work. In order to maintain this precision within reasonably close limits, physical standards of some sort must be provided at the very beginning. By developing a model for this purpose, two results can be accomplished at the same time. Such a model will test the manufacturing design for functioning, and will also provide the desired physical standards.

This model must be made with the greatest care and should represent the "danger zone"—that is, in most cases, the maximum metal or minimum clearance conditions. It is evident that these sizes are the most important. They control the interchangeability. No cuts, other than slight cornering and similar burring operations, should be made with a hand tool, such as a file. Whenever the contour of the surface in question is important, templets should be made to check the special tools used. These templets are an integral part of the model. All important locations of holes should be established from master plates. Templets, master plates, etc., as well as the model parts, are invaluable when the equipment is built; properly utilized, they will insure a high degree of uniformity at relatively small expense. Such a model must be used with the greatest care and becomes the court of last appeal in many of the perplexing questions which inevitably arise in the manufacturing departments of a plant engaged in producing an interchangeable product in large quantities.

This practice in regard to models is extensively followed in the manufacture of small arms. As stated before, it has a certain disadvantage when more than one factory is involved. As it is impossible to duplicate the model exactly, one of two courses is open. Either one model is standard for all plants—which entails much lost time in referring many detailed questions back to the central plant—or additional models may be made, which results in different basic standards at the various plants. If the second course is followed, and all parts of all models are mutually interchangeable, the product of the various factories will be interchangeable. However, this results in reducing the amount of the absolute tolerances available for manufacturing variations, as the variations in the different models consume a certain amount. In cases where the functional conditions are exacting, this method is often found impracticable. On the other hand, if the design of the mechanism is such that the absolute tolerances are liberal, the second method gives an economical solution.

All the foregoing model work, regardless of its purpose, is essentially a preliminary measure in the manufacture of a new or revised product. Properly conducted, it will stabilize the manufacturing design at a minimum expense. It takes considerable time, however, and that is one reason why models are not more extensively employed. For any commodity that is already under manufacture and the design of which is already standardized, models are of doubtful value.

* * *

OXY-ACETYLENE CUTTING

The oxy-acetylene cutting process was of vital importance during the war period in speeding up production. Several applications of the process are cited in a paper by R. R. Browning, vice-president of the Oxweld Acetylene Co., Chicago, Ill., which was presented at the annual convention of the International Acetylene Association. Two of the several interesting uses mentioned are the cutting of port-holes and the removing of extra metal from naval and field gun slides.

It has always been customary in shipyards to punch a large number of holes with a ½- or ¾-inch punch around the periphery of the proposed port-hole. The central portion, or plate, is removed in this manner, the edges then being trimmed by means of a chipping hammer. An average of 1½ hours was required to make a 12-inch port-hole by this method, whereas with an oxy-acetylene cutting blowpipe and a simple attachment, the port-holes were completed in an average time of five minutes each. This not only shows a considerable saving in time in doing the work, but it can also be said that the finished port-hole, when made by the oxy-acetylene cutting process, has a better appearance than results from the use of the older process.

Shortly after the United States entered the war, contracts were placed with numerous steel foundries throughout the country for castings to be used in the construction of naval and field guns. One of these castings, the gun slide, is very difficult to manufacture. It has a trunnion or projection of metal on each side, which is very heavy compared to the walls of the casting, and in order to eliminate shrinkage and cracking when the casting cools, the trunnion has to be carried clear across the casting. After the casting is cooled, part of the trunnion has to be removed. To remove this part by machining would be very slow and costly; hence a number of foundries used the oxy-acetylene cutting blowpipe for removing the surplus metal. The time saving, as compared with older methods, was an important factor in the speed of production.

* * *

Belgian reconstruction is proceeding rapidly in all the industries, as evidenced by the large amount of imports of machine tools and machinery of all kinds into that country. It has been decided to hold a national industry exhibition in Brussels in April, 1920. To what extent foreign exhibitors will be invited to exhibit has not yet been announced.

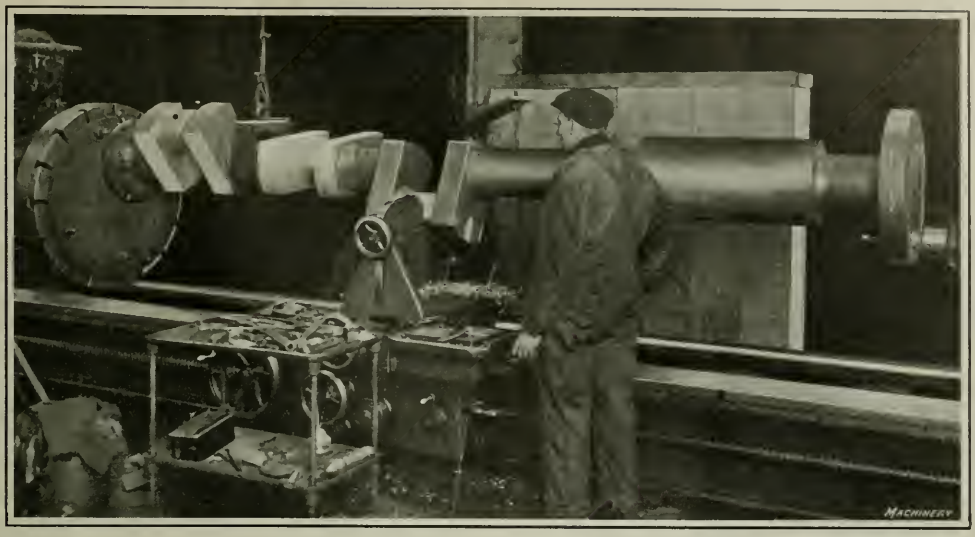


Fig. 1. Turning the Crankpins. Note the Special Design of Tool Support used

Turning a Marine Engine Crankshaft

THE turning of a crankshaft for a 500-horsepower, six-cylinder marine engine is shown in Figs. 1 and 2, which illustrate how this work is done at the Skandia Pacific Oil Engine Co., Oakland, Cal. The turning of a crankpin is illustrated in Fig. 1, which shows two interesting features of this work, namely, the special form of tool support used and the method of counterbalancing the crankshaft while the crankpins are being turned.

The tool-holder is designed to grip the tool and provide a solid unyielding support, but it has the advantage of being very narrow and does not interfere with the rotating webs of the crank. A detailed view of this tool-holder is shown in Fig. 3. The base is a heavy casting which is fitted to the ways of the carriage in place of the cross-slide. A flat steel plate about 1½ inch thick is fitted and securely clamped to this base casting. This flat plate has a notch or opening near the upper end for receiving the turning tool. Just above the tool there is a wedge-shaped clamp which is drawn back by means of a screw connecting with the handwheel seen at the front of the tool-holder. The tool itself is provided with a groove which engages a tongue on the lower side of the notch formed in the tool plate. The rear end of the tool also has an adjustable backing screw. With this arrangement, the tool is securely supported against endwise, lateral, and downward thrusts, and the tool-holding plate is so narrow that it occupies little room between the webs.

This six-throw crankshaft is formed of two sections of three throws each. These sections are flanged and bolted together and one is provided with thrust collars for the regular type of thrust bearing. Fig. 1 shows one of the sections in the lathe. The crankpins are located 120 degrees apart and each pin is aligned with the axis of the lathe by changing the position of the shaft relative to the special faceplate casting and by changing the position of the tailstock center. Three centers 120 degrees apart are formed in a ring that is bolted to the flange at the tailstock end of the crankshaft. At the opposite end the flange fits into a circular recess, the center of which is offset relative to the

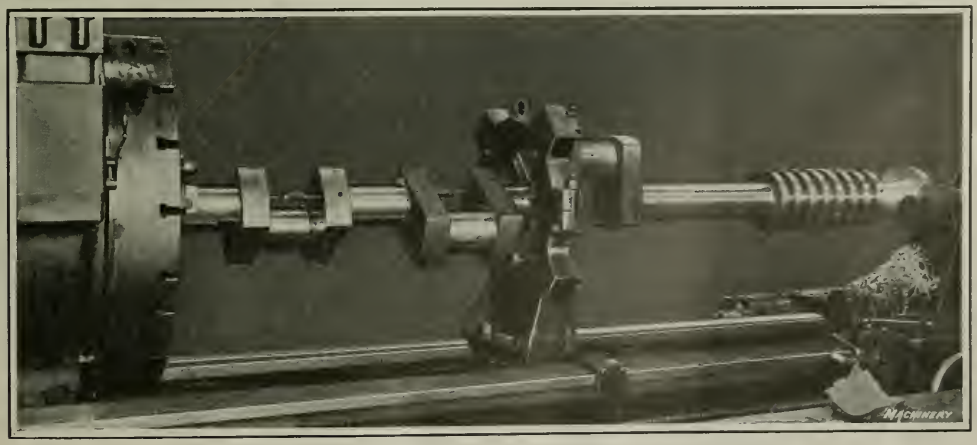


Fig. 2. Finishing the Journals after completing the Turning Operations on the Crankpins

axis of the lathe spindle a distance equal to the throw of the crank.

The counterbalancing of the crankshaft is effected by means of an ingenious, but simple, device consisting of a steel strap which surrounds one of the journals, as shown in Fig. 1, and is attached to a steel cable which passes over a pulley above the lathe to a counterweight attached to the opposite end. With this arrangement, when the unbalanced part of the crankshaft is revolving in an upward direction, the strap and counterweight assist in this upward movement. On the contrary, when the unbalanced mass is descending, it is supported by the counterweight. It will be seen, therefore, that the effect is similar to that obtained when weights are attached to the faceplate on the side opposite the heavy unbalanced sections. The advantage of using a strap and counterweight attached to a cable is that the counterbalancing can be applied at a point that is at least approximately in the center of the unbalanced mass instead of at one end; consequently the shaft not only is counterbalanced, but its tendency to sag is also overcome.

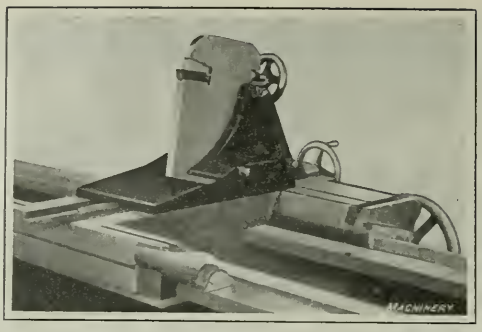


Fig. 3. Special Form of Tool-holder used for turning Crankshafts

Fig. 2 shows the crankshaft in position for finishing the journals. The center of the shaft is supported by means of a heavy steadyrest. The practice in machining these shafts is to first rough-turn the journals, then finish the crankpins complete, and finally place the crankshaft back on the main centers for finishing the journals to size. This method insures accuracy of alignment. These shafts measure 15 feet 6 inches over-all, and the journals and crankpins are 8½ inches in diameter. Each crankshaft section is forged from a solid billet of open-hearth steel. All important dimensions are said to be held within a tolerance of 0.0005 inch. The Houston, Stanwood & Gamble Co.'s lathes are used.

* * *

RECLAIMING WASTE AND OIL

By J. EMILE COLEMAN

A certain plant which uses approximately 19,000 pounds of waste yearly has installed an oil and waste reclaiming outfit, a description of which may be helpful to others. A large part of the waste is used in the milling machine and screw machine departments. This waste becomes saturated with expensive cutting oil and contains many sharp metal chips. At least 4000 pounds of waste are used in the paint shop each year, although no attempt to reclaim this has been made.

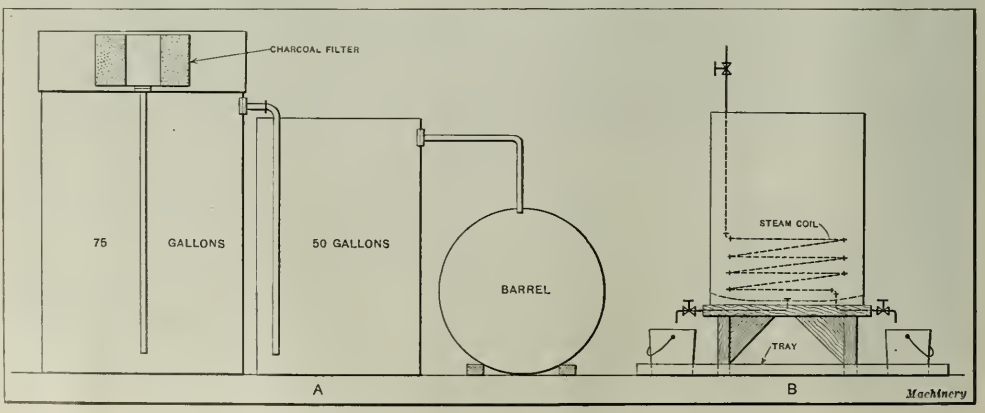
The outfit consists of a steam turbine-driven centrifugal machine in which, after being charged with waste, four operations are performed. First, the oil is extracted by centrifugal force, aided by the exhaust steam from the turbine. Second, the waste is washed in boiling water which contains washing powder. The third operation consists of rinsing the waste in fresh water, and finally the machine acts as a centrifugal drier. The apparatus was installed on the top floor of a five-story frame building, and had only a light wooden framework for a foundation. This location was tentatively chosen, because of available steam, water, and sewer connections. The machine is still operating there, however.

A steam pressure of 50 pounds gage is required to drive the turbine. The first trouble experienced arose from the excessive pressure drop, due to the long line of small piping from the boiler to the machine. As the line is fed from higher steam pressure through a reducing valve, this difficulty was easily overcome by increasing the pressure on the line. The next difficulty was due to small pieces of waste clogging the globe valves in the sewer pipe connection. The globe valves were then replaced by gate valves.

After being removed from the machine, the waste is spread out to dry, in layers about 4 inches deep on old iron window gratings. The gratings are raised from the floor so that the air is free to circulate under the waste. After it has become thoroughly dry, the loose dirt and chips are shaken out by hand, and any waste containing chips that cannot be easily removed is discarded. This loss does not amount to more than 5 per cent.

Reclaiming the Extracted Cutting Oil

Reclaiming the extracted oil was a more difficult process because the lard oil component emulsifies with the condensed steam during the extracting process. After standing for more than two weeks, even the oil from near the top of the container could not be used for cutting purposes. After experimenting, it was decided to give the emulsion a heat-treatment which would refine the oil. In the illustration at *B*, the arrangement used for accomplishing this purpose is shown. It consists of a galvanized iron barrel equipped with a steam coil made of ½-inch pipe and elbows. A drain



Equipment employed in refining Reclaimed Oil

pipe was tapped in at the lowest part of the slightly concave bottom of the barrel and the outside and bottom were covered with hair felt. The tank was then placed on a stand in a galvanized iron tray, high enough so that a pail could be placed under the drain pipe to catch the drip from the steam coil. The drain pipe was brought out beyond the side of the tank and provided with a gate valve. It was found that by slowly boiling the emulsion, the danger of boiling over was reduced, and disagreeable fumes were practically eliminated. Most of the water as it separates from the oil, collects at the bottom of the tank and is withdrawn from time to time through the drain pipe.

After boiling, the oil is put through a charcoal filter. It was found, however, that even then the oil contained too much water to be satisfactorily used as a cutting oil, but after standing in a tank for nearly a month, tests showed that no water existed in the mixture near the top of the tank, also that the composition of the oil at both the top and bottom of the tank was practically the same, and that the oil contained on inorganic matter. The arrangement shown at *A* in the illustration was consequently adopted for further treating the oil.

It consists of two galvanized iron tanks, one of 75 gallons and the other of 50 gallons capacity. A charcoal filter was made to fit the larger tank as a cover. The oil flows from the filter to the bottom of this tank through a pipe and from near the top of the tank it overflows through another pipe and is carried to the bottom of the smaller tank. From this tank, it again overflows through a pipe into a barrel. When the barrel is full, it is sent to the machine shop and another barrel put in its place. The oil thus treated has proved perfectly satisfactory for use as a cutting oil.

The Economical Value of the Process

During the first year of operation, 2700 pounds of waste and 230 gallons of oil were reclaimed, the following statement being self-explanatory:

Value of new cutting oil at 80 cents per gal.	$184	
Value of reclaimed waste at 14 cents per pound	378	
		$562
Labor cost	427	
Cost of washing powder	41	
		$468
Balance		$ 94

Out of this balance in favor of the reclaiming process must be deducted the cost of steam, overhead, depreciation, upkeep, and the interest on the cost of the apparatus and its installation. This would probably be covered by $50. It may not be correct to allow the full value of new oil for that reclaimed, because new oil is used on the screw-cutting machines before it is used on the milling machines, while the reclaimed oil is used only on the milling machines. The reclaimed waste, however, actually replaces new waste.

Probably 60 per cent of the labor cost is consumed in shaking out the washed waste, the cost of which could probably be considerably reduced. At first much prejudice existed against reclaiming the waste at all, on account of the danger of cuts from sharp metal chips which might be contained in it. There appears, however, to be no great difficulty in eliminating the chips, although it is comparatively expensive. From the factory records, it was found that in the six months previous to obtaining the above figures, 7384 pounds of new waste and 2344 pounds of washed waste had been used, from which it appears that only about one-quarter of the waste used is being reclaimed, and this is washed only once.

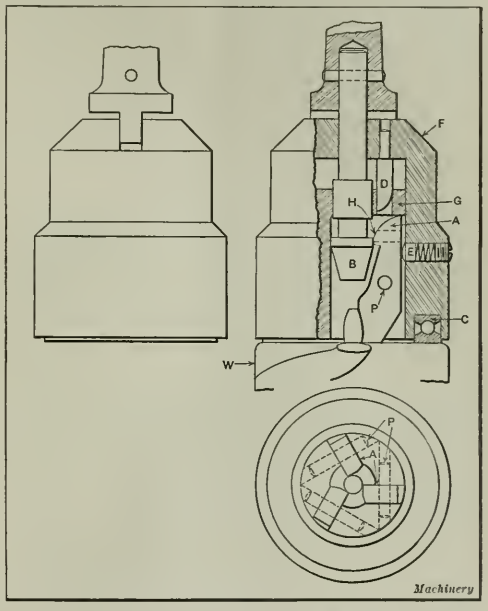
* * *

The great industrial expansion that is taking place in the United States is evidenced by the fact that new companies were formed or old companies added to their capital to the extent of $370,000,000 during the month of March, $515,000,000 during the month of April, and $750,000,000 during May.

AUTOMATIC TURNING TOOL

By O. H. KARCHER

The tool which is shown in the accompanying illustration may be used for turning small irregular shaped pieces in a drilling machine or in any other similar vertical machine. It is sometimes found impracticable to use a lathe or a turret machine for this class of work. The body *F* of the tool is bored to receive blade-holder *G*. The holder has three slots in which high-speed steel blades *A* are pivotally pinned at *P*. Plunger *B* is pinned to the shank of the tool and extends through a hole in the body *F* into a hole in the blade-holder *G*, but is not fixed to either of these parts. When in operation, the ball bearing *C* forms a support for the tool and practically eliminates the factor of friction. Before the operation starts, the blade-holder *G*, as well as the body itself, is supported by two shoulders formed on the plunger *B*.



Turning Tool for Use on Vertical Machines

As the machine spindle is lowered the body and the slotted holder are also lowered until they are stopped when the ball bearing comes into contact with the work *W*. The plunger, however, continues to descend, the tapered head coming into contact with the heel *H* of the blades and forcing the cutting ends toward the center, thus forming the work as shown.

When the plunger has forced the blades to their maximum closing position, with the heel of the blades resting on the cylindrical part of the head, as shown in the illustration, the plunger has only a slight additional distance to travel before the spring plunger *E* will force the blades against the neck of plunger *B*, thus opening the tool. The blade-holder *G* and its blades, which are now hooked over the shoulder of the tapered head, will be raised with the plunger until they come into contact with the end of pins *D*, which forces them open again against the action of the plunger *E*. This allows the plunger *B* to continue upward independently until the shoulders come into contact with the body and with holder *G*, from which point upward these two parts will also be raised with the plunger.

* * *

A South African inventor, J. Penhale, is said to have discovered a substitute for gasoline which is called "Penrol" and is obtained by absorbing pure acetylene in pure alcohol to the saturation point and adding 0.3 per cent of acrolein.

Time Slide-rules for Standard Types of Gear-cutting Machines

By S. D. G.

THE use of slide-rules and charts for determining the cutting speeds, time consumed and other data for turning, boring, drilling and planing operations is not an uncommon practice, and in most cases this method of calculating has given the desired results. Slide-rules for gear-cutters and gear shapers, however, are rarely used. One method of obtaining the desired information is to time the actual operation of the cutting of a gear, or to calculate the time from known factors by the use of a formula and the regular mathematical functions, or by the use of a formula and a standard slide-rule. It is the intention here to deal with the subject of time slide-rules for gear-cutting machinery in such a manner as will be of aid to those who regularly have need of such in their work.

Slide-rule for Fellows Gear Shaper

The time slide-rule for the Fellows gear shaper, here illustrated and described, embodies three formulas, a combination of which will give the desired result when properly applied. These three formulas give, respectively, the feeding-in time, the pitch diameter, and the cutting time. To find the total time consumed, the feeding-in time is added to the cutting time. The first formula is in the following form:

$$T_1 = \frac{W}{0.0018S} \qquad (1)$$

in which 0.0018 is the depth to which the cutter is fed per stroke of the gear shaper (constant), and

T_1 = time in minutes required to feed in to the tooth depth;
W = whole depth of tooth of gear;
S = strokes of gear shaper per minute;

The second formula used is the well-known gear formula:

$$D = \frac{N}{P} \qquad (2)$$

in which

D = pitch diameter in inches;
N = number of teeth;
P = diametral pitch.

The third formula is:

$$T_2 = \frac{XD}{S} \qquad (3)$$

in which

T_2 = time in minutes required for the blank to make one complete revolution;
X = strokes of machine per inch of pitch diameter of gear being cut;
D = pitch diameter in inches of gear being cut;
S = strokes of gear shaper per minute.

The slide-rule contains six scales, two of which D and W are on the upper part of the rule. Scale W is for the whole depth of the gear tooth and is represented by pitch numbers from 20 to 3. Since the pitch varies proportionately with the depth of tooth, this scale was made to read "pitch" instead of "tooth depth," thus making other calculations unnecessary. The scale D represents the pitch diameter of the gear in inches, and is graduated from 1 to 40 inches.

The pitch scale P on the upper side of the slide is graduated from 20 to 2 pitch, reading from the middle of the slide to the right. The other upper scale on the slide is for the strokes X of machine per inch of pitch diameter of the gear and extends from the graduation 1500 on the left to the graduation 100 in the middle. The graduations 1-F, 1-M, 1-C, 2-F, etc., on this scale are for definite strokes of the machine for 1-inch, 2-inch, etc., diameter cutters, with fine (F), medium (M), or coarse (C) feeds. This scale also shows the pointer for the feeding-in constant which is used to obtain the feeding-in time; its use will be understood later from the examples which are to follow. The lower scale of the slide is for the strokes per minute S and number of teeth N, the scale being graduated from 300 to 10.

The lower part of the rule contains one scale for both the feeding-in time and the cutting time in minutes and hours. To obtain the feeding-in time, however, it is necessary after obtaining the reading, to divide the result by 10. To obtain the total time required to cut the gear, add T_1 and T_2. This scale also contains a pointer for the diameter constant, which is used to obtain the pitch diameter, as will be explained in the following.

Examples Illustrating the Use of the Fellows Slide-rule

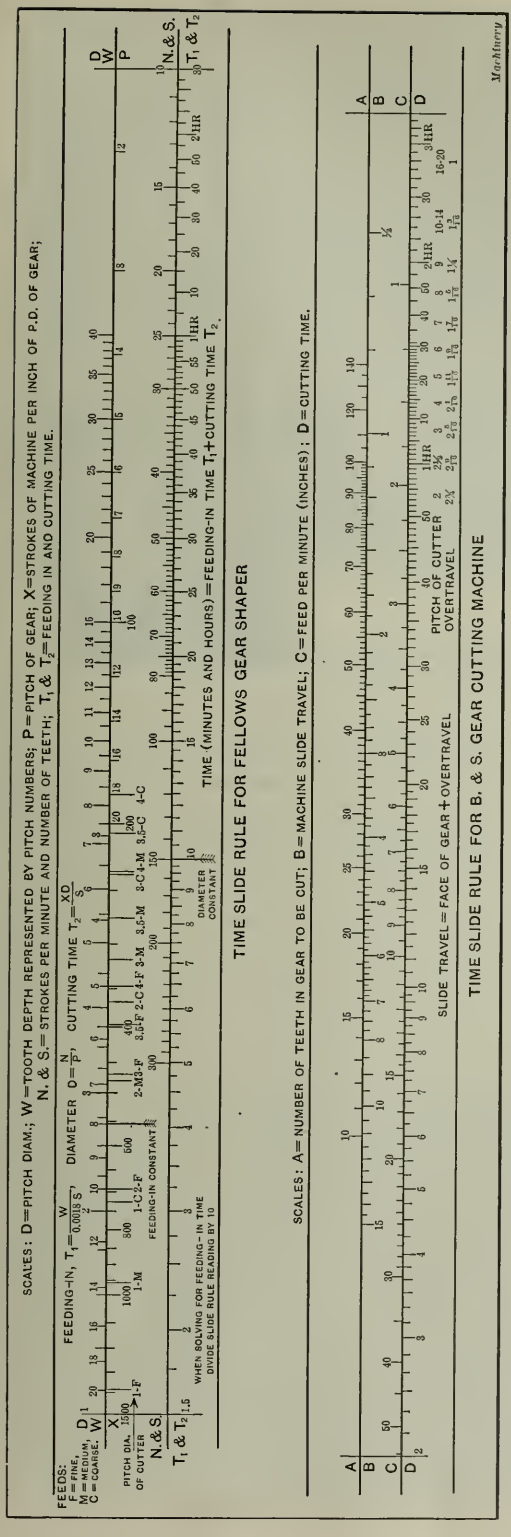
To obtain the pitch diameter of a gear of 150 teeth and 5 pitch (Formula 2), set 150 on the N & S scale of the slide opposite the pointer "diameter constant" and read, opposite graduation 5 on scale P, the pitch diameter on scale D, which in this case is 30 inches.

To obtain the feeding-in time on an 8-pitch gear with 300 strokes per minute of the machine (Formula 1), proceed as follows: It should be observed that, although the full depth of an 8-pitch tooth is 0.2696 inch, this value is not used because the scale is laid out according to the corresponding pitches. Therefore, set the pointer marked "feeding-in constant" on the slide, opposite graduation 8 on scale W, and read the value on scale T_1 and T_2 opposite 300 on the scale N & S, in this case 4.99, or approximately 5 minutes. Dividing this reading by 10 in accordance with the instructions given above, the result is 0.499, or approximately 0.5 minute for the feeding-in time.

To obtain the cutting time on an 8-pitch gear blank of 8⅜ inches pitch diameter when using a 4-inch diameter cutter with a coarse feed, the machine operating at 150 strokes per minute, first set graduation 4-C on the scale "Pitch Diameter of Cutter," opposite 8⅜ on scale D, and then read opposite 150 on the scale N & S, 10 minutes on scale T_1 and T_2. This is the cutting time. It will be noticed that graduations 4-C and 180 coincide, indicating that a cutter of 4 inches pitch diameter, with coarse feed, would make 180 strokes for every inch of pitch diameter. Thus, $\frac{4 \times 180}{150} = 4.8$ minutes for each revolution of the cutter, and since the cutter makes $\frac{8.375}{4}$, or 2.094 revolutions while the gear is being cut, 2.094×4.8 minutes, or 10 minutes, equals the cutting time. The feeding-in time will be found to be approximately one minute which, if added to the cutting time, will give the total time consumed in cutting the gear, or $10 + 1 = 11$ minutes.

Slide-rule for B. & S. Gear-cutting Machine

Referring to the illustration of the slide-rule used in connection with B. & S. gear-cutting machines it will be noted that in order to use the machine-slide travel factor, it was found necessary to embody the separate conversion table,



shown in the lower right-hand corner of the illustration. To obtain the proper slide travel, add the width of the face of the gear to be cut and the over-travel of the cutter. The amount of over-travel depends upon the pitch of the cutter; for instance, the over-travel for a 2-pitch cutter is 2¾ inches.

The formula used to obtain the cutting time on B. & S. gear-cutting machines is as follows:

$$D = \frac{AB}{C}$$

in which

D = time in minutes for the gear blank to make one complete revolution;

A = number of teeth to be cut in the gear;

B = total length of the slide travel in inches;

C = feed of cutter in inches per minute.

This formula is embodied in the slide-rule, which contains four scales. The top part of the rule contains scale A, which represents the number of teeth to be cut in the gear. The slide contains two scales, B and C. Scale B represents the slide travel in inches, and scale C the feed in inches per minute. The bottom part of the rule contains scale D which represents the time required to cut a gear.

Example Illustrating the Use of the B. & S. Slide-rule

To find the cutting time of a 3-pitch, 25-tooth gear having a face width of 2⅛ inches, feeding at the rate of 6 inches per minute and cutting one gear at a time, proceed as follows: First find the value of B as used in the above formula:

B = over-travel + width of face = 2 5/16 + 2 1/8 = 4 7/16 inches.

Then substituting in the above formula the values given,

$$D = \frac{25 \times 4\ 7/16}{6} = 18\ 1/2 \text{ minutes}$$

In order to solve the problem by the use of the slide-rule, proceed as follows: Opposite graduation 25 on scale A, set 4 7/16 on scale B, and read, opposite graduation 6 on scale C, the cutting time on scale D, or 18 1/2 minutes. If it is desired to cut two or more gears at one time, the length of the slide travel will, of course, be equal to the sum of the faces of the gears to be cut and the over-travel for one gear; also, if more than one revolution of the gear is required to cut the gear, the time obtained on the slide-rule is multiplied by that number of revolutions.

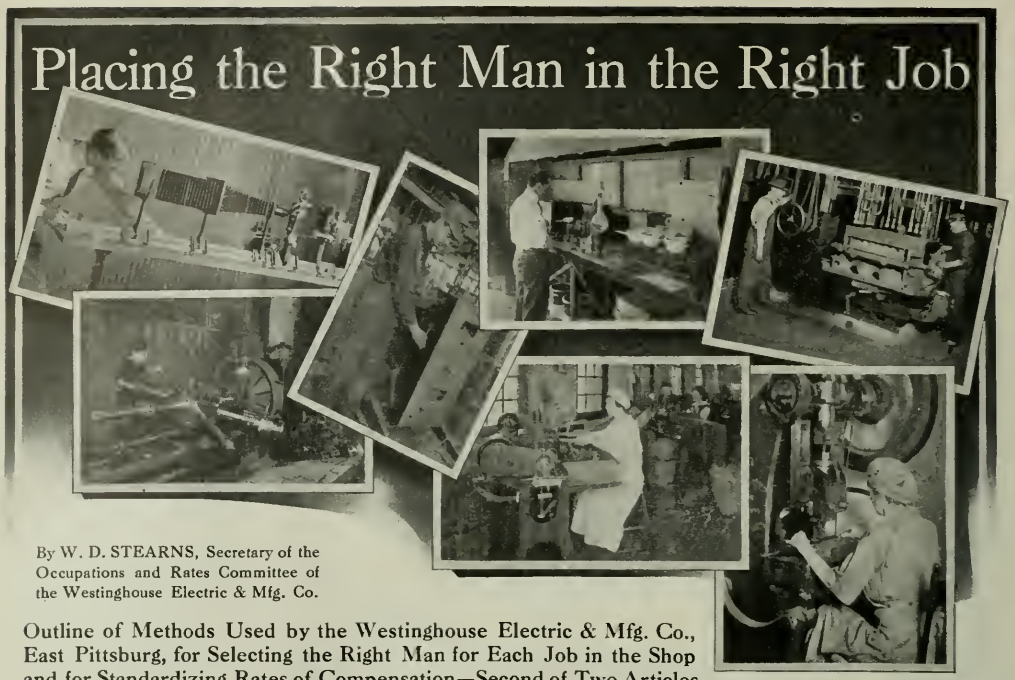
Theoretically, the time consumed by the return travel of the slide should be included in these calculations, but as this is usually negligible it has been omitted. On most B. & S. machines, the return travel requires from one to three seconds. So, if in the above example the return travel consumed two seconds, the amount to be added to the calculated cutting time would be $\frac{25 \times 2}{60} = 5/6$ minutes, or 18.5 + 0.83 = 19.33 minutes = the actual cutting time.

* * *

FLEXIBLE METAL TUBING

The lack of any standard method of measuring tubing with respect to its being twisted tightly or loosely, and in specifying whether or not the inside or outside diameter should be the nominal diameter has caused much confusion. Flexible metal tubing is generally supplied to the trade in diameters varying by 1/32 inch and even closer in some cases, for sizes ranging from 3/4 inch to 4 inches in diameter. The tubing thicknesses also vary and the tubing is made either with or without packing. On account of these unstandardized conditions, the tubing manufacturers have taken this matter up with the Society of Automotive Engineers, and its Miscellaneous Division, after careful consideration, has made the following recommendations: For tubing from 3/4 inch to and including 1 1/2 inches, outside diameter, sizes vary by sixteenths; from 1 5/8 to 2 1/2 inches inclusive, sizes vary by eighths; from 2 3/4 to 4 inches inclusive, sizes vary by quarters of an inch.

Placing the Right Man in the Right Job



By W. D. STEARNS, Secretary of the Occupations and Rates Committee of the Westinghouse Electric & Mfg. Co.

Outline of Methods Used by the Westinghouse Electric & Mfg. Co., East Pittsburg, for Selecting the Right Man for Each Job in the Shop and for Standardizing Rates of Compensation—Second of Two Articles

IN the first installment of this article, the standardization of occupations was dealt with, and standard descriptions of typical occupations were given. In the present installment the actual job analyses will be dealt with, and it will be shown in detail how the work of analyzing the various jobs in a large shop is carried through.

Job Analysis

When the superintendent or foreman requires supplies or materials, he writes out an order specifying what he wants in minute detail. In the same way, the job analysis card as used by the Westinghouse Electric & Mfg. Co., enables the foreman to specify exactly what he wants when he needs a man for a certain job. Figs. 1 and 2 show the two sides of the job analysis card that is used. This card is needed in addition to the occupational dictionary, because the latter is merely a foundation which provides a common language in matters relating to the occupations in the shop, while the job analysis card may be said to be the foreman's specification of the kind of man he needs. The card also gives, on the reverse side, such a description of the work as should be given to the applicant, so that he will know, before taking the job, exactly what kind of work he is agreeing to do.

All the information given on the job analysis card need not be checked ordinarily. It is necessary to check only those conditions that are unusual in some respects. Spaces need not be provided for such words as "clean," "normal temperature," etc. If the word "dirty" is not checked, it may be assumed that the job is relatively clean, and when the words "hot" or "cold" are not checked, it may be assumed that the temperature is normal. In the same way, characteristics that are desirable in all employes are omitted, unless they are of particular importance on account of the nature of the work.

The job analysis card is made in the standard 4- by 6-inch size, which is large enough, if both sides are used. As far as possible, records of this kind should be arranged so that they can be filled in by check marks rather than by writing in blank spaces, as shown by Figs. 1 and 2; and if any writing is required, it ought to be only "yes" or "no." When a space is not checked, it is assumed that this particular item is of no importance for the job specified.

There are two specific reasons for a careful job analysis. It is an aid in selecting the right man for a job, and an assistance in finding the proper kind of job for a man. When there is a scarcity of help, it is a case of selecting from the available men those that are best fitted for the jobs.

How the Job Analysis Card was Developed

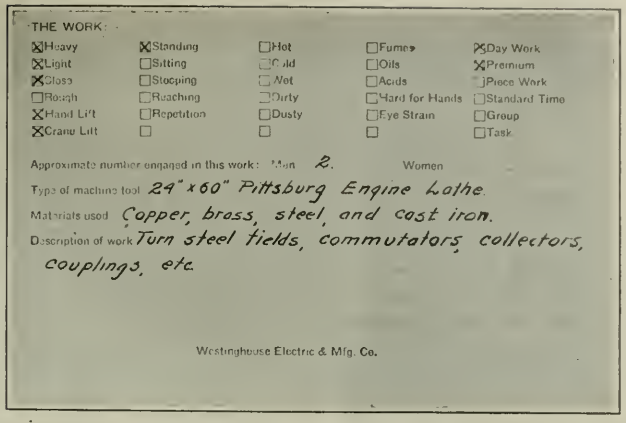
In deciding upon a form for the job analysis card, it was so designed as to cover all classes of labor—skilled, semi-skilled, and unskilled, for both men and women. Each card has an individual identification number, beginning with 1 for each department. Cards which analyze jobs intended specifically for women should be marked "W," to separate them from the cards for men's jobs. Before the cards for a department are numbered, they are arranged in alphabetical order, and then numbered consecutively. The space provided for classification indicates the rate of pay, as will be explained later. It is better to have only a class indication of the rate of pay than to put down the actual rate in cents, because the rates for various jobs may change from time to time, according to labor conditions. There should also be a range of rates for every job, to take care of increased efficiency and length of service. In the line "Type of Machine Tool" will be given the maker's name, the type, and the size of the machine as it is generally known in the trade. As regards the check marks to be filled in on the card, the following remarks may prove of value:

"Colored" is checked only when there is a specific preference for colored help. "Tall," and "medium" are checked only when it is required that the man should meet one or the other of these requirements; otherwise, both are left blank. If the man must be of at least medium height, then only "medium" is checked; and if he must be tall, then only "tall" is checked. If a man must be heavy, the minimum weight is given in pounds. If age is of importance, minimum and maximum ages are stated. Under "experience" is given the required experience in months or years, or, in general, the time that it would take a man to obtain average

efficiency in the work. "To learn" is checked when the applicant is expected to learn the work in the shop, and "how taught" indicates whether the employe is taught by an instructor in the department, by personal experience, or in a special training department. If the operator should own any tools, these are specified.

A study of the reverse side of the card will show that this gives a brief description of the work. Most of the items here given are self-explanatory. If "repetition" is checked, it indicates that the work is a repetitive job, and hence of a monotonous nature. The number of men and women engaged on the same work is given, because sometimes this may affect the type of employe that would be selected for a special job.

In preparing the job analysis card, the cooperation of the foreman is necessary. The best way is to go over each job analysis with the foreman, the men having the job analysis in charge doing the checking. If time is limited, the cards may be distributed to each foreman, and he may fill them out himself for every job in his department. The details, of course, should be thoroughly explained to him before he is asked to check the cards. A more uniform result will be obtained if the man who has charge of the job analysis cards goes over each job, item by item, with the foreman. As it is necessary that all the cards be placed on a standard basis, as nearly as possible, the latter plan should be used. When all the cards have been filled out, they are classified according to occupation, and then those covering the same class of work in each occupation are made to harmonize with each other, so that, in every case where it is intended to express the same idea, the wording on the cards also conforms.


THE WORK:

☒Heavy	☒Standing	☐Hot	☐Fumes	☒Day Work
☒Light	☐Sitting	☐Cold	☐Oils	☒Premium
☒Close	☐Stooping	☐Wet	☐Acids	☐Piece Work
☐Rough	☐Reaching	☐Dirty	☐Hard for Hands	☐Standard Time
☒Hand Lift	☐Repetition	☐Dusty	☐Eye Strain	☐Group
☒Crane Lift	☐	☐	☐	☐Task

Approximate number engaged in this work: Men 2. Women

Type of machine tool 24"x60" Pittsburg Engine Lathe.

Materials used Copper, brass, steel, and cast iron.

Description of work Turn steel fields, commutators, collectors, couplings, etc.

Westinghouse Electric & Mfg. Co.

Fig. 2. Back of Job Analysis Card shown in Fig. 1

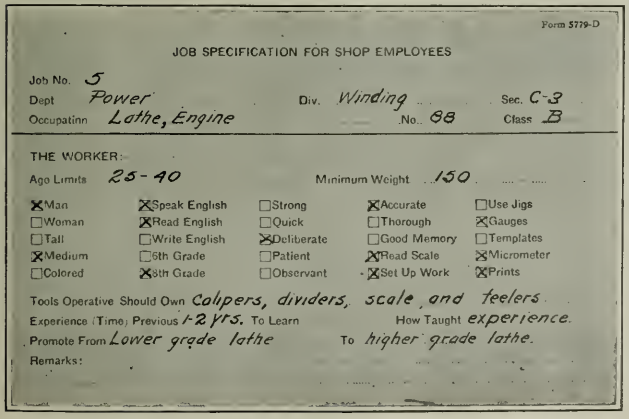
Proper Use of Job Analysis Cards

It would be possible to have each requisition for help in the form of a job analysis which would be filled out each time the foreman needed a new man. If this plan were used, the record would always be up to date, but it has several serious disadvantages. The foreman's time would be taken to make out a complete job analysis card whenever he should need a new man. The information on the card would not be uniform and would often be hurriedly indicated; hence requisitions made from time to time by the same foreman would not be consistent with each other, and the requisitions from different departments would vary widely. The correct way to use job analysis cards, therefore, is to have a complete set of cards filed in the employment department, the foreman having a duplicate set in his department. The foreman then merely gives the number of the card to the employment department, and by referring to that card information is obtained as to what kind of man to select. The cards, of course, must be kept up to date, because there are constant changes taking place. Some jobs are cancelled, and sometimes the equipment in the shop may call for new requirements in the employe.

Classification of Jobs with a View to Obtaining Standard Wage Rates

When the occupations have been standardized and the job analysis cards made, the jobs may be classified with a view to obtaining a standard for the payment of a fair wage. This can be done more easily after the work already outlined has been completed, so that all the requirements are known and the relative values of the various jobs are understood. The classification of the jobs with a view to obtaining fair wage payments is, in fact, the most important part of the whole work, and the preceding steps have merely been taken to lead up to this point.

The jobs, and not the employes, should be classified. The employe's value to the company is not based upon what he may be capable of doing, but upon what he is actually doing on the job that he holds; hence, the classification relates to the job and not to the man. By having a classification of the relative values of the jobs, however, there is a chance not only to compensate the men properly for the work they do, but also to promote them to jobs that pay better, when they prove capable of doing higher grade work.


Form 5779-D

JOB SPECIFICATION FOR SHOP EMPLOYEES

Job No. 5

Dept Power Div. Winding Sec. C-3

Occupation Lathe, Engine No. 88 Class B

THE WORKER:

Age Limits 25-40 Minimum Weight 150

☒Man	☒Speak English	☐Strong	☒Accurate	☐Use Jigs
☐Woman	☒Read English	☐Quick	☐Thorough	☒Gauges
☐Tall	☐Write English	☒Deliberate	☐Good Memory	☐Templates
☒Medium	☐6th Grade	☐Patient	☒Read Scale	☒Micrometer
☐Colored	☒8th Grade	☐Observant	☒Set Up Work	☒Prints

Tools Operative Should Own Calipers, dividers, scale, and feelers

Experience (Time) Previous 1-2 yrs. To Learn How Taught experience

Promote From Lower grade lathe To higher grade lathe.

Remarks:

Fig. 1. Job Analysis Card for Shop Employes

Determining the Relative Values of the Jobs in the Shop

There are five important reasons why one job is of a higher relative value than another: (1) The work may require knowledge obtained only by long experience. (2) It may require manual skill which can be obtained only by long practice. (3) It may require physical strength. (4) It may require executive ability. (5) The working conditions may make the job undesirable, because the hours are long, because of night work, or because the work is dirty, hot, cold, unhealthful, or dangerous.

In addition, there are a number of other factors which must be taken into consideration. For example, two jobs may require a similar operation, but in one case, the operation may be performed on a simple part, and if spoiled, the loss in material or labor would be small. In the other case, the same

JOB SPECIFICATION FOR OFFICE EMPLOYEES — Form No. 7542

J No. 27
Dept. Sales — Division Clerical — Section 2
Classification Stenographer — No. 515 — Class B
Age Limits

Men	Grade	English	☒ Accuracy	Memory
☒ Women	☒ High School	Mathematics	Alertness	☒ Initiative
Girl	☒	☒ Stenography	Analytical	Observation
Machine		☒ Typing	Concentration	☒ Speed
		Writing	Deliberate	☒ Systematic
			Executive	Tact

Experience time Prefer 2 years — To Learn — How Taught Experience.
Remarks: Should avoid extremes in appearance and have poise.

Fig. 3. Job Specifications for Office Employes

operation may be performed on a part on which much labor has already been spent, so that if the work is spoiled, the loss involved may be great. It is evident that the job in the second case requires a careful and dependable man, and hence, the value of the job is relatively higher.

Division of Classification

At the Westinghouse plant, jobs have been divided into five main classes as follows:

Class A—This class covers jobs requiring only those "masters of their trade," who thoroughly understand their work in a broad way, and who are competent to work without immediate supervision; jobs requiring leaders in charge of groups, experimental workers, and those on the highest grade production or tool work. General knowledge of machine tools, speeds, materials, etc., judgment, accuracy without the use of jigs, and a high degree of skill and dependability are required. *Examples*—Engine lathe, planer, and boring mill operators on very large work where great loss is incurred if mistakes are made; engine lathe operators on smaller accurate work not depending on grinding for final finish; tool work, such as thread gages; machine tool repair work; winders on turbo and large generator work; and experimental work.

Class B—This class may require as good a worker on certain specific operations as does the Class A job, but his experience does not need to cover as broad a field and he requires some supervision; accurate, dependable workers with considerable ability and experience, but who do not have the thorough knowledge or experience required of those in Class A; operators on accurate or heavy work which is usually repeated. Accuracy, knowledge of speeds and materials, reading of blueprints and use of gages are required. *Examples*—Engine lathe operators, work not especially accurate, but laborious; work on smaller lathes where there is great responsibility, as on commutators and collectors after they have been assembled on shafts. Planer operators on medium sized repetitive work. Vertical boring mill operators on large work or on accurate, difficult work on smaller mills.

Class C—This class is intended to cover specialists, or "machine operators," rather than mechanics. It is intended to include workmen who have become proficient on specific operations. *Examples*—Engine lathe operators on repetition work and roughing shafts. Planer operators on rough work, such as roughing stock for poles. Boring mill operators on small repetition work.

Class D—This includes jobs requiring the type of man who is somewhat above the laboring class and who shows a reasonable degree of intelligence and interest in his work, with a desire to learn. On these jobs, in general, the workman is trained for a Class C job. It also covers jobs so simple, and which take so short a time for training, that they are not included in Class C. *Examples*—Employes learning to operate engine lathes, planers, and boring mills, and learning to wind. Stockmen, filers, chippers, machine helpers, and punch press operators.

Class E—This class covers what are usually called laborers. These are unskilled workmen with practically no previous training; men on work where only a small degree of skill, accuracy, or knowledge is needed. The jobs are rough, and the operations are repeated and are extremely simple, requiring a minimum of time to learn. *Examples*—Truckers, material handlers, sweepers, machine helpers, janitors, and ashmen.

Table 1 in the article in the September number, giving the occupations in the plant of the Westinghouse Electric & Mfg. Co., also gives the classification that is used for the different occupations. It is evident that each occupation may embrace several classifications. For example, by referring to the table, it will be found that milling machine operators are in either Classes A, B, C, or D. This depends entirely upon the nature of the work performed on the machine—whether it is rough plain milling or a high-class special milling job, such as spiral gear cutting or similar work.

In classifying the jobs, five drawers were used, and the cards were sorted by putting those for each class in one drawer. In doing the work, it was found that some jobs were sorted with little or no difficulty, those that were most easily sorted being Class A and Class E. When there was doubt about the proper classification, the card was set aside for further consideration, and after the sorting was completed, the cards in the different classes were compared to see that they were properly classified. In doubtful cases, an investigation was made, and the foremen in the different departments were asked to cooperate in determining the class in which the job should be put.

Use of Classification of Jobs

As soon as the jobs in the shop had been classified, the Committee on Occupations and Rates, which represents the management and the employment, the time-study and the

The Work: —
Hours 8:30 to 5:00 Sat 8:30 to 12:15 — ☐ Regular Overtime
Promote From Lower grade stenographer to Secretarial work.
Approximate Number on This Work Men — Women 4
Objectionable Features — Machine Royal typewriter.

☐ Adding Machine	☐ Blue Prints	☒ Sitting	☐ Check
☐ Comptometer	☐ Routine	☐ Standing	☐ Hourly
☒ Dictaphone	☐ Supervised	☐ Reaching	☒ Salary
☐ Slide Rule	☐	☐ Walking	☐

Description of Work:— General stenographic work, taking dictation from four or five men, small amount of dictophone and copy work. Outside correspondence.

Westinghouse Electric & Mfg. Co.

Fig. 4. Back of Card shown in Fig. 3

manufacturing departments, went over the classification and set the rates to be paid for each class. This committee is a permanent one, and approves changes in the rates and also the addition of new occupations and classifications. The committee also investigates all conditions that arise in connection with the rates of pay in force at the factory. It is understood that the classification should not be altered unless the nature of the work or operation is changed, because changes in classification mean changes in wage rates.

If it should be found, however, that the rate specified for a job is insufficient for a certain employe, and if it is believed that he is fitted for work in a higher classification, then he should be promoted to a job requiring greater skill. If at any time the requests for increases in pay on a large number of jobs are numerous, it is an indication that there should be a flat increase in the wage rate. In that case, the committee passes upon the rate and recommends a higher rate, if it deems this advisable.

Method of Determining Rates for the Various Classes of Jobs

When a classification is completed, the actual wage rates in cents are set for each class. First the rates which are paid for Classes A and E are determined by making a study of the prevailing wages in the locality for these classes of labor. Having set a rate for these two classes, the rates for the intermediate classes are interpolated between them. A so-called "key sheet" is provided which gives the rates for each class. The rates might be somewhat as follows:

Class	Day-work Rate
A	71-80
B	61-70
C	51-60
D	41-50
E	30-40

Piece-work rates and premium rates are graded according to the day-work rate. The key sheet should also give these rates. When, for example, a system is used by which an employe is paid a higher rate for work that is performed in a given time, this standard time rate is a certain percentage greater than the day-work rate—perhaps 10 per cent. The key sheet for Class A, in that case, might be as follows:

Class	Day-work Rate	Standard Time Rate
A	80	88
A	79	87
A	78	86
A	77	85
A	76	84
A	75	82
A	74	81
A	73	80
A	72	79
A	71	78

If, for example, six hours' time is allowed for a given job and the day-work rate is 88 cents per hour, then an employe performing this work in six hours or less will receive $6 \times 0.88 = \$5.28$ for the work. The standard time rate arranged on this basis makes it possible to pay proportionately higher standard time rates to men whose regular day rate is high. The Westinghouse company makes it a rule to hire men at the minimum rate in each class, and the higher rates are used only for the most skilled in that class. Furthermore, the higher class occupations requiring skill, experience, or special ability are filled whenever possible by promotions or transfers within the organization.

Conclusion

These systems, much as outlined above, have been in use at the Westinghouse plant for several years, and have proved entirely satisfactory. They aid in the intelligent hiring of men for the jobs for which they are intended, make it possible to give the men an idea about the work they are expected to do, and make it possible to pay the employe a fair and equitable compensation based upon the work that he is doing. The savings that have been accomplished through these systems cannot be definitely estimated in dollars and cents, but the benefits have been so great that the general methods are being constantly perfected and extended. Recently, the system has been applied to office employes as well, the job analysis card for these employes being shown in Figs. 3 and 4.

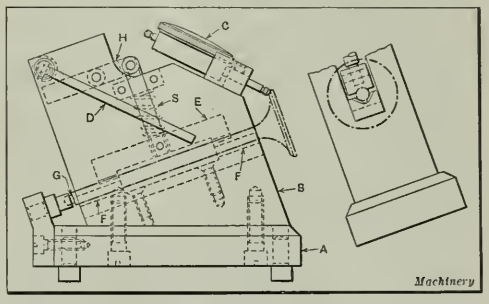
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CONCENTRICITY GAGE FOR POPPET VALVES

By J. L. HAYES

A gage for testing the concentricity of the face or seat of a poppet valve in relation to its stem should be designed so as to be easily operated and yet function accurately. Such a gage is shown in the accompanying illustration, consisting of three principal parts, the base *A*, body *B*, and the dial indicator *C*. All the smaller parts are mounted in the body except the stop, which is attached to the base. The dial indicator is mounted on the body at an angle of 45 degrees to the center line of the valve, when it is located in the gage. This angular position brings the point of the indicator perpendicular to the face of the valve. The position of the indicator may be slightly adjusted to overcome wear on its point.

In using the gage to inspect valves, the cam-lever *D* is first pressed downward slightly, which raises the jaw *E* by means of the fulcrum lever *H* and its connection to the jaw. The jaw is grooved to fit the valve stem, and after the piece has been placed in the V-blocks *F*, the lever *D* is released



Indicator Gage for inspecting the Concentricity of Poppet Valve Seats

and the action of the spring *S* seats the valve stem and holds it lightly, the end resting against the hardened steel ball *G*. This ball is free to revolve, and furnishes a single-point stop for the stem—an arrangement which allows the valve to be revolved when inspecting the concentricity of its face, without disturbing its lateral position. It can readily be seen that by turning the valve and observing the deflection on the indicator hand, an accurate inspection of the concentricity of the face can be made. The position of the valve, which is inclined at an angle of 20 degrees makes it convenient for the operator to inspect it.

* * *

MACHINE TOOLS IN LATIN-AMERICAN SHOPS

In an address made at the Second Pan-American Commercial Conference held at Washington, D. C., June 2 to 6 inclusive, Commissioner Frederick A. Halsey, American Institute of Weights and Measures, stated that an accurate census of the machine tools in Latin-American shops and factories under pre-war conditions shows that 39.3 per cent of the tools were made in the United States and 43.2 per cent in Great Britain, a total of 82.5 per cent being therefore made to the English system, while the remaining 17.5 per cent were made in France, Belgium, and Germany and to the metric system. Mr. Halsey does not think that our manufacturers of machinery will follow the advice of the well-meaning gentlemen who have no knowledge of the industry, but who state that Latin-America will not buy machinery manufactured in the United States unless made to the metric system.

Mechanical Sketching

By F. D. Jones



The Value of Sketches in Mechanical Work, and a Simple but Rapid Method of Making Neat, Well-proportioned Sketches of Tools and Machine Details without the Use of Drawing Instruments

PENCIL sketches are commonly used by almost everyone engaged in mechanical work. The inventor and designer frequently uses rough sketches in developing new appliances, the mental picture being transferred to paper so that it becomes clearer. Sketches assist in developing an idea, and they often reveal faults, or show that the idea is entirely impracticable. A number of sketches are often made to illustrate different solutions of the same problem. During the preliminary steps in the development of a design, free-hand sketches may serve the purpose about as well as accurate drawings, and the former are preferable since they can be made quite rapidly.

Another important use of sketches in mechanical work is for showing the form and arrangement of existing devices, such as tools, machine details, or a complete mechanism. The original drawings of a machine may have been destroyed by fire or lost; and if new ones are needed, rough free-hand sketches are frequently made first, because it is not convenient for the draftsman to make the scale drawings directly from the machine. After one or more sketches have been made, all important parts of the machine are measured, and these measurements are marked on the sketches, which are then used by the draftsman as a guide for making a more complete and accurate drawing.

Sketches are used universally to illustrate ideas of a mechanical nature. For instance, whenever there are discussions on mechanical subjects, a pencil and paper are generally required to show by a drawing or sketch what cannot be explained clearly by words alone. While the ability to sketch is essential to the draftsman or designer, at least some skill in sketching is also useful to the man in the shop. The machinist or toolmaker often relies upon a sketch to illustrate some existing tool or mechanism, or as the means of representing what is considered, at least, to be a new or improved device or method. Drawing has sometimes been referred to as the "language of the shop," and inability to draw or sketch is often a great handicap to the shop man.

Experienced machinists and toolmakers usually know more or less about mechanical drawing methods owing to the continual use of blueprints in the shop. They understand what the different views represent, or are able to "read a drawing." Practice in the reading of various kinds of drawings tends to teach the methods of making mechanical drawings, so far as the number of views required and their arrangement are concerned; but the actual making of a neat drawing or sketch especially without the use of instruments, requires practice and the understanding of a few simple principles. It is the purpose of this article to give a few hints on sketching to shop men who are already familiar with the projection method of drawing, and also to draftsmen who find it difficult to make satisfactory sketches. It is a mistake to suppose that neat sketches can only be made by those having a special talent in that direction. Most machinists and toolmakers can become fairly proficient in sketching if they are willing to practice, and it is important to remember that the amount of practice necessary can be reduced greatly if the proper methods are followed.

An Important Principle in Sketching

The real difference between a poor sketch and one that is neatly executed is that a poor sketch is composed of crooked lines which are not of the right length or do not bear the proper relation to one another, while in a good sketch the reverse condition obtains. Now, most mechanical drawings, whether they represent a complicated mechanism or some simple part, consist largely of straight horizontal and vertical lines, which vary as to length and as to their location relative to one another. The first step, then, in acquiring skill in sketching without the aid of instruments, is to learn how to draw fairly straight lines, and the next step is to make lines of the right length and place them where they belong. That sounds easy and it is not as difficult as many imagine.

A finished sketch may appear complex and difficult just because it is composed of many different lines. The drawing of a few lines would not seem difficult, but when a lot of lines are combined to form a complete drawing, the making of such a sketch is considered almost impossible by many mechanics who have never considered themselves handy with a pencil. Now the fact is that a sketch which is formed of a mass of lines may be drawn almost as easily as a much simpler one, except that more time is required. If two straight lines can be drawn on a sketching pad, there should be no difficulty in drawing four, eight, or any required number of lines; and that is an important point to bear in mind. It is, in fact, a principle which applies not only to drawing but to the building of machinery and to a thousand and one other activities. If each detail of the work is carried on correctly, the completed job, whether it be a sketch or a complex machine, will finally be the result. The appearance of the completed work may prove rather deceptive. It may seem to the inexperienced as hopelessly difficult, when it is merely a lot of simple details put together in the right way.



Fig. 1. Drawing Straight Parallel Lines by guiding the Pencil from the Edges of Sketching Pad



Fig. 2. End of Little Finger is held against Edge of Pad so that Pencil will follow a Straight Line

Most drawings, as was said before, are formed largely of straight lines that are perpendicular to one another. Some drawings also have quite a number of circles or arcs of circles, and there may be, in addition, lines at various angles to each other, and irregular curves. It is evident that one who can draw these lines, and especially the straight ones, with fair accuracy, without using mechanical drawing instruments, has at least a good chance of becoming reasonably proficient in the art of sketching. Locating and proportioning the lines is another essential requirement. These two general features of sketching will be dealt with.

Drawing Straight Parallel Lines

It is preferable when sketching by the method to be explained to use a pad having a cardboard back to make it rigid. The size of the pad is not very important, although an 8- by 10-inch size will be found convenient for most sketching. A good exercise to begin with is that of drawing straight parallel lines. An easy method of doing this is illustrated in Figs. 1 and 2. The pencil is guided, as it is drawn across the paper, by one finger which slides along the edge of the pad. Either the little finger or the ring finger next to it is used to guide the pencil, depending on the distance from the edge of the pad to the line to be drawn. Unless the line is quite close to the edge—say less than one inch—the little finger should be used (see Fig. 2). As the little finger follows the edge of the pad, the ring finger slides lightly over the top surface of the pad and supports the hand. By adopting this simple method, lines that are practically straight and parallel can be drawn with a little practice, and the movement of the pencil can be quite rapid without impairing the straightness of the lines; in fact, a somewhat rapid stroke is preferable. This method will be found decidedly superior to the common way of attempting to draw a straight line by a series of short successive follow-up strokes.

After it has become easy to draw straight lines near the edge of the pad, the pencil should be moved nearer the center as shown in Fig. 3. This exercise is a little more difficult because the pencil is farther from the guiding finger. The pencil is held at different distances from the edge of the pad simply by separating the guiding finger more or less from the remainder of the hand. When making a sketch, that edge of the pad nearest the line to be drawn should ordinarily be used for guiding, and in this way the entire surface can be covered, provided it is not over 8 or 10 inches wide.

The next exercise should be that of drawing lines of various lengths at right angles to one another as illustrated in Fig. 4. The pencil is guided by the little finger the same as before, and the end of the pad is used as well as the side. These exercises should be continued until the drawing of lines by this method becomes natural and easy. Simple figures, such as squares and rectangles of different sizes, should be drawn next to obtain practice in the matter of locating the lines properly and getting them somewhere near the right length. This next step is a little more difficult than the first because drawing a lot of miscellaneous lines is much easier than making a drawing of some definite object.

How to Proceed when Making a Sketch

If the shape of a casting or forging or the arrangement of some mechanism is to be shown by a sketch, the lines which



Fig. 3. Position of Hand when drawing a Straight Line which is located near the Center of the Pad



Fig. 4. Lines drawn at Right Angles and in Different Positions by guiding Pencil from Four Edges of Pad

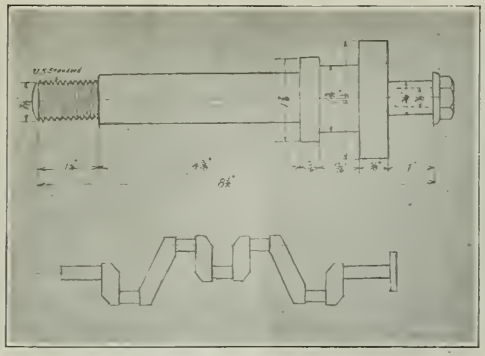


Fig. 5. Illustration showing Methods of Procedure in making Sketches

form it must be properly proportioned, their length and location agreeing approximately with the size and location of the different surfaces or parts which they represent. Success in this branch of the work is achieved partly by method and partly by practice. Some sense of proportion is also needed, but most machinists are good judges of short distances and should be able with practice to proportion a sketch accurately enough if the right method is adopted. It is important to draw the main parts first and then the details, because the proper proportions and locations are secured more easily in this way.

In order to illustrate some of the points to be observed when sketching and the general method of procedure, one or two practical examples will be given. As an illustration, suppose a sketch similar to the one shown in the upper part of Fig. 5 is to be made. The first thing to decide is how and where to begin. It would be possible to start in several different ways. For example, we could first draw the collar at the right-hand end, then the threaded end at the left, and finally connect these sections by drawing the long horizontal lines, but it is quite evident that this would not be the best way to proceed. The proper way would be to first draw a center line, then the principal lines, and finally the smaller details. Center lines are not always needed in sketching, but as a rule they enable the different parts, even of a simple sketch, to be more accurately located relative to each other. Take for example the sketch of a gas engine crankshaft shown in the lower part of Fig. 5. In this case, it is desirable to have different bearings approximately in line. To accomplish this, three parallel and equally spaced center lines extending lengthwise of the shaft should be drawn first. If these lines are drawn fairly straight and are spaced about equally, the crankshaft can be sketched around them easily. This shaft could also be sketched without center lines by first drawing lightly three sets of double parallel lines. The two lines in the center serve as a guide for aligning the shaft bearings, and the outer lines serve to locate the crankpin bearings. The shaft is then drawn in heavier lines by beginning at one end and finishing each crank successively.

It is not necessary or advisable to guide the pencil from the edge of the pad for drawing all straight lines. This would be a very awkward way to draw the numerous short connecting ends which form the smaller details on many sketches. The pencil should only be guided when drawing the longer lines which form the principal part of the sketch. For instance, when sketching the crankshaft, the pencil should be guided while drawing the center lines or the light parallel guide lines, but the cross lines are so short in this instance that they could doubtless be drawn to better advantage without attempting to steady the hand from the edge of the pad. A sketch of this kind could be made easily on cross-sectioned paper, but such paper may not always be at hand, and a plain pad is just as good for many purposes. The cross-sectioned paper with its guide lines accurately spaced is excellent when it is of especial importance to make a sketch accurate to scale.

Whenever possible, only one view is shown on a sketch, even though two views might be considered necessary on a working drawing. Many parts are understood to be round or of circular cross-section by mechanics, and an end view is not needed or, in some cases, an explanatory note may be added to the sketch to avoid an extra view. If one section of a circular piece were of special shape or had a slot cut in it, it might be advisable to make an additional view.

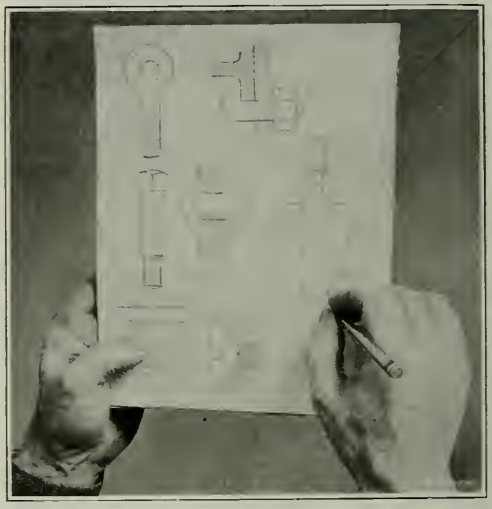


Fig. 6. Sketching Small Details—an Exercise in drawing Lines and in proportioning Parts

The sketching of small details such as are shown in Fig. 6 is good practice and should precede the making of larger sketches. When starting the sketch it is often advisable to draw very light guide lines which serve to block out the principal parts of whatever object is being drawn. Such guide lines, as a rule, will greatly assist in proportioning the sketch and make it possible to complete a sketch with

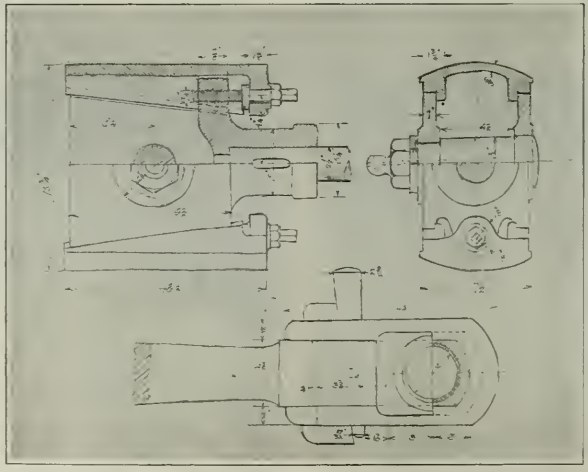


Fig. 7. Engine Details. Note how Straight Horizontal and Vertical Lines predominate in these Sketches



Fig. 8. Drawing a Circle by turning Pad beneath Pencil which is pivoted between Knee and Little Finger



Fig. 9. The Joint of the Little Finger may be used as a Pivot when drawing the Larger Circles

little or no erasing. When simple details can be drawn readily sketches of larger and more complicated parts should be made. The example shown in Fig. 7 represents an engine cross-head and one end of a connecting-rod. These sketches illustrate the important point that plain straight lines which are parallel and at right angles to one another form a large part of most sketches. There are doubtless many mechanics who do not believe that they could make sketches even after considerable practice, which would be as well proportioned as those shown in Fig. 7, and yet knowing how to draw straight parallel lines by guiding the pencil from each of the four edges of the pad is practically all that is necessary in making sketches of this kind, aside from the ability to judge distances between lines and their relative lengths.

When lines are at an angle with the sides of the pad and the finger cannot be used for guiding the pencil, a good way to draw such lines is to look at the point on the paper where the line is to end and then move the pencil quite rapidly toward this point. When drawing lines of this sort a bold and fairly rapid stroke is better than a slow hesitating movement. The eyes should be fixed on the place where the line is to end instead of following the pencil point. With a little practice, diagonal lines that are quite straight can be made in this way.

Proportioning the Parts of the Sketch

When a mechanical drawing is being made, the length and position of the lines depends upon measurements; but when making a sketch of some mechanical device or machine part, judgment regarding the relative sizes of the different details is needed to secure the proper proportions, although, as previously mentioned, one's judgment can be greatly aided by proceeding in the proper way. As an illustration, assume that a sketch is to be made which represents a side elevation of a planer. A good way to begin this sketch would be to first draw the long lines representing the bed, by guiding the pencil from the edge of the pad. The length of the lines would be governed entirely by the size of sketch wanted. The vertical lines which represent the front side of the housing would then be drawn to a height proportional to the length of the bed. That is, if the housing of the planer being sketched is judged by the eye to be about one-half as high as the bed is long, the height of the vertical lines should be one-half the length of the horizontal lines. Other important parts can be proportioned in the same way. After the large parts have been sketched to about the correct proportion by this comparative method, it will be found quite easy to draw the details somewhere near the right size. This idea, as applied to sketches generally, may be summarized as follows: Draw the long or "foundation" lines first and then it will be comparatively easy to sketch in the small details.

There is a decided advantage in making the principal lines fairly accurate and straight, not so much to secure neatness as accuracy of proportion. A drawing can be quite rough and "sketchy" and still be a good representation of the part drawn, provided the proportion is somewhere nearly correct.



Fig. 10. View showing Accuracy of Circle which may be drawn



Fig. 11. Drawing Arc of Large Radius by using Elbow as Pivot

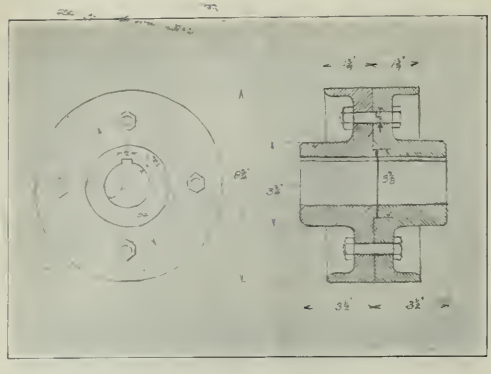


Fig. 12. Sketch of Flange Coupling

This is illustrated by the fact that when a mechanical drawing which has been made by the use of instruments is traced free-hand on transparent paper, the lines may be rough and uneven, but the drawing has a good appearance, nevertheless, because the proportions are accurate.

Free-hand sketches should not be relied upon too much, particularly when they are used in originating new forms of mechanism or designs which are rather complex.

Drawing Circles without Instruments

Thus far nothing has been said about drawing circles, and unfortunately some sketches require circular as well as straight lines. It is rather difficult to draw, free-hand, what, even in the spirit of charity, might be called a circle although circles can be drawn quite satisfactorily by the method illustrated in Figs. 8, 9, and 10. The circle is drawn by turning the pad around instead of the pencil. The pad is supported on the knee, and the little finger of the hand, holding the pencil, supports the hand, and should be directly over the knee to act as a pivot for the pad. The end of the finger may bear against the pad, as shown in Fig. 8, but, for the larger circles, some prefer to form a pivot by bending the finger so that the first joint rests upon the pad as in Fig. 9. It is necessary to apply some pressure in order to prevent the hand from shifting relative to the pad which is turned around by the other hand. Fig. 10 shows how accurately a circle may be drawn by this simple method. Circles of different diameters may be drawn by varying the distance between the pencil and the little finger. This method of drawing a circle is very convenient, although it requires some practice. Quite accurate circles may also be drawn by this method upon a single sheet of paper. The latter is placed upon a table or board and is slowly turned about the point where the little finger holds the paper in contact with the board.

When a large circle forms a prominent part of a sketch it is better to draw it first, as the other details can then be located and proportioned with reference to the circle. For example, when making a sketch of the coupling shown in Fig. 12, the circle representing the outside of the coupling should be drawn first. A center line is then drawn through the circle, and in this way the sectional view is located quite accurately in relation to the circle. If an attempt were made to draw the center line first and then the circle, it might prove difficult to locate the center of the circle exactly on the center line when the circle is drawn by the method illustrated in Figs. 8 and 9. The sketch of this coupling, as well as the other sketches shown in connection with this article, were drawn by following the methods described.

The gearing sketch shown in Fig. 13 is another example intended to illustrate the possibilities of drawing circles without the use of instruments. A simple sketch of this kind might be much less accurate than the one shown and still meet all practical requirements, although if a neat and well-proportioned sketch can be made without special effort and unnecessary waste of time, it is certainly preferable. Besides, as pointed out before, a reasonable degree of accuracy is often essential. The outer circle or arc representing the outer ends of the gear teeth in Fig. 13 does not vary more than about 1/32 inch from a true arc on the original sketch, and it was drawn by the method previously described. When making a sketch of this kind, it is easy to locate the side view at the right by simply drawing light projection lines across from the end view.

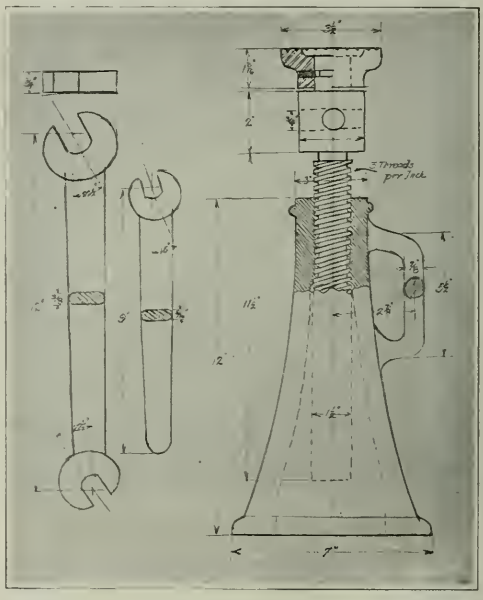


Fig. 14. Sketch of Wrenches and Screw Jack—Curved Lines of Jack Body are drawn by Method illustrated in Fig. 11

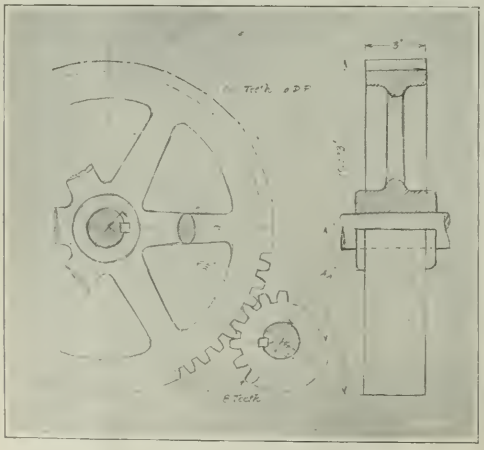


Fig. 13. Sketch of Spur Gear and Pinion

If an arc of quite large radius is required, the elbow can be used as a pivot for the pencil, as demonstrated in Fig. 11. The elbow rests upon a table or desk and the pencil strikes an arc having a radius which is about equal to the length of the forearm. This method was employed for drawing the curved lines which form the body of the jack shown by the sketch Fig. 14. After drawing a center line and lines representing the top and base of the jack body, these arcs are struck and then it is easy to fill in the smaller details.

The Design of Small Machinery

A Description of the Requirements, General Methods Employed, and Some Novel Machines

By W. E. THOMPSON

SPECIFIC rules to govern the design of machines for producing work automatically are not feasible, for the reason that no set of rules or standard parts can be complete enough to cover more than a few cases arising in general practice, no two cases being worked out by exactly the same method of procedure. In view of the variety of methods and principles that may be used to obtain a given result, the application must necessarily become a matter of choosing the best one for each purpose, and in this selection is shown the individuality and versatility of each designer, since no two designers, working independently, arrive at the same conclusion in exactly the same way.

In brief, the general method employed is to plan the handling of the material through the various operations of the machine in their proper sequence, roughly sketch diagrams of the various movements that may be used, and choose the ones most suitable in the general combination. Enough views of the assembled machine must be drawn to illustrate clearly all of its working features; these drawings must then be checked at least twice by other designers and changed, if necessary, until a majority agreement as to the practicability of the design is reached; and finally the detail drawings and tracings must be made and checked at least once before they are sent to the shop to start actual production. In the case of a complicated machine, where doubt exists as to the manner of handling the problem, the suggested method should be tested experimentally to avoid carrying it to completion before finding it worthless for the purpose intended.

Some General Qualifications Necessary for Single-purpose Machines

Although it is not practicable to formulate standard rules governing the design of machines, as stated in the foregoing, there are some general qualifications that machines for work of a special nature must have in order to avoid trouble, and the following series of observations should be helpful in the design of such machines.

All machine parts should be designed so as to have a high factor of safety in order to withstand the greatest strain that may be thrown on them. For small strains, calculations are generally unnecessary, but when designing parts used for such work as the making of rivets, rolled thread screws, or heavy wire forming, the pressures needed should be calculated, or preferably measured when possible, and the working parts should be figured with a factor of safety of from 5 to 9, in order to overcome this resistance.

Slides should have their cross-sectional area and bearing length proportioned so as to avoid unnecessary friction or tendency to cramp; cams should be so designed as to avoid heavy strains on their driving mechanism; levers should be proportioned to obtain rigidity with subsequent uniformity of movement; and the general frame should be so designed as to withstand the strains applied to it by the various movements, without having excess weight. A practical knowledge of the construction and operation of successful machines for producing a similar class of work to that for which the machine being designed is intended is invaluable, thus eliminating much calculation when proportioning the details, by using such known parts as standards.

Movements should be made positive in cases where their failure to operate is likely to cause the machine to become inoperative. Springs or balance weights, which are employed as a means of performing a partial movement, are not positive and should not be depended upon if the action is vital to the proper functioning of the machine. In case they are used, however, provision should be made for disconnecting the driving mechanism as a means of insuring against breakage in case of failure to perform their function, and springs should be made long enough to avoid excessive overload being placed on them. Slides which are actuated by cams should preferably be operated in both directions by such cams, but where this is not necessary they should always have their working cycle cam-operated, or otherwise positively moved.

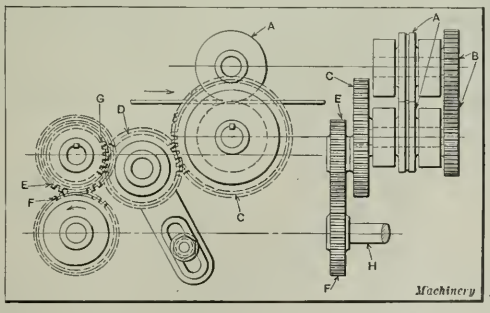


Fig. 1. Arrangement of Rolls and Gears on Wire-feeding Mechanism

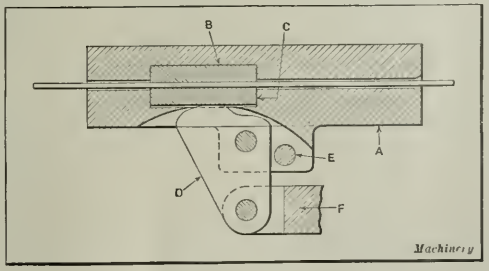


Fig. 2. Gripping Device for a Slide Wire-feed

The application of natural physical forces for performing work ought to be considered, as one or more may be employed in every machine. Some examples of the mechanical use of physical forces are: The application of atmospheric pressure and of friction for handling paper; the use of the force of gravity for assorting, separating, and feeding parts; combinations of heat and extreme cold for producing high vacuums; the application of light to extreme measurements; and the almost unlimited utilization of electricity.

Automatic feeding mechanisms and work-holding chucks should be carefully developed and should have an ample margin of strength for performing their particular functions. They should also be positively controlled and

locked, and the element of chance as affecting their movement should be eliminated to as great a degree as possible in order to avoid failure and the subsequent breakage of other parts of the mechanism.

Selection of the Proper Bearing Materials

The selection of correct bearing materials is often overlooked even in the redesign of standard machines, but special consideration should be given these parts, as being one of the most important factors governing the life of the machine. It is the customary practice to make the wearing surfaces of parts that have a sliding friction of two different materials, in order to reduce the natural property of adhesion. The most common combinations for use on machines which are to be operated by a varied class of workmen, and a combination which is least likely to suffer from lack of lubrication, consists of steel and a lead base material, or bronze and steel. In many cases the use of cast iron on cast iron is permissible, giving extreme durability at a low cost, but such bearings must have some form of continuous oiling arrangement to prevent adhesion of the surfaces. Cast-iron surfaces, after running a certain length of time, if well oiled, take a glaze that wears favorably as compared with hardened steel surfaces. Bearings made of steel—hardened, ground, and lapped—if well lubricated, give exceptionally long service and excellent results under close adjustment such as are needed in small lathes, screw machines, and high-speed grinding devices. For bearings that run continuously under medium pressure, where the use of oil is objectionable and where close adjustment is not a prime factor, steel or cast iron in combination with impregnated wood, gives wonderful results. A countershaft for driving light machinery, using steel and cast iron on impregnated wood is very serviceable; in fact the writer knows of a case where over two hundred such bearings have been running continuously without oil for about five years, without wearing loose or requiring repairs.

The use of fiber in bearings should be avoided, because the chemicals used in its manufacture have a deleterious action on such metals as steel or brass. The use of ball and roller bearings is often overlooked, but they should be employed wherever it is necessary to reduce the factor of inertia as much as possible. Ball and roller bearings have the lowest coefficient of friction of any commercial bearing, but they should be well lubricated, nevertheless, in order to obtain the maximum amount of service from them. In many cases, the size of such bearings for the capacity needed and the number of movable parts prohibits their use, but they are highly efficient where the design makes replacement a simple matter.

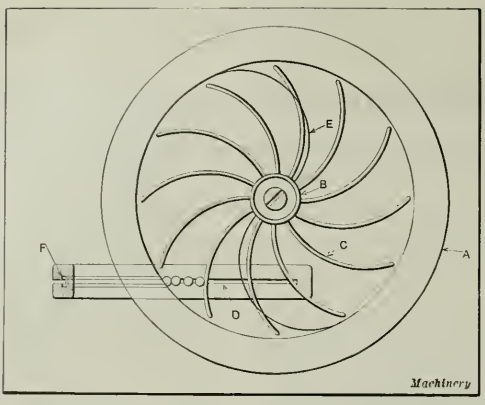


Fig. 3. Hopper for feeding Screws through a Chute

Feeding Mechanisms for Wire-bending Machines

Various movements are used for feeding wire, among which are rolls having an intermittent gear drive and slides in which the wire is locked during the feeding stroke and released during the return. The roll feed mechanism shown in Fig. 1 is used on a machine for cutting straight wire to length, and consists of two rolls *A*, having grooves on their faces in which the wire is held, the rolls being caused to rotate together by means of gears *B*. The upper roll may be adjusted for pressure by screws. Change-gear *C* is keyed to the lower roll shaft and is driven through the idler *D* by means of another change-gear *G*, which is keyed on the same shaft as intermittent gear *E*. An intermittent driving gear *F*, keyed to the main driving shaft, operates the feed and times it with the cut-off mechanism, which is operated by a cam on the same shaft. The rolls are at rest during the cutting-off period, which is very short, and the motion of the wire is nearly continuous. One objection to using a roll feed is the small arc of gripping contact which exists between the rolls and the wire.

Fig. 2 shows the gripping mechanism of a slide wire-feed such as is used on a wire-forming machine, which consists of a slide *A*, carrying two jaws *B* and *C*, between which the wire is held. The lever *D* is operated by a lever and cam through the link *F*. On the forward or feeding stroke of the machine, the lever *D* forces the lower jaw *C* into contact with the wire, and the greater the force exerted against the jaw, the tighter it grips. On the backward stroke, lever *D* is pulled away from contact with the gripping jaw, until it comes to a stop against a pin *E* in the slide, at which time the slide has returned to its starting position. The length of the gripping surface that may be obtained, makes the use of the slide feed desirable for hard wire that needs considerable pull through the straightener. When a slide is used, the wire is held during the return stroke either by the cutting-off jaws or by the straightening rolls.

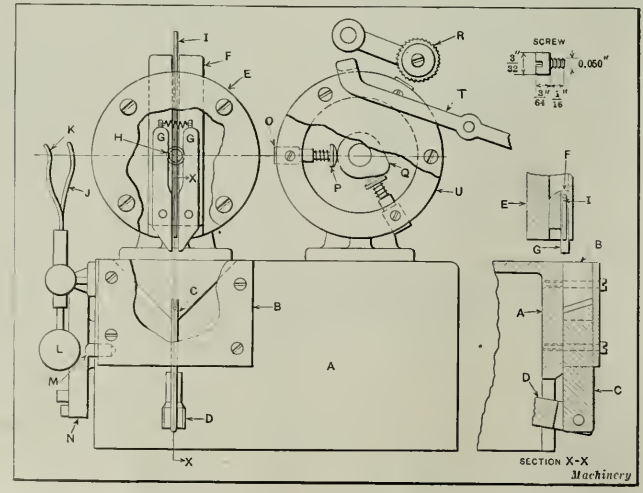


Fig. 4. Automatic Screw-feeding Mechanism for Special Screws

Hoppers for Screw-slotting Machines

The automatic separation of partly finished parts and their alignment into position for chucking is best accomplished by means of hoppers. Quantities of the parts are usually placed in a receptacle and means provided for agitating them continuously against the mouth of an opening in the side of the reservoir, the opening being just large enough to allow one piece to pass through at a time in the desired

position. Springs and brushes are commonly used in connection with this arrangement, but these have a tendency to force the parts into the opening in the wrong position and thus block it.

A hopper which is used to feed one type of screws is shown in Fig. 3. This consists of a stationary circular dish *A*, a rotary spindle *B*, to which is attached a series of curved spring arms *C*, set above the surface of the dish, a distance slightly greater than the height of the screw head, and two light spring arms *E*. The purpose of these arms is to stir the screws and to push them into the chute *F*. The chute is set into the bottom of dish *A* flush with its surface, so that the screws fall into slot *D*, in which they are supported by their heads. This type of hopper is satisfactory for screws in which the threaded part is heavier than the head, but is not suitable for very short screws.

An illustration of the hopper and the series of movements used in handling a very short screw is shown in Fig. 4. This arrangement illustrates an example of a machine having each separate movement protected against breakage caused by defective parts. The screw (which is shown in the detail view) has a head weighing more than the threaded part, and the natural tendency is for it to lie with the head down. Much trouble was experienced in trying to handle this work until it was discovered that the screws would stand upright in a close-fitting groove at an angle of 20 degrees from the horizontal, and a successful hopper feed was consequently made.

The screws are placed in a V-shaped reservoir *B*, attached to the machine base, in which a slide *C* reciprocates vertically. This slide passes down through the screws and on its upward stroke picks up at least two screws which slide to the lowest point of a groove cut in the top of the slide at an angle of 70 degrees with its edge and in which the shank of the screw fits loosely. The movement of the slide is controlled by a lever *D* and a cam on the main shaft. When the slide reaches the end of its upward movement, the screw head enters the lower end of the chuck jaws *G*, which are then closed on it by means of a tapered rod *H*, operated from a cam on the main shaft. These jaws are pivoted on a slide *F*, which is held up against a stop by a spring (not shown) on the under side. The drum *E* is then turned through 90 degrees, bringing the screw in line with holder *O*, at which time lever *J* pushes the slide forward until the threaded end of the screw enters this holder. Lever *K*, operating the rod *I*, then pushes the screw into its seat, the chuck jaws *G* having in the meantime been released. Both the levers *K* and *J* are operated by the cam *N*, and are made in the form of flat springs having a ball *L* at the lower end of each to return them to their normal position. One of these balls strikes intermittently, during a short period, against a pin *M* set in the hopper reservoir, and produces enough vibration to jar the screws and cause them to slide to the lowest point of the slide incline, those not in proper position falling off before reaching the chuck.

When the screw has been seated in holder *O*, the drum *U* is turned 120 degrees and locked; this brings the screw under the saw *R*, which then comes into action and mills the slot. During the next movement of the drum through 120 degrees, a knock-out *P* passes over the cam *Q* and the screw is ejected into a container. A brush is provided for removing loose saw chips, and a safety trip *T* releases the driving clutch when a screw having an extra long head passes under it, which prevents breakage of the saw. Both drums *E* and *U* are operated by cams through a rack and gear and are positively locked in their working positions. This type of hopper has given successful results, causing no trouble whatever. Should a screw lie across the top of slide *C* and be carried against the chuck it would simply push the chuck slide (which is held by a light spring) away from it and against a heavy spring stop. On the down stroke any screws not in the groove are knocked off by other screws, the only possible loss being one cycle of movements. In actual practice, the operation of the device is nearly continuous, the slide being nearly full of screws all the time, and a capacity of 3000 screws an hour may easily be obtained.

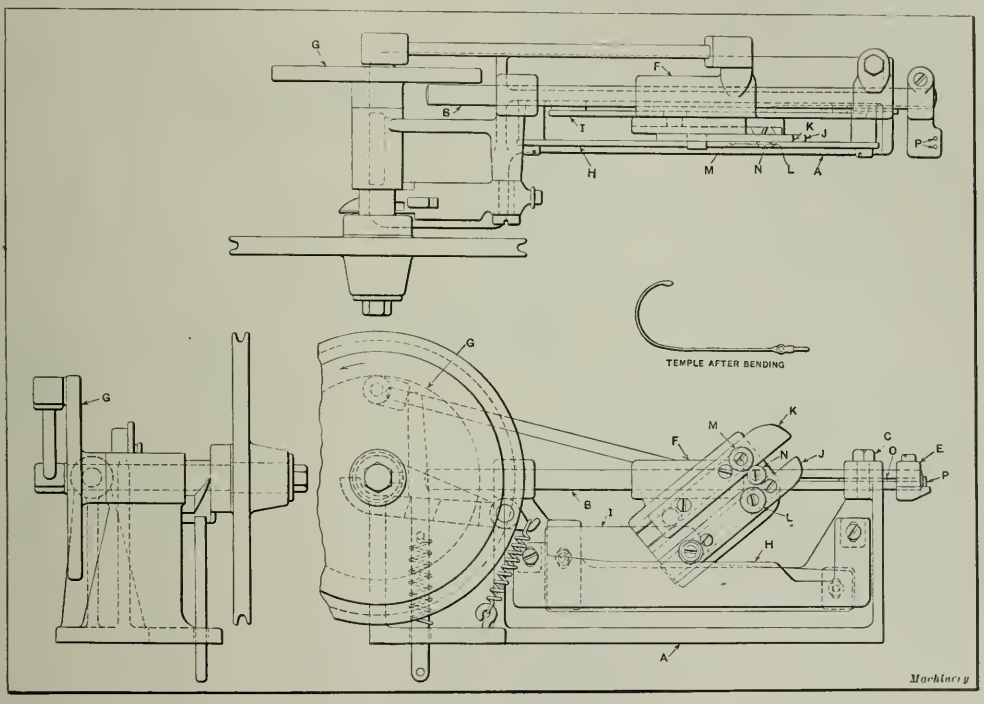


Fig. 5. Machine for bending Spectacle Temples

Design and Construction of Eyeglass and Spectacle Wire-forming Machines

Machines for forming wire of various cross-sectional shapes embody in their design a large variety of mechanical movements. Machines for making chain and wire mesh are particularly complicated, and those used for working wire parts for spectacle and eyeglass frames (two of which are to be described), also represent a high class of specialized design. In the evolution of machines of this type there are some general principles which are applicable, among which are the following:

The movements necessary to produce all the different bends in their proper sequence should first be planned and laid out. Each forming movement should have an individual adjustment, easily accessible, in order to obtain a uniform result from different coils of material, since it is practically impossible to obtain wire commercially, that has a uniform degree of temper. It is poor practice to design a forming surface to rub or drag on the metal; therefore provision should be made for a rolling contact or some movement that will form the wire with the least possible amount of slippage. A wire straightener that drags on the surface of the metal is not necessary and is objectionable—a series of rollers should be used instead.

Both rotary- and stationary-base straightening attachments are used on wire-forming machines, but the stationary base on which are mounted two sets of rollers, set at right angles to each other, is the less troublesome type on account of its simplicity. It requires more skill to set than a rotary head which has only one set of posts, but the stationary-head roller does not rub or drag on the metal, whereas the use of a rotary head necessitates making the wire-forming points of soft material, so as to prevent marking the highly finished surface of the wire, and these points become quickly worn. Wire that does not have a circular cross-section, must be straightened in a stationary-base attachment.

At one time spectacle temples, after assembling to the frames, were bent to conform to the ear by passing them through three fingers of the hand. This operation required considerable skill on the part of the workman and a number of different mechanical methods were employed in a certain plant to duplicate the hand-bent article, but without success until the machine shown in Fig. 5 was made. The working points of this machine have the same movement as the three fingers, but have the added advantages of mechanical uniformity and speed.

The machine consists of a frame *A*, in which is mounted a rod *B* which is adjustable longitudinally to suit different lengths of temples, being locked by a split bearing and a cap-screw *C*, and prevented from turning by a key *D*. The gage *E* is locked on one end of this rod. The part *F* is actuated by a crank and crank disk *G* and slides freely on the rod. Cams *H* and *I* control the movement of slides *J* and *K*, respectively. These slides move freely in the part *F* and are held in contact with the cams by gravity. The rollers *L* and *M* are carried on the slides and move in directions governed by the outlines of cams *H* and *I*. The roller *N* is attached to part *F* and moves horizontally only. A sliding key clutch connected with a foot-treadle, made so as to allow only one complete revolution of the driving shaft without releasing the foot, is used to actuate the machine. Part *F*, with the slides attached, is a sliding fit between the two cams *H* and *I*, which are secured to the frame, the elongated screw-holes allowing them to be adjusted vertically. The temple, with the end piece assembled, is inserted between the two gage-pins *P* and gaged against the surface of the slides, while lying in the groove of roller *N*. The three rollers, on the forward movement of the machine, close on the wire, thus producing a bending, wiping action that shapes the temple to the proper form. The temple is bent, partially straightened, and rebent, giving it a much more permanent set than could be obtained by the old hand method of bending.

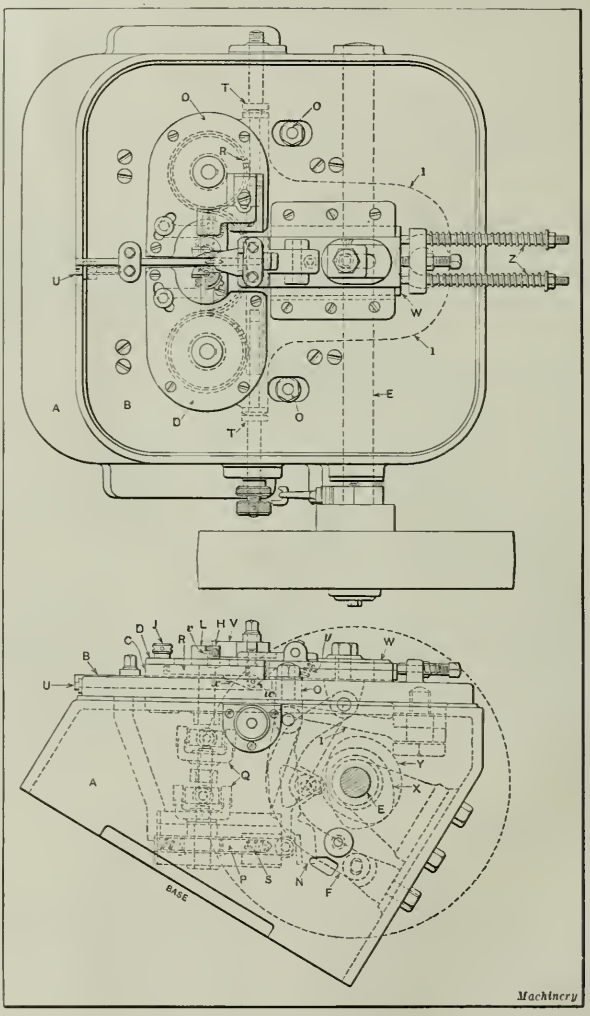


Fig. 6. Wire-bending Machine for forming Bridges for Eyeglasses

The nose pieces, or bridges, of eyeglasses and spectacles are commonly made from wire having an oval cross-section, but the highest grades are made by reducing the ends of round wire, previously cut to a uniform length, striking these blanks between press dies to form a thin wide section at the center, tapering to an oval section at each end, and then bending them to shape. In Fig. 6 is shown a plan and an elevation view of a machine for completely forming any shape or size of bridge, while Fig. 7 is an enlarged view of the forming mechanism employed in the machine. This machine consists of a base *A* on which are mounted the driv-

ing shaft *E*, lever *F*, and the cover *B*. Nearly all of the working parts of the machine are attached to the cover. It will be noticed that the machine has a sort of twin construction, and in all cases one reference letter will be sufficient to designate twin parts, regardless of which view is being referred to. Two arms, *I*, Fig. 6, are pivoted on the under side of the cover and are held apart and against stops *T* by means of a spring. These stops are adjusted by a knurled collar operating right- and left-hand screws on opposite ends of the machine, which are connected so as to turn together by a keyed sliding sleeve. The screws may be locked in position by means of a knurled nut. The swing arms *I* support the shank-forming anvils *L* (see Fig. 7), the rotative position of which is adjusted and locked by the bolts *J*. The shanks of these anvils pass down through plates *C*, attached to the swing arms, and form a bearing about which the two gear segments *K*, Fig. 7, may oscillate. These gear segments, to which are bolted the shank bending arms *M*, are oscillated through approximately 90 degrees in the following manner: Cams *Y* (shown in the side elevation, Fig. 6) operate the levers *N* which are pivoted adjustably on the studs *O*, in relation to the cover *B*. The levers operate a rack and gear *P*, transmitting motion through the universal joints *Q* to the gears *R*. The entire movement is positive on the bending part of its cycle, the parts being returned to their normal position by a spring *S* in each rack.

The gears and gear segments are held in place by the cover

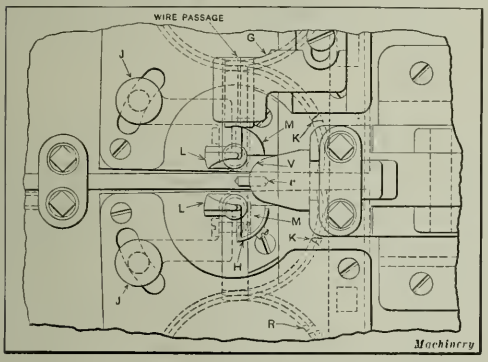


Fig. 7. Enlarged View of the Forming Mechanism employed in the Machine shown in Fig. 6

plates *D*, which also protect them from dirt, and to one of these is bolted an adjustable arm which supports a wire guide and cutting-off blade *G* (see Fig. 7). This arm may be adjusted in relation to one of the bending arms *M* which constitutes a cutting member when operating with the cutting-off blade. The interchangeable former *V* is clamped in an arm which is pivoted in the slide *W*, Fig. 6, the movement of which is controlled by cam *X*, lever *F*, and two springs *Z*, between which is an adjustable stop. The upper pivot of lever *F* is attached to a plate which has a sliding adjustment in *W*, and is provided with a series of graduations which enables this pivot to be readily set for different depths of bend. The adjustable stop against which the slide rests when in its normal position is regulated to hold the nose of the former *V* in line with the bending surfaces of the arms *M* (see Fig. 7). Each former *V* has a pin *v* driven into it, which normally extends under the wire to be formed. The arm which carries the former *V* has a cam roller *w* (see side elevation, Fig. 6) under it which is held against the adjustable cam *x* by a spring *y*. The adjustable cam is regulated by means of screw *U*, and its function is to cause the pin *v* to raise the wire as the former *V* bends it, and thus obtain the desired offset. The machine is driven by a flywheel which is equipped with a Horton clutch, so arranged as to return the foot-treadle to the starting position with every revolution.

Operation of the Bridge Forming Machine

The cycle of operations for making bridges of wire having a uniform cross-section is as follows: Referring to Fig. 7, the wire is fed by hand from a coil, previously straightened, through a passage in *G*, in which it is a sliding fit, until it comes to a stop against the gage *H* (see also Fig. 6). It passes between the forming surfaces of the bending arms *M* and the nose of former *V* on one side, and the points of the anvils *L* on the other side, resting on shelves formed on the small end of the anvils, thus gaging its vertical position. The machine first cuts off the wire and bends the ends around to points of the anvils *L*, locking it firmly while the former *V* comes forward and upward to make the nose bend and offset. After the operation is completed, all the parts return to their starting position and the bridge is removed by hand. When the former bends the wire between the points of the anvils, these points pivot on their respective swing arms *I* (shown in Fig. 6) until they bring the wire into close contact with the sides of former *V*. It is due to this swing, which is variable for different widths of bridges, that the universal joints *Q*, Fig. 6, are necessary in the operating mechanism. When bending bridges which have previously been cut off, and which do not have a uniform cross-section, the part *G* is removed and the bridge placed in position by hand, one end being held against the gage *H*. The cycle of movements is otherwise the same as described.

This machine has a capacity of 2000 pieces per hour. If the machine were equipped with an automatic feed no advantage would be gained over the hand feed, because these parts are generally carried through in small lots of many different sizes and shapes. It will be noticed that the top plate *B*, Fig. 6, is set at an angle with the base. This is for the purpose of placing the parts in the best working position, so that the workmen may plainly see to operate and place the pieces in the machine.

* * *

NATIONAL SAFETY CONGRESS

The National Safety Congress, held in Cleveland with headquarters at Hotel Statler, October 1 to 4, will be divided into sections representing, respectively, the automotive, cement, chemical, structural, metal, mining, woodworking, rubber, packing, paper and pulp, and textile industries, with special sections relating to steam and electric railroads, women in industry, employes' representation, Americanization, health service, public safety, public utilities, and marine and navigation. The papers to be read before the metal section, which are of particular interest to the readers of MACHINERY, were given in the September number of MACHINERY, page 91. Other papers that will prove of interest to manufacturers and executives engaged in the machinery and metal trades are those read at the employes' representation session, which are as follows: "Cooperation and Industrial Progress," by Cyrus McCormick, Jr.; "Experience of William Demuth & Co. in Industrial Democracy," by F. L. Feuerbach; "Practical Aspects of Employes' Representation," by E. B. Tolsted; "Employes' Representation from the Standpoint of Organized Labor"; and "Labor Management and Collective Bargaining," by W. M. Leiserson.

In connection with the congress, the most complete collection of commercial and non-commercial safeguards, appliances, devices, and accident prevention information ever arranged in the history of the National Safety Council will be shown at the exhibit to be held at Gray's Armory, in Cleveland. There will be seventy booths in which will be shown types of safety equipment for every industry.

* * *

When equal parts of copper and antimony are melted together, an alloy of a beautiful violet color is formed which takes a nice polish, but as it is too hard for many purposes, a substitute can be produced by copper-plating an iron casting, and then immersing it in a solution containing antimony.

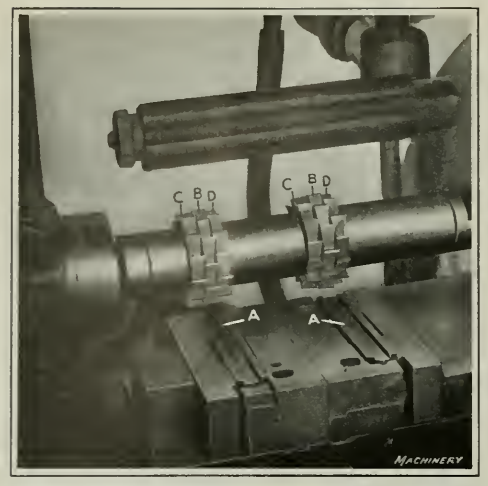


Fig. 1. Rough- and finish-milling Base of Back Sight Beds for Guns on 8-inch Automatic Milling Machine

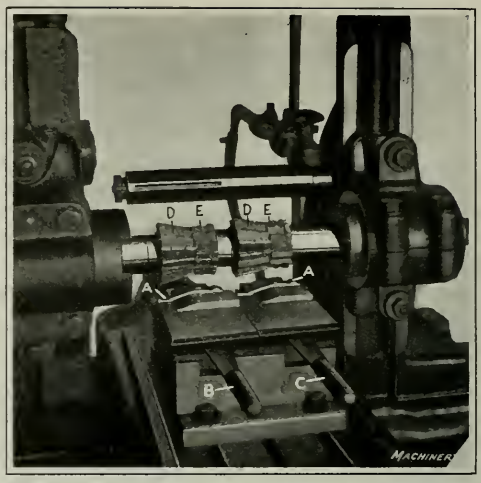


Fig. 2. Rough- and finish-milling Formed Top of Back Sight Beds for Guns on 12-inch Automatic Milling Machine

Production Milling on Automatic Machines

Second of Two Articles Describing Advanced Practice in the Milling of Duplicate Parts

By EDWARD K. HAMMOND

IN shops where large numbers of relatively small duplicate parts require milling operations to be performed on them, automatic milling machines built by the Pratt & Whitney Co., of Hartford, Conn., give very satisfactory service from the standpoints of rates of production and accuracy of the finished work. These millers have been evolved from the Lincoln type of milling machine, and they are equipped with an intermittent table feed and fast traversing mechanism, and an automatic quick return for the table. All of these table movements are controlled by means of adjustable tripping dogs that are mounted on a plate which is conveniently located at the front of the machine. With this arrangement for controlling the table, provision is made for having the work approach the cutter at the fast traverse speed, and when the cutter is about to engage the work, the regular rate of feed is automatically thrown into operation. After the cut has been completed, the direction of table movement is automatically reversed and the table is rapidly traversed back to the starting position. While returning to the starting point, the table is automatically lowered in order to prevent the milling cutters from dragging over the work and marring its finished surface; and at the end of the return movement, the table is automatically raised to the cutting position. This receding movement of the table is accomplished without impairing the rigidity of the supporting members or accuracy of the table movement.

By having the feed and traverse movements of the table automatically controlled, the amount of non-productive time of the machine is substantially reduced. The operator's work is also greatly simplified, as he is merely required to remove milled pieces from the work-holding fixture and set up fresh blanks in their places. As a result, one man is able to look after several machines, the exact number being dependent upon the length of time required to complete a single operation. Another case in which the automatic table control proves of value in reducing production costs is for milling work on which there are several lugs or bosses to be machined, which are spaced some distance apart, or where a number of small parts are set up at intervals along a string fixture. In such cases, the intermittent feed arrangement permits the table to be rapidly traversed from one cutting position to another, thus greatly reducing the machining time. In its loading position, the table must also carry the fixture far enough away from the cutters to permit the work to be easily set up, and the power rapid traverse then permits the table to be advanced quickly to its cutting position. In fact, the general statement may be made that to obtain the highest rate of production on these machines, the feed movement of the table should only be used during the actual cutting period; at all other times, the fast traverse is employed. Pratt & Whitney automatic milling machines are made in four different sizes with a table traverse of 5, 8, 10, and 12 inches, respectively. Each size of machine is furnished with a range of spindle speeds and rates of feed that are suitable for all classes of work that will be done on a machine of this size. In many



Fig. 3. Eight-inch Automatic Milling Machine for rough- and finish-milling Base of Back Sight Beds for Guns

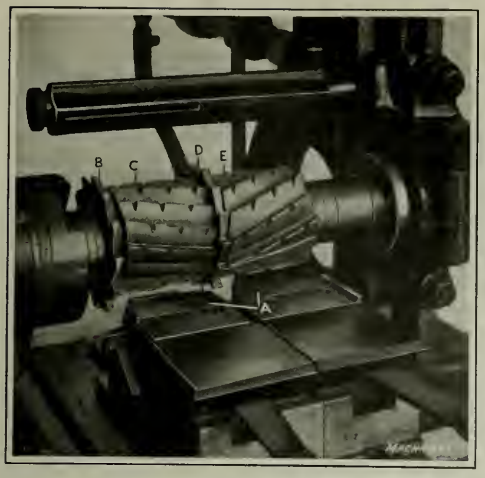


Fig. 4. Twelve-inch Automatic Milling Machine milling Top, Bottom, and Ends of Back Sight Leaf

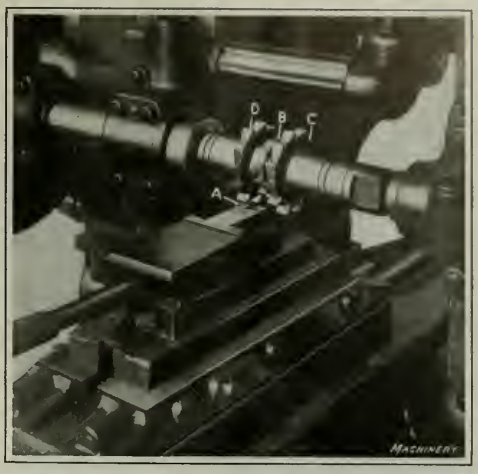


Fig. 5. Five-inch Automatic Milling Machine facing Ends and milling Groove in Back Sight Leaf Slide

plants, a machine adjuster, who is a skilled mechanic, is made responsible for the setting up and sharpening of cutters used on anywhere from twenty to thirty machines, while the machine operator is a semi-skilled man who may be trained quickly to perform his part of the work. During the last few years, girls have been successfully employed as operators of these machines.

Work-holding Fixtures for Automatic Millers

As in the case of work-holding fixtures used on other types of machines, there are several general principles which must be adhered to in making fixtures for holding the work on automatic millers, if the maximum production is to be secured. The two following are most essential: First, in order to obtain accurate results (and if accuracy is a requirement, it must be secured at any cost) the work must be held solidly and rigidly. Second, in order to obtain the maximum production, the fixture must operate rapidly. As far as possible, all of these milling fixtures should be so designed that they are locked and unlocked by a single movement of an operating handle. To carry this principle out in practice often imposes a difficult task upon the tool designer, yet, with but few exceptions, it may be successfully accomplished. In many cases, it will undoubtedly add to the cost of the fixture, yet it becomes a paying investment if a great number of pieces are to be machined. The fixture is made only once; but it is operated every time a part is milled. Therefore, if the expenditure of an extra hundred hours of work in making the fixture will save a thousand hours in production time, the economical solution of the problem of fixture design is to add this time to the making of the fixture.

For holding a large variety of small sized pieces of work to be milled, a very satisfactory and inexpensive work-holding fixture is made by applying special jaws to a standard milling machine vise. The Pratt & Whitney Co. has developed a line of quick-action manufacturers' vises which carry out the two basic principles stated previously; namely, rigidity and quick operation. These are made in both single and double types. In the case of the double vises, the position of one vise is made adjustable, so the work in either vise can be independently set up in relation to the cutters.

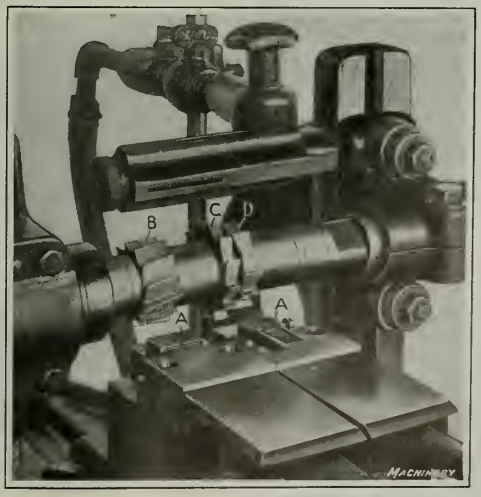


Fig. 6. Five-inch Automatic Milling Machine milling Top, Side, and End of Back Sight Leaf Slide Dog

Grouping Milling Operations According to Time Required to Perform Them

In order to secure the maximum production, where one operator handles several automatic milling machines, great care must be exercised in grouping the operations. The actual machining time of the operations handled by one man should be the same as or even multiples of each other. To make this point clear, suppose there are several milling operations which it is desirable to group. The time per operation on the first is three minutes; on the second, four minutes; on the third, eight minutes; and on the fourth, nine minutes. If there are a sufficient number of parts requiring any one of these operations to be performed on them, to keep one man busy, the planning department would naturally group them together. If not, the next best method is to group three of the three-minute operations with one requiring nine minutes; and two of the four-minute operations with one requiring eight minutes. In this way, it will be possible to maintain the maximum rate of production. In many cases, the variety of milling operations to be performed is so small that it does not leave a wide choice in grouping. Under such conditions, the grouping should be arranged to reduce to a minimum lost time of both the operators and the machines. In cases where maintaining rates of production is of paramount importance, the machines should be kept busy, even at the cost of an excessive amount of idle time of the operators.

Automatic Miller Equipped for Rough- and Finish-milling Operations

Fig. 3 shows an 8-inch Pratt & Whitney automatic milling



Fig. 7. Twelve-inch Automatic Milling Machine rough- and finish-milling Nine Faces on a Follower

machine equipped to provide for rough- and finish-milling the base and groove of a gun part known as a "back sight bed." Fig. 1 illustrates the cutters, work-holding fixtures, and pieces *A* to be milled, in greater detail. In performing this milling operation, a roughing cut is first taken on the work held in the left-hand fixture; and after this has been done, the rough-milled part is transferred to the right-hand fixture, in which it is held while the finishing cut is taken. It will be apparent that after the rough-milled part is placed in the right-hand fixture, a fresh blank will be set up in the left-hand fixture, so that for each traverse of the milling machine table, one finished part will be obtained. If the desired rate of production were greater, a similar set-up could be employed, except that two roughing operations would be performed on one machine and two finishing operations on another. With such an arrangement, two pieces would be secured for each cycle of movements of the milling machine table. It will be quite evident from Fig. 1 that there are two gangs of similar cutters used for performing the roughing and finishing operations on these parts. Cutter *B* mills the groove in the work, and cutters *C* and *D* mill the surface at either side of the groove. The work-holding fixture consists of special jaws mounted in a standard Pratt & Whitney quick-action manufacturers' vise. This work-holding fixture is operated by a single motion of the clamping handle, thus greatly reducing the non-productive time of the machine. The cutting speed is 65 to 75 feet per minute, with a feed of 2.14 inches per minute. The pieces *A* to be milled are made of steel. The actual cutting time is 2 minutes 10 seconds per operation, and the loading and unloading time is 37 seconds, making the total operating period 2 minutes 47 seconds. One operator is able to take care of a group of three machines working on this job.

Rough- and Finish-milling Work to Desired Contour

Fig. 2 illustrates a 12-inch Pratt & Whitney automatic miller set up to rough- and finish-mill the top of back sight beds for guns, and shows clearly the cutters, work-holding fixture, and the form to which parts *A* have to be milled. As in the case of the rough- and finish-milling operation which has just been discussed, the roughing cut on the present job is taken with the work held in the left-hand fixture; and after this preliminary operation has been performed, the work is reset in the right-hand fixture ready for the finish-milling operation. At the time each piece is finish-milled at the right-hand side of the table, another piece is rough-milled at the left-hand side, so that one piece is finished for each cycle of table movements. The work-holding fixture consists of special jaws applied to a standard milling vise; and to clamp or release the work at either side of the table, it is merely necessary to give a single movement to lever *B* or *C*. To provide for obtaining the desired contour, two gangs of milling cutters are mounted on the arbor, each gang consisting of two cutters *D* and *E*. It will be seen that cutters *D* are angular mills which provide for finishing the inclined face of the work, while cutters *E* are formed to produce the desired contour at the right-hand end of each piece. On this job, the cutting speed is 73 feet per minute, and the feed is 1.86 inches per minute. The actual cutting time per piece is 1 minute 11 seconds, and the loading time is 40 seconds, making the total time per operation 1 minute 51 seconds.

Machine Equipped for Milling Top, Bottom, and Ends of Work

In producing the back sight leaf for a certain type of gun, it is required to finish the top, bottom, and both ends of the work. Fig. 4 shows a 12-inch Pratt & Whitney automatic miller which is equipped for performing all of these operations. At the left-hand side of the machine there is a fixture in which the work is held to allow the top and both ends of the work to be milled; and after this cut has been completed, the piece is transferred to the fixture at the right-hand side of the milling machine table, in which it is held while the bottom of the work is being milled. The fixtures consist of standard vises equipped with special jaws; and each of the two vises can be tightened or loosened by manipulating a single handle. These gun sight leaves are machined from bar stock 13/16 inch by 1/2 inch in cross-sectional area by 3 1/2 inches in length. A gang of three cutters *B*, *C*, and *D* is employed for performing the first operation. The angular mill *B* finishes the inclined left-hand end of the work, and the plain mill *C* faces off the top, while the narrow side milling cutter *D* finishes the right-hand end of the work. Cutter *E*, which performs the second operation, is not fully shown in Fig. 4. From this illustration the impression would be gained that this is a plain mill, but at its right-hand end, this cutter has an angular face which provides for milling the inclined shoulder at the right-hand end of the work. The cutting speed is from 80 to 95 feet per minute, with a feed of 1.22 inches per minute. The actual machining time is 1 minute 58 seconds, and the loading and unloading time is 43 seconds, making the total production time per operation 2 minutes 41 seconds. On this job, the operator looks after a group of two machines.

Milling Ends of Work and a Groove in the Top Face

To provide for simultaneously milling both ends and a groove in the top face of a gun part known as the "back

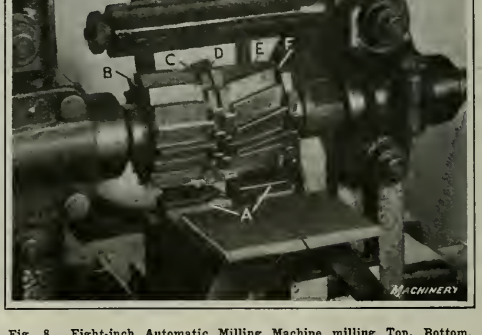


Fig. 8. Eight-inch Automatic Milling Machine milling Top, Bottom, and One End of the Forging for a Lower Band Spring

sight leaf slide," a 5-inch Pratt & Whitney automatic milling machine is used, which is equipped as shown in Fig. 5. The piece *A* to be milled is made from bar stock 3/8 by 9/16 inch in cross-sectional area by 1 1/8 inches in length. In this case, the work-holding fixture provides for setting up only one piece for the milling operation. This fixture has a pair of special jaws mounted in a single quick-action vise of standard design. The arrangement of milling cutters is quite simple. It consists of a gang of three side mills, cutter *B* being utilized for producing the shallow groove in the work, while cutters *C* and *D* face off the ends. On this job, the cutting speed is 80 to 105 feet per minute with a feed of 1.18 inches per minute. The machining time per cut is 1 minute 39 seconds, and the loading time is 27 seconds, making the total time per operation 2 minutes 6 seconds. One operator handles three machines working on this job.

Milling Top, Side, and End of Work

Fig. 6 shows another 5-inch size of Pratt & Whitney automatic milling machine, this tool being equipped to provide for milling the top, one side, and one end of a gun part known as a "back sight leaf slide dog," which is shown at *A*. A facing cut is taken on the top of this piece, while it is held in the fixture at the left-hand side of the machine, and both the end and a groove in one side are milled with the work held in a fixture at the right-hand side of the table. The work is held in a standard double milling vise provided with special jaws. It will be apparent from the illustration that a plain milling cutter *B* provides for taking a facing cut on the top of the work, while a gang of two cutters *C* and *D* performs the second operation. Cutter *C* faces off the end of the work, while cutter *D* mills the groove in the side. This job is performed with a cutting speed of 95 feet per minute, with a feed of 1.18 inches per minute. The actual machining time is 57 seconds, and the loading time is 33 seconds, making a total production time of 1 minute 30 seconds. This cut is so short that the operator is only able to handle a single machine.

Rough- and Finish-milling Work to Desired Form

On the 12-inch Pratt & Whitney automatic milling machine shown in Fig. 7, it will be seen that two gangs of six cutters each are utilized for rough- and finish-milling a gun part *A* known as a "follower," which must have the form shown in this illustration. As in preceding cases, the roughing operation is performed with the work held in the left-hand fixture, and the finishing operation with the same piece in the right-hand fixture. The method of setting up the work is also the same as that previously described, so that one finished

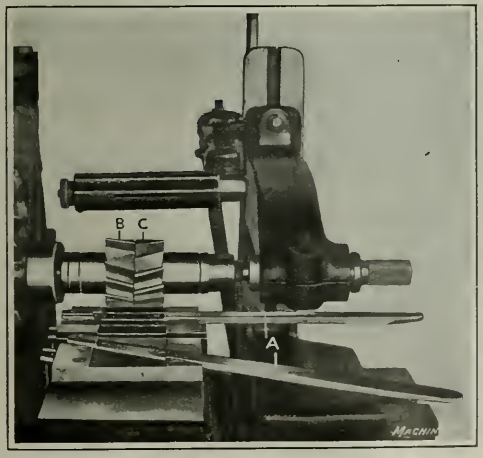


Fig. 9. Eight-inch Automatic Milling Machine milling the Non-parallel Sides and Bottom of the Lock Groove in a Bayonet

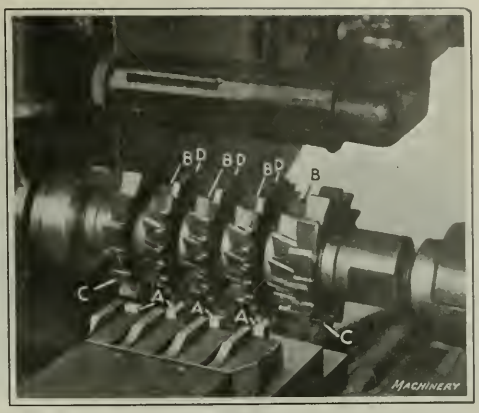


Fig. 10. Five-inch Automatic Milling Machine milling Top and Ends of Four Bayonet Locking Bolts, and cutting them off from the Bar of Stock

piece is produced for each cycle of table movements. It will be evident that each gang of cutters consists of six mills *B*, *C*, *D*, *E*, *F*, and *G*, each of these cutters being made of the proper diameter to mill one face of the work in the correct relative position to other finished surfaces. Cutter *G* is of sufficient size so that it overhangs the end of the work and provides for milling it at the same time that the five top faces of the piece are machined. These followers are made from steel bar stock 7/16 by 7/8 inch in cross-sectional area by 3 1/2 inches in length. The cutting speed is 69 to 89 feet per minute with a feed of 1.86 inches per minute. On this job, the actual machining time is 1 minute 51 seconds, and the loading time is 1 minute 8 seconds, making the total production time per operation 2 minutes 59 seconds. One operator is able to handle two machines working on this job.

Milling Top and Bottom Faces and One End of a Forging

The part shown set up on the 8-inch Pratt & Whitney automatic milling machine in Fig. 8 is a lower band spring for a gun. This part is made from a forging, and it is required to mill the top and bottom faces and one end of the work. It will be apparent from the illustration that the bottom face of work *A* must be machined to an irregular contour, and to obtain this result, a gang of three cutters *B*, *C*, and *D* is used. Cutter *B* is formed to correspond with the irregular contour of the curved section, while cutters *C* and *D* provide for milling the square shoulder and the end of the work, respectively. After this cut has been completed, the work is placed in the right-hand fixture and two cutters *E* and *F* are utilized for facing off the flat surface of the work and for straddle-milling the wall at the right-hand end. The cutting speed on this job is from 73 to 85 feet per minute, with a feed of 1.86 inches per minute. The actual machining time per operation is 1 minute 24 seconds, and the unloading and loading time is 53 seconds, giving a total production time per operation of 2 minutes 17 seconds. Sufficient time is allowed by the cut to enable one man to operate two machines working on this job.

Milling a Slot with Non-parallel Sides

An interesting operation is shown in Fig. 9, which consists of milling the non-parallel sides and bottom of a slot in the end of a bayonet, to receive the locking bolt. Two pieces of work *A* are set up in the fixture, one behind the other, in such relative positions that one side and part of the bottom of the slot are milled in the first piece; and when the second piece is carried up to the cutter, the opposite side and remainder of the bottom of the slot are milled. Two plain cutters *B* and *C* are used in order that the spiral angles of the teeth may be opposed to each other to neutralize the end thrust; otherwise, a single cutter could just as well be employed. After each traverse of the table, the partially milled

piece is removed from the first station of the fixture and reset in the second position. A fresh blank is then set up in the first station. With this arrangement, it will be evident that one piece is completely milled at each cycle of movements of the milling machine table. The construction of the fixture used for performing this operation is shown in Fig. 11. It has a clamping mechanism that is operated with a single cam lever *A*, the cam being attached to a sliding member *B*, and acting against a sliding block *C*. This results in drawing back the sliding member *B* and pushing forward block *C*. Sliding member *B* carries a jaw at the front of the fixture, and the rear jaw *E* is operated through a rocker arm *D* which is actuated by sliding block *C*. With this arrangement, the single clamping lever provides for securing both parts under an equal pressure. It will be noted that, in both positions, the work is held by fixed jaws acting against the cutter and clamped from the front. Attention is also called to the fact that there is a solid metal support under the cutter in both positions where the work is held. Thus, the maximum rigidity is secured for the fixture. On this job, the cutting speed is 67 feet per minute with a feed of 1.86 inches per minute. The actual machining time is 2 minutes 58 seconds, and the unloading and loading time is 1 minute 14 seconds, giving a total production time for this operation of 4 minutes 12 seconds. One operator looks after two machines engaged on this job.

Milling Top and Ends of Four Pieces of Work and Cutting them off the Bar

Fig. 10 shows a 5-inch Pratt & Whitney automatic milling machine equipped to mill the top and ends of four bayonet locking bolts *A* which are made from a single piece of bar steel 5/16 by 5/8 inch in cross-sectional area, by 4 1/4 inches in length. The work-holding fixture used for this job consists of a quick-acting vise, provided with special jaws and equalizing clamps operated from a single cam. A double "whiffletree" construction is employed for operating the equalizing clamps, which holds each part under an equal pressure, so that there is no danger of the work sliding at the time it is cut off. It will be seen that a gang of nine cutters is required for the performance of this operation. Four plain cutters *B* mill the sides of the shoulders and face the surfaces to the right of the shoulders. Two side milling cutters *C* face the ends of the work, and three cutting-off saws *D* divide the single blank into the four parts which are required. On this job, the cutting speed is 90 to 116 feet per minute, with a feed of 0.87 inch per minute. The actual cutting time is 2 minutes 1 second, and the unloading and loading time is 36 seconds, making the total time per operation 2 minutes 37 seconds. One operator is able to attend to two machines working on this job.

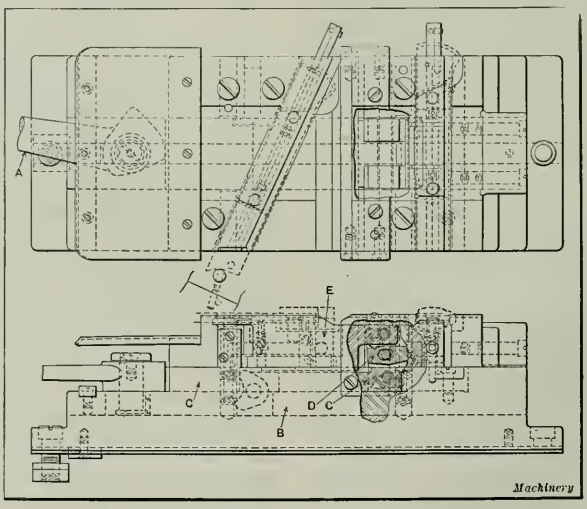


Fig. 11. Design of the Work-holding Fixture used on the Machine shown in Fig. 9

* * *

Bulgaria is now represented in the United States by a commercial commission which is here to undertake the re-establishment of trade relations. Bulgaria's first need is for food. Clothing, shoes, cotton, and petroleum are next in demand. With these primary needs fulfilled, Bulgaria will be in the market for manufactured articles.

THE BUREAU OF STANDARDS' WORK ON TOLERANCES

In connection with its work on tolerances and limits, mentioned in an editorial in the September number of MACHINERY, the Bureau of Standards has sent out a questionnaire regarding tolerances to a large list of manufacturing organizations requesting information upon the following points:

1. If you are establishing tolerances on your work in accordance with a system or table of allowances and limits for various kinds of fits, a copy of such table is desired.

2. For each class of work or machine that you manufacture, what tolerances are applied to the dimensions of fitted parts? This information may be transmitted by blueprints.

3. In assigning tolerances to parts, do you take the hole as basic or the shaft?

4. Are tolerances given on drawings rigidly adhered to, or are they exceeded, and to what extent?

5. How do you express tolerances on component drawings? (For example: $0.675 \begin{smallmatrix}+0.006\\-0.000\end{smallmatrix}$ or $\frac{0.681}{0.675}$ or 0.678 ± 0.003, or by some other system?)

6. In general, to what accuracy are you able to do work on various standard types of machine tools such as lathes, milling machines, grinders, shapers, etc.? If you have used any non-ferrous metals, to what accuracy can they be worked?

7. In ordering machine tools, what accuracy do you specify on such items as feed- and lead-screws, gears, etc.? Or if you are a manufacturer of machine tools, what accuracy do you guarantee?

8. If you buy your parts, either finished or partly finished, do you specify the limits to be used, or does the manufacturer of the part set his own limits to work to?

9. To what extent are the parts of your machine interchangeable?

10. To what extent do you conduct inspection in your plant? Information as to the inspection facilities and organization, system of inspection in the shop and assembly room, extent of use of gages, etc., is desired.

11. Do you permit the inspector to use larger tolerances than the workmen?

12. Do you attempt to have the gages used by the workman within the limits of the gages used by the inspector?

13. Do you conduct inspection to obtain interchangeability, and what other objects do you endeavor to attain by your inspection system?

14. What relation is maintained between the tolerances permitted in the manufacture of your gages and the tolerance on the part to be gaged?

15. What tolerances or allowances, if any, do you make for parts that will work under high temperatures?

16. In the case of shrink, press, and drive fits, do you modify the allowance for differences in length of contact? That is, should the allowance on the diameter for a hub 6 inches long be the same as that for a hub 1 inch long?

17. Are you as a manufacturer interested in these points?

Replies should be forwarded to the Gage Section, Bureau of Standards, Washington, D. C.



Die-Casting and Die-Casting Metals

An Article Describing the General Organization of a Plant for Making Die-molded Castings, and Reviewing the Metals Now Commercially Used in Die-casting Practice—Based upon the Experience of, and the Methods Used by, the Stewart Mfg. Corporation, Chicago, Ill.

By ERIK OBERG

SEVERAL years ago, a number of articles were published in MACHINERY dealing with what was then a new development in the metal industries—the art of die-casting. The machines and methods used in the early development of this new industry were described, and the metals that, up to that time, had been found most suitable for die-casting purposes were reviewed. Since that time, the industry has made enormous strides; semi-automatic and automatic machines have replaced the early hand-operated types; large factories have sprung up devoted entirely to the manufacture of die-castings, and an entirely new industry of large ramifications has been created. It is the object of the present article to describe the general organization of one of the most modern of these die-casting factories, built by the Stewart Mfg. Corporation, Chicago, Ill., in 1918, as a description of this company's plant and methods will provide a general idea of the remarkable development that has taken place in the die-casting industry in the last ten years.

Plant of the Stewart Mfg. Corporation

The heading illustration shows a view of the new plant of the Stewart Mfg. Corporation. This plant covers an area of 300 by 300 feet, the office building being two stories in height while the main factory building is of one-story, sawtooth roof construction. The floor plan of the factory is shown in Fig. 2, this floor plan indicating what a die-casting plant comprises and the various departments required in a complete plant making die-molded castings. By reference to the illustration, it will be seen that the plant is divided mainly into nine departments as follows:

1. *Melting Department*—In this department the various metals used are compounded or mixed and then cast into ingots which are subsequently remelted in the casting machines.

2. *White Metal (White Brass) and Aluminum Die-casting Department*—This department is the main die-casting department of the factory and may be considered the principal department as far as the product is concerned.

3. *Inspection Department*—There are two inspection departments—one in which the castings are inspected when coming from the casting department, and one in which the final inspection takes place previous to shipping. The first of these departments, as will be seen, is located next to the die-casting department, while the other is located in immediate proximity to the shipping room.

4. *Cleaning Department*—In this department the die-castings are cleaned by the removal of fins, and other finishing operations for which machine tools are used are performed.

5. *Plating Department*—Such die-castings as require a fine outside finish are nickel-plated (or brass-plated) in this department.

6. *Polishing Department*—The plated die-castings are polished here in order to improve their appearance.

7. *Yellow Brass Die-casting Department*—The recent development in the die-casting of brass and bronze has necessitated a special department for the making of die-castings from these materials.

8. *Tool-room*—The tool-room in a die-casting plant is one of the most important and one of the largest departments, because of the great number of dies that are required for the different castings to be made.

9. *Machine Shop*—The Stewart Mfg. Corporation builds all of its own die-casting machines, and hence a machine shop of



Fig. 1. A General View of the Melting Room where the Various Metals used in the Die-casting Machines are alloyed

considerable proportions is required for the making of these machines and for keeping them in repair.

In addition, an extensive engineering department is required for the designing of dies and special tools and for the development of improvements in, or the design of, entirely new die-casting machines.

The Melting Room

The original metals are bought in their commercial form by the company and are melted and alloyed in a separate melting room, a view of which is shown in Fig. 1. Molds for casting the ingots are here provided in the form of an endless chain conveyor, as shown. The metal is poured into these molds, and as the conveyor moves toward the right, it will throw the ingots, which have solidified by the time they arrive at the end of the conveyor, on the floor. From here, the ingots are taken to the die-casting room where they are remelted in the melting pots of the machines as required.

A most important part of the work, both in alloying and in remelting, is the temperature control. During the alloying, the metal is mechanically stirred to insure proper mixing. The temperature is recorded for each melting furnace on a recording pyrometer. There is one recording instrument for every two melting furnaces, so arranged as to give one record for each. The chief chemist examines the charts from the recording instruments which are sent to him daily, and in that way, proper control of the melting temperatures and, in consequence, of the die-casting metals is possible. The temperature control at the die-casting machines is made in the same manner, there being one pyrometer to every two machines. The shipments of raw material received are also analyzed to make sure that the proper metals are being used.

Equipment of the Die-casting Rooms

The die-casting department is divided into sections by sheet-steel partitions, and similar partitions are also placed between the individual machines in each section or battery, as shown in Fig. 3, which gives a good idea of the arrangement of the machines in rows, much the same as would be the arrangement in a regular machine shop. The melting pots are heated by gas, and many of the machines are pneumatically operated, which accounts for the great amount of piping seen in the illustration. The die-casting room is equipped with one hundred twenty-five die-casting machines of different types, according to the work for which they are intended. Altogether, there are five specific types employed.

First, there is the standard line of Stewart die-casting machines employed for white-metal and bearing-metal cast-

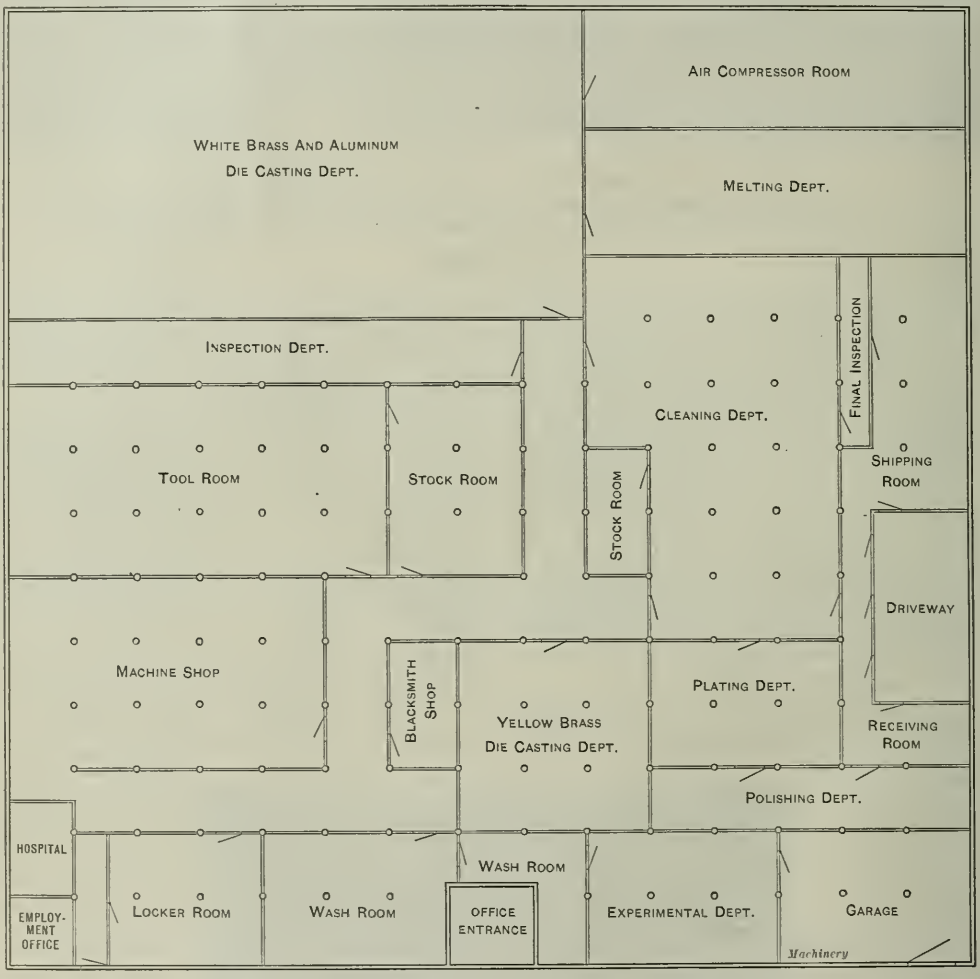


Fig. 2. Plan of the Stewart Mfg. Corporation's Plant showing the Different Departments

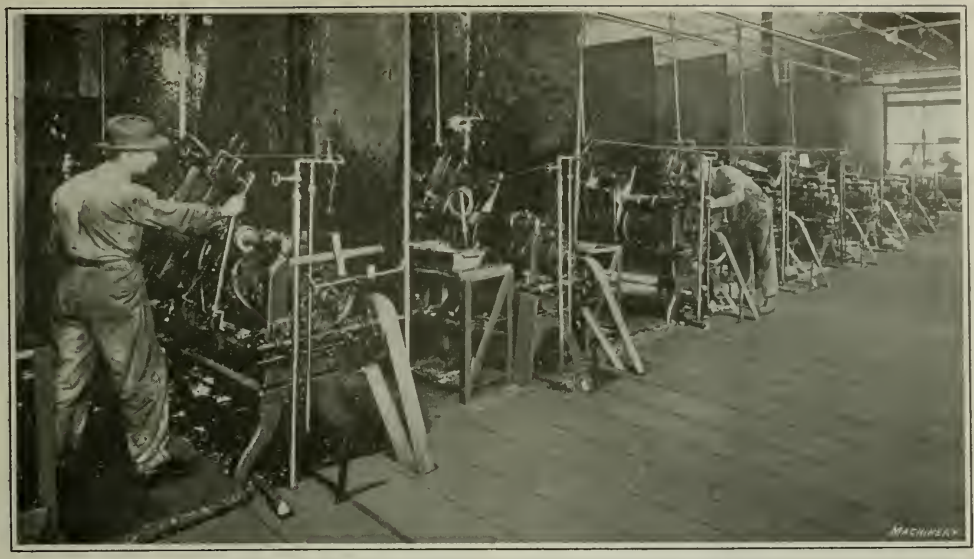


Fig. 3. A View in the Die-casting Department, showing a Battery of Die-casting Machines

ings. These are the machines shown in Fig. 3. They are mechanically operated, being provided with cams for the operation of the various die slides and heads, the action being much the same as that of automatic screw machines. The white-metal machines force the metal into the dies by pneumatic means, while the bearing-metal machines are of the plunger-operated type.

In the past, great difficulties were met with by many die-casting concerns in using machines in which the metal was forced into the dies by compressed air. The Stewart Mfg. Corporation has overcome this difficulty, the secret of success being in the use of dry air. The air is delivered to the machines after having passed through heated coils somewhat in the same manner as steam is passed through coils in a steam superheater. The greatest difficulties with moisture in the air are met with in the hot weather; but the drying system has proved effective even under the most trying weather conditions. All of the standard line of die-casting machines that are referred to are of the horizontal type.

The second type of machines is represented by those used for medium-sized white-metal castings. These are of a special design and the whole machine is mechanically operated. These machines are also of the horizontal type.

The third type of machines used is the vertical type employed for heavy white-metal castings. These machines are mechanically operated and use compressed air for forcing the metal into the dies.

The fourth type of machines employed is the regular line of aluminum-casting machines which are used for aluminum alloys. These machines are of the horizontal type, mechanically operated, except that the metal is forced into the dies



Fig. 4. A View in the Large Tool-room where One Hundred Forty Diemakers and Toolmakers are Normally employed

by pneumatic means. There are some very large machines of this type, however, which are vertical and are pneumatically operated throughout.

Finally, there are the machines used for brass and bronze castings. These machines employ non-metallic molds, are vertical in their design, and are operated entirely by compressed air.

Air Pressures Required to Force Metal into Molds

The pressure for forcing the metal into the molds ranges from 100 to 1500 pounds per square inch, according to the kind of metal being cast and the size and shape of the casting. The more intricate the shape of the casting being made, the higher must be the pressure, so that all the parts of the mold may be properly filled. The size and section thus determines entirely the pressure required. The lowest pressure is used on heavy large castings. On ordinary white-metal and aluminum castings this pressure varies from 100 to 500 pounds per square inch, with 300 pounds per square inch as an average for small castings. Bearing castings are made with high pressures in order to obtain a firm solid casting. The pressure used when casting bearings may vary from 500 to 1500 pounds per square inch. Brass and bronze are cast under comparatively low pressures, not generally exceeding 80 pounds per square inch.

Inspection and Cleaning after Casting

After the castings pass from the die-casting room they are first given a general inspection. This inspection is intended to remove all castings that have obvious defects, such as blow-holes, cracks, defective outside appearance, etc. Such defective outside appearance may be caused by the operator failing to throw out the castings that are made immediately after the dies have been lubricated. The dies must be lubricated at intervals, and the castings that are made immediately after the lubrication are defective and are not intended to be passed along with the perfect castings. An analysis of the metal in the castings is also made at the time of the first inspection, and is repeated from time to time for each lot of castings to insure that the castings retain their proper chemical composition.

From the inspection department, the castings are delivered to the cleaning room. In case large quantities of similar castings are made, special tools are generally provided for cleaning and trimming the castings. The equipment in the cleaning room consists of punches, arbor presses, hand screw machines, lathes, drill presses, and milling machines. Oil-groove machines are also provided for cutting oil-grooves in bearings, or for cleaning out oil-grooves that have been cast directly in the bearings.

From the cleaning room, the castings are sent directly to the final inspection department, where they are inspected mainly for the operations in the cleaning room and are also engaged to make sure that the dimensions are correct. From this department the parts that are not plated go to the shipping room. If the parts are to be plated, they pass from the inspection room to the plating room, and after plating, they are polished and are then inspected again. Nearly all of the plating performed on die-castings is nickel-plating, although some parts are also brass-plated.

Tool-room and Production Department

The Stewart Mfg. Corporation employs about six hundred men. An idea of the importance of the toolmaking department in a die-casting plant may be formed from the fact that out of this number nearly 25 per cent, or 140, are toolmakers engaged in the making of dies for the product made by the company. When the dies are made, samples are cast from them and these samples are checked by the tool inspection department. In some instances, the samples are sent to the customers for approval. When returned from the customer with his approval, the office notifies the production department that the samples meet the requirements, and the production department then schedules the work for the die-casting room. The general foreman of the die-casting room determines the machine on which each particular job is to be done, unless a special device is required for a special die-casting job, in which case this equipment would be provided by the engineering department. The production department also is required to see that proper gages, cleaning-up tools, trimming dies, etc., are provided for each job.

The complete organization required for a plant of the size described includes about 200 men in the melting and casting rooms, 120 men in the cleaning department, 50 men in the inspection department, and 40 men in the polishing and plating departments. It has already been mentioned that the toolmaking department employs about 140 toolmakers, and the machine shop, in which the company's own machines are being built, employs about 50 men. As many as 800,000 die-castings have been made in a single day, indicating the enormous production that is possible by die-casting methods.

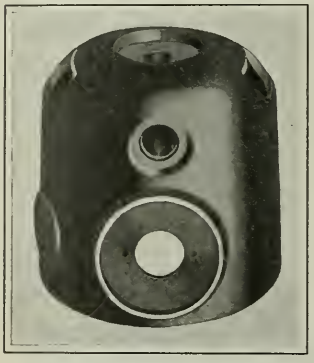


Fig. 5. Small Motor Housing produced by the Die-casting Process

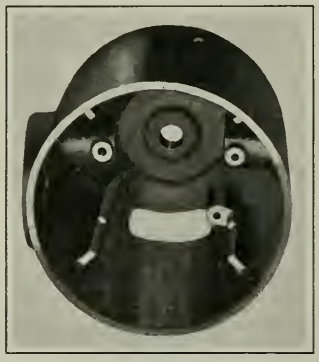


Fig. 6. Another View of the Housing illustrated in Fig. 5



Fig. 7. A Bracket with Bores and Holes, produced completely in Die-molds

Present Possibilities in Die-casting

The advantages gained by the use of die-castings have frequently been pointed out, and the accuracy obtainable and saving in machine work are well known. Die-castings, when they come from the mold, are practically finished parts, except for the removal of fins and some trimming or shaving that may be required on some surfaces. Holes can be cored accurately within 0.001 inch, and the most accurate bearings require no other machining work than a finish-reaming operation. The art has now advanced so that quite large castings are being made by this process, and shapes formerly believed too intricate to be handled in this way are now successfully dealt with. Figs. 5 to 10, inclusive, show a

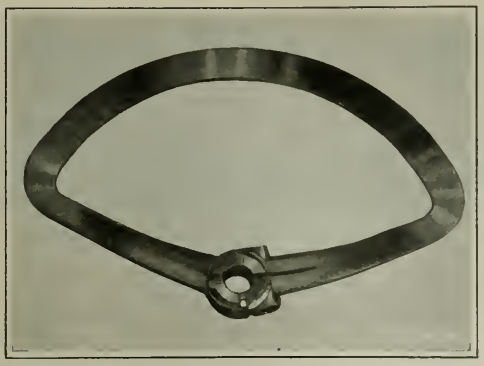


Fig. 8. A Slender Piece of Large Dimensions, which well illustrates the Possibilities of Die-casting

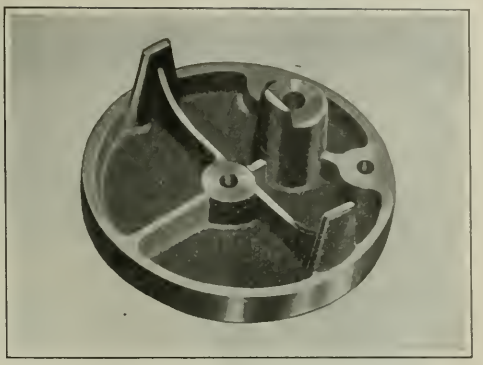


Fig. 9. Another Example of a Die-cast Product, showing the Application to Parts with Numerous Holes and Projections

number of castings made from white-metal and aluminum alloys, while Fig. 11 shows castings made from brass. The casting of brass parts, especially parts such as those shown in Fig. 11, by means of the die-molding process is a comparatively new development. Non-metallic molds of special composition are used for this purpose; otherwise the process is, in principle, similar to the method used for casting white-metal and aluminum alloys.

Figs. 5 and 6 show outside and inside views of a small motor housing, indicating how all the holes and bores are provided directly in the die-casting, and giving a fair idea of the complicated shapes that may be produced in this manner. The bracket in Fig. 7 is another good example of work of this character, while Fig. 8 shows a casting of an entirely different kind and indicates what can be done along the lines of producing a part of slender proportions but of large dimensions. Fig. 10 shows examples of gears cast with the teeth in place. These teeth will not require machining, but will run satisfactorily as they come from the die-molds. Of course, gears are only die-cast when they are not subject to a great deal of wear, and when the strength of the teeth need not be as great as if the gear were made from steel.

It should be noted, however, that at the present time die-castings are used in many instances where considerable strength is required. A few years ago it was not thought possible to use parts made in this manner for any conditions where strength was an important factor. Special treatment of the die-cast metal and special compositions of alloys have been developed which have a considerable tensile and compressive strength. Aluminum alloys, especially, are made that give very satisfactory results as regards strength and durability. The field for die-castings is, therefore, constantly widening, and as the art of making die-molded castings from brass and bronze is being further perfected, there will be a still broader scope for this industry.

Metals Used for Die-castings

In the early development of the die-casting art, a great many alloys were experimented with and the variety of alloys used at that time was very great. With the development of the industry, however, it has been found that a relatively small number of alloys meet the requirements, and the different compositions employed have narrowed down to a few comparatively well standardized metals. Broadly speaking, the metals that are die-cast may be divided into four broad groups as follows: (1) the white-metal group; (2) the tin-base group; (3) the aluminum group; and (4) the brass and bronze group. In addition, lead-base alloys are becoming quite generally used for bearing purposes.

The White-metal Alloys

The white-metal group comprises the zinc-base alloys which frequently are also known as "white brasses." The metals in this group used for die-casting purposes contain zinc, tin, and copper. The zinc-base alloys are more easily handled in the die-casting process than any other alloys and are, therefore, most generally used. They may be employed for all purposes where cast iron or yellow brasses can be used. It should be noted, however, that the tensile strength of the alloy is less than that of the brasses, so that castings made from this alloy can only be used to replace yellow-brass castings when the tensile strength required does not exceed from 17,000 to 20,000 pounds per square inch. This strength, however, is obtainable by zinc-base alloys when the metal is properly treated during the process of alloying or casting. Zinc-base castings present about the same wearing surface as cast iron or yellow brass and are used extensively for small electric motor frames, magneto castings, many automobile parts, and castings used in the electrical industries. Generally speaking, the characteristics of the zinc-base alloys used for die-castings are similar to those of



Fig. 10. Die-cast Spur and Bevel Gears



Fig. 11. Die-molded Brass Castings

cast iron. The most commonly used composition for a zinc-base alloy contains about 86 per cent of zinc, from 7 to 10 per cent of tin, and from 4 to 7 per cent of copper. Sometimes there would be some slight trace of aluminum or bismuth in the metal. A higher percentage of tin will make the alloy very ductile, while a higher percentage of copper will produce greater hardness.

The Tin-base Alloys

The tin-base alloys are used principally for bearings, and are, practically speaking, nothing but babbitt metals, it being well known that the so-called babbitt metals vary considerably in composition, some containing up to 90 per cent of tin, while the cheaper bearing metals in the babbitt group contain a much smaller percentage of tin. In addition to being used for bearings, the tin-base alloys are also employed for parts that must be resistant to acids, as, for example, parts for milking machines and other apparatus used in the food industries. The most acid-proof of the tin-base alloys are those which are high in tin, a favored composition being 90 per cent of tin, 4 per cent of copper, and 6 per cent of antimony, the copper and antimony increasing the hardness of the alloy.

Aluminum and Aluminum Alloys

Pure aluminum can now be die-cast on a commercial scale, but this is very seldom done, because there is no particular commercial application for such castings. They are too soft for commercial use, and the standard aluminum alloys which contain a high percentage of aluminum alloyed with copper are so far superior in every respect to the pure aluminum that these alloys are practically always used when a light casting is required, having considerable strength. The most commonly used of all aluminum alloys is that known as No. 12 composition, which consists of 92 per cent of aluminum and 8 per cent of copper. This alloy, when produced by die-casting, will have a tensile strength of 20,000 pounds per square inch, and is employed whenever a light strong alloy is required. The die-casting process increases the tensile strength of this alloy about 25 per cent.

Another alloy that is quite frequently used for automobile parts is a magnesium-aluminum alloy containing from 2 to 5 per cent of magnesium and from 3 to 7 per cent of copper, with the remainder aluminum. This alloy is much stronger than the No. 12 alloy, and by proper treatment in melting and casting, it is possible to obtain a tensile strength of from 32,000 to 35,000 pounds per square inch. The copper hardens the metal while the magnesium seems to act as a deoxidizer and produces a closer grain in the casting than can be obtained in an alloy consisting simply of aluminum and copper. Nickel is sometimes added to this alloy in quantities of from 1 to 3 per cent. The effect of the nickel is to produce still greater hardness than is obtained by copper alone, and in addition, the casting will have a much brighter finish.

When gears are die-cast, the No. 12 alloy is generally used, as it produces a good wearing surface. It should be mentioned, however, that it is not very often that gears are die-cast, because, as a rule, the gear teeth require greater strength and a better wearing surface than can be expected from a die-casting, in which case, steel is, of course, practically the only satisfactory material. Nevertheless, there are hundreds of cases where gears are not subjected to heavy wear, but merely transmit motion without transmitting a great deal of power, and in that case a die-cast gear will meet the requirements, as the accuracy required is easily obtained, and a great saving can be effected because of eliminating the cutting of the teeth on a gear-cutting machine. Spur, spiral, bevel, and worm gears can be die-cast, although the process is most generally applied to spur and bevel gears, examples of which are shown in Fig. 10.

The magnesium-aluminum alloy referred to above is especially suitable for intricate castings, because it flows more freely and will fill all cavities in the mold perfectly.

Comparison between Aluminum-alloy and White-metal Castings

White-metal castings are easier to make and are cheaper than aluminum-alloy castings and are, therefore, used whenever there is no need for an alloy stronger or lighter than the zinc-base composition. Aluminum-alloy castings, however, are used when lightness and strength are required at the same time. The alloy itself is more costly and does not cast as easily, making the die-casting produced from this alloy more expensive. The aluminum castings, however, have a fine finish and only need to be polished after they come from the molds, whereas white-metal parts must be plated if a high polish is required.

Brasses and Bronzes

Any composition of brass or bronze can now be die-cast by methods that have been developed successfully during the last year or two. Castings of complicated shape can be produced, as indicated by the examples shown in Fig. 11, particular attention being called to the cage shown in the lower right-hand corner of the illustration. Practically the same shapes can be produced in brass as are produced from the other die-casting alloys, the only limitation being that very small holes cannot be cored and produced directly in the casting, but must usually be drilled afterward. The reason for this is that the pins of small diameter which are necessary to produce these small holes show a tendency to warp when subjected to the high temperatures which are required for keeping brass and bronze in a molten condition. The advantage of die-cast brass and bronze pieces over those cast in sand is that the surface of the casting is harder than a sand casting would be, while the interior of the casting is practically the same as that of a sand casting.

The preceding review gives a general idea of the present state of the die-casting art. There is, however, a constant development taking place in this industry, and work formerly thought impracticable for production by die-casting methods is successfully undertaken. It is likely that the next few years will show a still further advance of the art, especially in the casting of the metals melting at high temperatures, such as brasses and bronzes. When the art of casting brasses and bronzes in permanent molds, such as are used in the die-casting process, has been fully developed, it will revolutionize many of the processes now used in the metal-working field.

* * *

WESTINGHOUSE COMPANY BUILDS HOMES FOR EMPLOYES

Owing to the difficulties experienced by the employes of the Westinghouse Electric & Mfg. Co. in obtaining homes near the East Pittsburg works, the company has resumed its home building activities that were postponed during the war. Forty-eight houses are now under construction and it is expected ultimately to erect, on the tract of 109 acres on which these homes are now built, homes for 600 families. The houses are of first-class construction, built from brick with hollow tile backing, and have concrete cellars and cement porches. They consist mainly of five, six, and seven rooms, and will be sold at cost on easy terms to the employes of the company. In the past the Westinghouse company has constructed a great number of homes for its employes and also owns a number of homes and apartments which are rented to the men in the plant. An effort is made, however, to have the men acquire their own homes, and this, without question, is one of the best steps toward assisting the workers in becoming stable, self-respecting men and home-owners who cannot be easily swayed by unsound economic doctrines. If all manufacturing enterprises of a size large enough to warrant the undertaking would attempt to "plant" their employes firmly on the ground, they would render a great service both to their men and to the industries as a whole.

Cylinder Patterns

By Joseph A. Shelly



Second of Two Articles Describing Methods of Laying Out and Constructing Patterns and Core-boxes for Pump Cylinders

THE first installment of this article on cylinder patterns dealt with steam-port core-boxes, exhaust-port core-boxes, pump cylinders, and pump cylinder core-boxes. The present and last installment of the article will deal with cylinder patterns for vacuum pumps, core-boxes for jacketed cylinders, cylinder head patterns, cylinder feet, and discharge cover patterns.

Cylinder Patterns for Vacuum Pumps

The vacuum pump cylinder pattern shown in Fig. 11 has a valve plate located at an angle. The pattern is boxed with cross-bracing where needed and is well corner-blocked inside. It is made to mold with the flange down, the molder's parting running along the bottom of the flange. The print only is made in the drag, and the portion from this parting to the center of the barrel is in the cheek and the rest of the pattern in the cope. The hub on the end at the flange, the feet on the barrel, and the half flanges with core-prints under the pattern parting are loose. The two half flanges are let into the ends of the pattern and dovetailed into place. These half flanges and core-prints are turned, but the barrel itself is planed and the swells at the ends built on.

An end view of the core-box is shown at *B*. This view shows how it was built and also the angular valve plate which holds the discharge valves. A central rib in the upper half divides the core, making three cores in one box. The upper and lower halves of the box are loose from the valve plate, being held in position by dowels. These cores could be made in separate boxes, but this type of cylinder is very light and great trouble was experienced when the cores were made that way. This difficulty led to the adoption of the box illustrated. To avoid getting the core in the wrong way, a corner of the print was cut away and the box filled in to suit; the piece cut away was small and the box was filled in right down to the plate which left a V-shaped corner in the casting but did no harm. Valve-seat prints were located on the plate and on the level part; they were placed on both sides so that the seat cores would project into both larger cores and keep the top ones from slipping down the incline. The prints on the angular part of the plate had to be tapered enough to draw when the plate was lifted in the direction indicated by the arrow at *C*. The top of the box was strickled to fit the swells on the bore core.

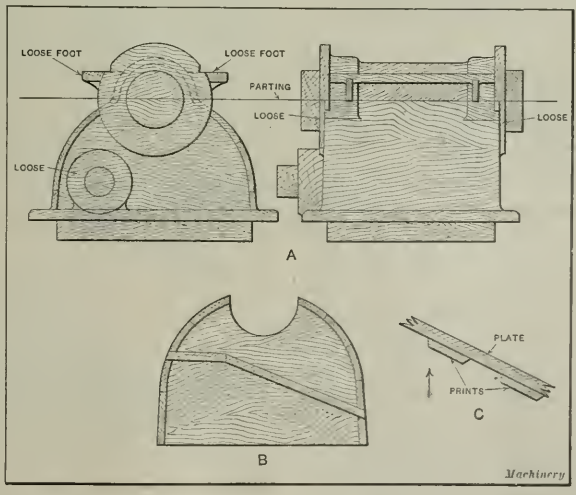


Fig. 11. Pattern for Cylinder of Vacuum Pump

Core-box for Jacketed Cylinders

Jacketed cylinders are those having a space between the outer and the inner walls for circulating cooling water. The core used for making this space is called a jacket core and must fit around the bore core. It is supported by openings either through the sides of the cylinder or through the flanges at the end. When the openings are through the sides, they generally have bosses so as to give enough metal to tap for pipe plugs to close the openings, as at *A*, Fig. 12. The core-box *B* is a half round box corresponding to the outer diameter of the jacket and filled in at each end to the inner diameter for the strickle to slide on. The cavity in the bottom is to reduce the amount of metal in the breast, and there are blocks in this cavity to form metal around the straight ports that extend through the breast face. The jacket core-box must always be filled in where openings extend from the outside to the inner bore to form metal around such openings. The cavity of this box was filled in to make the other half of the jacket core. With most jacketed cylinders it will be found more convenient to build projections on the side instead of at the bottom. These boxes are sometimes built the reverse way, and the openings then have to be cut through pieces doweled to the ends and running lengthwise of the box, but a core made in this way is difficult to handle. When the openings are to extend through the ends a print corresponding to the outside diameter of the jacket is made on the end of the pattern, as at *A*, Fig. 13. The openings are cut through the end piece that is placed in the core-box as at *B*, the piece parting as shown. The inside diameter of these ends must be the same as the diameter of the bore core around which the end fits; therefore, in order to make the part between the ends right for the inner diameter of the jacket, a strickle must be used to remove the surplus sand as at *C*. Small jacket boxes are often made complete, and this type of cylinder is frequently poured with the mold on end to secure a sounder casting.

A back cylinder head is shown at *A*, Fig. 14.

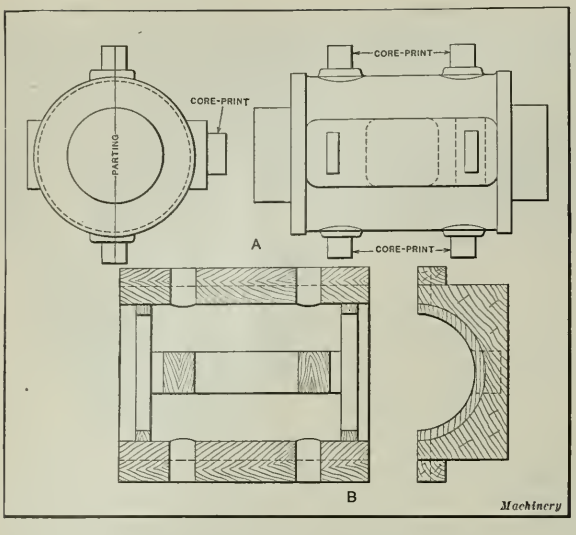


Fig. 12. Pattern and Core-box Work on Jacketed Cylinder

The swell on the outside is necessary because of the recess turned on the inner side to accommodate the piston-rod nut. The smaller sizes are usually made of a solid piece, preferably of hard wood, but the larger sizes must be constructed by segments with the rim in three courses and the center of a solid piece as at *B*. Other examples of segment construction are shown in Fig. 15. In fitting the segment ring and center together, the recess is first turned in the ring and the center turned to fit it; the ring is then fastened in place and the inside turned to a templet. The pattern is

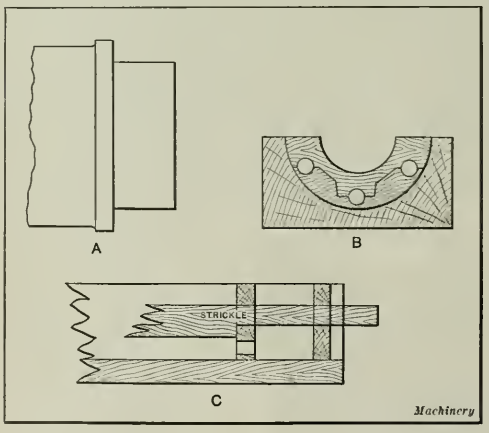


Fig. 13. Details of Pattern and Core-box Work on Jacketed Cylinder

next rechucked on the fitting piece for turning the outer face; the finishing of the diameter should be left to the last. A front head *B*, Fig. 15, is built in the same way except that instead of a swell it has a hub to form the stuffing-box. If it is the type of head that has a deep projection into the cylinder, which will come into the cope, it should be made loose, and if the loose piece is doweled to the cope side there will be no necessity for rechucking the pattern. Water-jacketed heads are made in a similar manner to cored pistons, one pattern usually being made to answer for both front and back heads by placing a hub in the core-box and a boss on the outside for the purpose of making the stuffing-box.

Cylinder Feet

Cylinder feet are either cast as a part of the cylinder or are separate pieces bolted to pads placed on the cylinder for that purpose. Duplex steam cylinders are often cast separately and bolted to a long foot called, in some localities, a "cricket." Small feet are usually what are known as open and have a single central rib or two ribs placed at the edges. These feet are fastened to the cylinder by gaining the web (which is made long) flush with the joint and fastening with screws as at *A*, Fig. 16. The closed or cored foot *B* has a projecting core-print. This core-print must be long enough to balance the core that is made in a half box which does not part, as it is possible in a case like this to give the box considerable taper. The rounded end is formed by a loose piece fitting into the end of the box. In making these feet the sides *a* (see view *C*) should be thick enough to cut them back to make the core-prints, and the top piece *b* should be kept back so that the flange may be fastened to the sides and also be nailed through the face into *b*, as this does away with the necessity of fitting and fastening to a taper. The top part of the print is put on last and the inside corners should be reinforced with corner-blocks. This style of foot is fastened

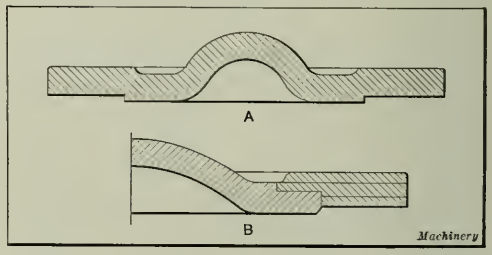


Fig. 14. Cylinder Head Patterns

from the inside, which is an easy matter when it is staved; otherwise screw pockets will have to be made in the joint and the screws driven at an angle.

When the face of the foot is parallel to the parting (as at *D*, Fig. 16) there is no necessity of parting it and if the lift on the inside is not deep and of such form that it provides plenty of taper, it may be made to leave its own core. If the lift is deep and heavy, a print should be placed on the face and a core-box made. This print need not be very deep as its only function is to locate the core which in most cases will have to be hung in the cope.

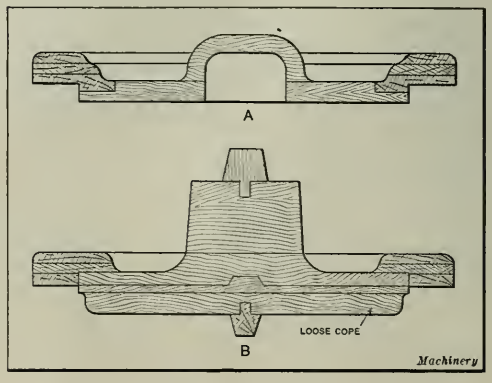


Fig. 15. Other Examples of Cylinder Head Patterns

There are a number of styles of separate feet to bolt on, the designs *E*, *F*, and *G* being typical. Pattern *E* is solid, the sides being nailed to the end pieces which are worked to shape and fastened to the top before the sides are nailed and glued. Pattern *F* has a central web and is parted and usually made in two ways; at view *F* the sides are placed between the top and bottom and the half web is fastened on each joint, while at *G* the top and bottom are placed between the sides which run to the center, and the joint is rabbeted to receive the web. The construction at *G* does away with the projecting end wood, which is a good feature and also eliminates the feather edge where the side joins the bottom at *F*.

The draws on some of these patterns are quite deep so plenty of draft should be provided on the inside. Loose feet are rabbeted into the barrel in order to avoid fitting to the round.

The style of machine foot shown at *H*, Fig. 16, is closed on the bottom and is only partly open at the top; it is necessary to make this foot with a core to obtain the best results. The core-print is made flush with the under side of the top pads. The core-box extends from the end of the foot to the center rib and the round column is fastened to a batten that is screwed across the face of the core-box.

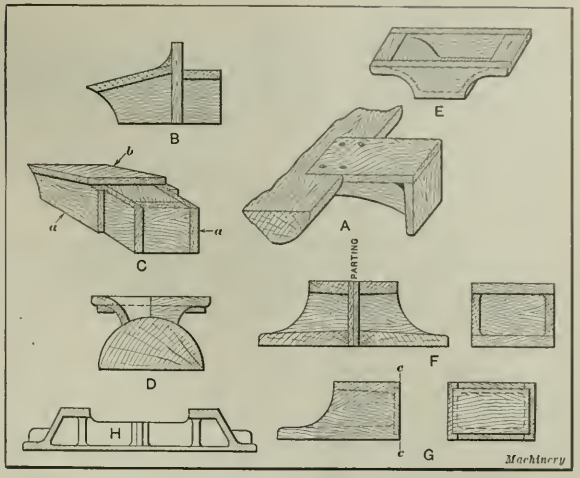


Fig. 16. Different Forms of Feet or Supports for Cylinders

Patterns for Discharge Covers

Patterns for small discharge covers (*A*, Fig. 17) are frequently carved from a solid piece. Hard wood is best for the purpose. The pattern block is parted through the center for laying out, the inside finished, and the block glued together before the outside is touched.

A larger size of cover such as is illustrated at *A*, Fig. 18, will have to be built up. The lower rounded corner should be worked inside and out up to the point where it meets the curved top; this point is indicated on the lay-out at *a*. This curved part is made like molding and is mitered at the corners as shown at *B*. These miters are cut in a miter-box with a form to hold the molding in place. Half-lapped joints are used at the corners where the flange is fitted around the mitered part and the top is made of two pieces of suitable thickness fitted into the opening in the mitered frame and resting on the angular edges. The reason for fitting this piece in halves is to lay it out on the joint and bandsaw the central hole. The hand-hole bosses are fitted afterward, and the core-prints are left loose for drawing. If the opening in the mitered frame is too large to be filled by a piece made in this way, it will have to be built of comparatively narrow pieces.

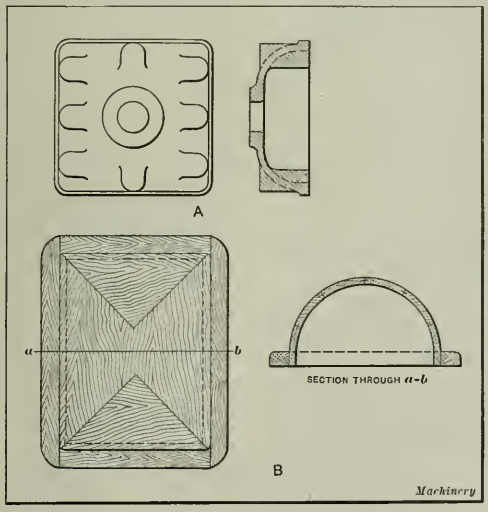


Fig. 17. Cover Patterns

Covers are sometimes semicircular in cross-section as at *B*, Fig. 17, in which case it is customary to build a piece the full section lengthwise and miter the ends. This piece is built on forms with feathers in the joints and it is mitered on the band saw by fastening a board to the bottom on which the miter is laid out. By cutting the miter on the straight part with a band saw the band saw can be kept to the line by watching through the arch. The ends are cut in the same manner, a form being used to hold them in the correct position.

The discharge cover shown in Fig. 19 which has an opening at each end at the top and hand-hole pads on the sides, presents a more difficult molding problem than the other covers, although the pattern itself is perhaps not so difficult to make as the one with the arched top. The pattern is made to leave its own core and to mold while in the position shown in the illustration. It must be given a fair amount of draft on the straight sides, tapering from the top side of the flange at the bottom up to the parting at the top. The hand-hole plates, with prints attached, are doweled to the angular ends with the dowel-pin holes bored parallel to the line of the draw. The pipe at the top is turned and cut to make the loose ends below the parting. These short pieces have hard wood pieces fastened on the ends to make the fillet which is left ¼ inch thick at the edges and gained into the sides and held in place with dovetails; a single dovetail piece is placed in the center of each. In turning the pipe section, dowel-pins should be placed in the core-prints, and the print to carry the core is made to run through the pattern from side to side on the inside so that a single length of straight

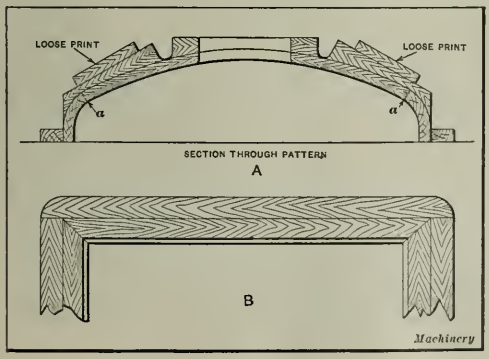


Fig. 18. Pattern for Large Cover

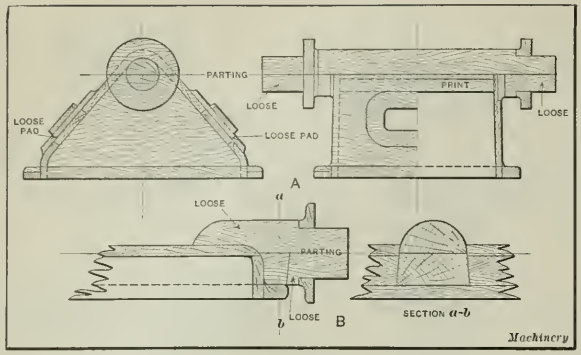


Fig. 19. Discharge Cover Pattern made to leave its own Core

round core is all that is required. In making these patterns, the body is made to fit the inside of the flange which is glued after being framed with corner lap joints, as this makes a pattern that cannot spread and can be more securely fastened than if the pattern is built on top of the flange which sometimes results in the flange projecting inside of the pattern and causing an under-cut.

The vacuum cylinder cover shown at *B*, Fig. 19, is a flat shallow box with the discharge opening on the top and projecting over the side. The parting line is indicated on the illustration. The piece below the parting is made loose at the flange. This parting in the mold does not follow the pattern parting but runs along the center and extends at an angle to the corner of the flange. In order that the section over the flange may lift away with the cope, it is made as shown in section. Very often hand-hole pads will project on the flange and cover a spot where a stud hole is to come and it will be necessary to place a core-print on the flange and core a pocket for the nut.

* * *

A RECORD OF BUSINESS CONDITIONS 1905-1919

The accompanying chart provides an interesting record of the ups and downs in the machinery business during the past fourteen years. The chart is based upon the volume of business done by the Bantam Ball Bearing Co., Bantam, Conn., and while it represents particularly the conditions in the ball bearing industry, it has been ascertained that it pictures quite accurately the conditions that have prevailed during the past fourteen years in the machine tool and some of the allied industries as well. Of course the values in the chart must be considered simply as relative, because the Bantam Ball Bearing Co. has probably grown more rapidly during the past fourteen years in proportion to its size in 1905 than have many of the old established concerns. Hence the volume of business in 1906 and 1907 will appear small as compared with the volume of business done in 1913 and 1914; but the interest centers not so much in the direct comparison of different years as in the ups and downs of the business during the period covered by the chart. For example, the effect of the so-called "Roosevelt panic" in the latter part of 1907 is easily discernible and so is also the effect of the "Wall Street panic" in the latter part of 1910.

In 1913 we notice two decided drops, each lasting a couple of months. The first of these drops was caused by the apprehension produced by new tariff legislation and the second by similar apprehension after the new currency and banking legislation had been passed. It will be noticed, however, that business recovered rapidly from the effects of these depressions and showed an upward tendency for several months previous to the beginning of the war in August, 1914. At that time the war panic caused a very decided drop lasting for about six months, after which there was a gradual improvement resulting in a tremendous output immediately after the United States had entered the war in 1917. The signing of the armistice did not immediately affect the output of many industries and this is also evident in the chart, where a high output was carried over into the first two months of 1919. From that point on there was a drop back to the 1916 conditions, after which an improvement is again recorded.

This chart was begun when the Bantam Ball Bearing Co. started in business in 1905. It is open to the inspection not only of the management, the directors and the stockholders, but also of the employes of the company. In addition to showing the fluctuations in actual output of the plant, the chart also contains, in an upper part (not shown), a line indicating the capital and the value of the plant inventory. The freedom with which the employes are permitted to learn of the actual financial conditions and the business fluctuations is stated to be one of the many reasons for harmonious relations between employer and employes at the Bantam Ball Bearing Co. It has always been the belief of the company that the more freely the management permitted the employes to study and become familiar with the actual financial conditions of the business, the less likelihood would there be for misunderstandings.

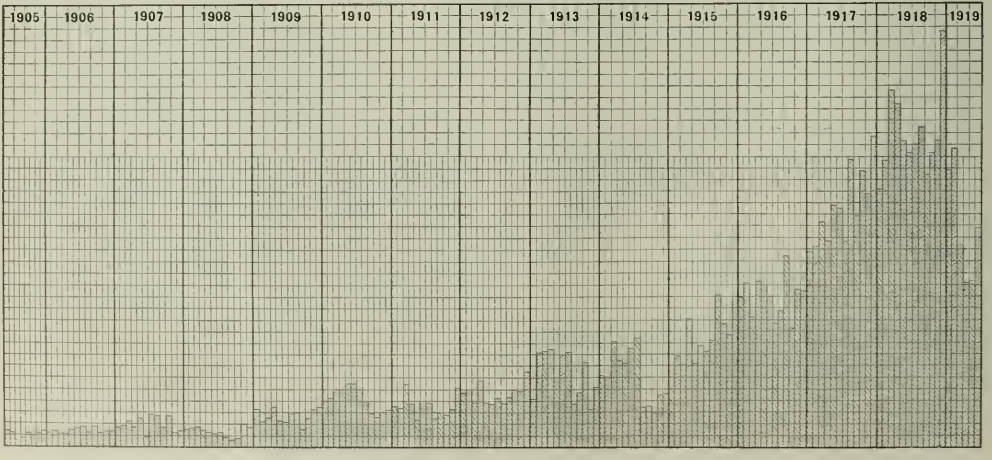


Chart showing Record of Business Conditions in the Machinery Industry from 1905 to 1919

LETTERS ON PRACTICAL SUBJECTS

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FORMING AND DRAWING DIES FOR SHEET-STEEL SHELLS

Difficulties encountered in the drawing operations on a steel shell, which is used as a vacuum pot on a certain type of computing scale, were overcome by using the dies here illustrated. The illustrations show each die used and the drawn shell as it appears after each operation. All the steel parts employed in the forming and drawing operations are hardened and ground. The corresponding parts of the various dies have the same reference letters throughout the description. The blank of sheet steel from which the shell is drawn is 0.065 inch thick and 5 7/16 inches in diameter.

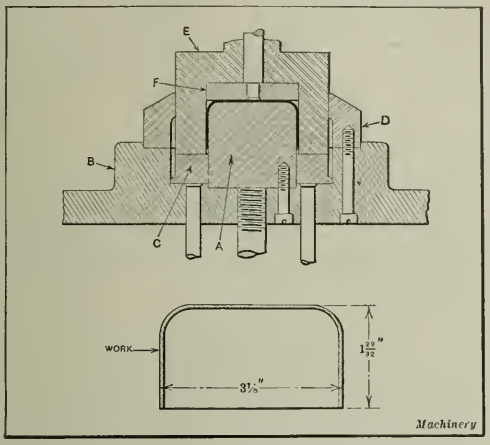


Fig. 1. Blanking and Forming Die used on First Operation

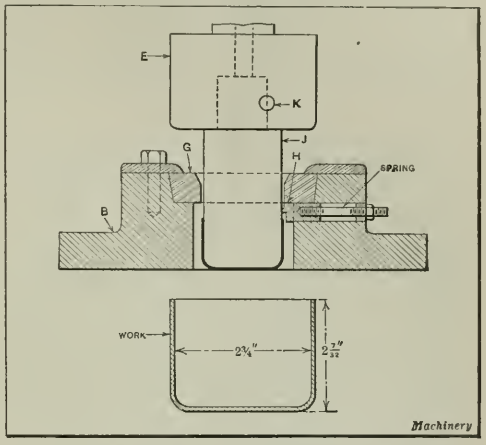


Fig. 2. Die for reducing the Diameter of the Shell

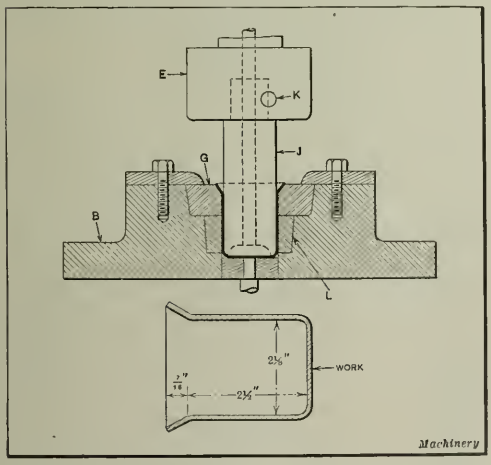


Fig. 3. Die for further reducing the Shell Diameter and partially forming the Flange

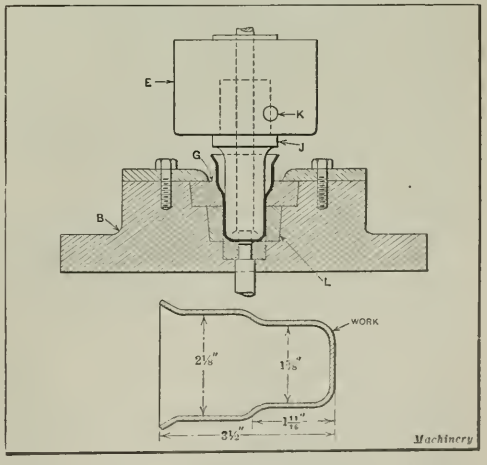


Fig. 4. Die for the Fourth Operation which elongates the Shell and forms the Small End

The die shown in Fig. 1 is a combination die which cuts the blank and performs the first drawing operation. It consists of a forming die *A*, die-block *B*, drawing ring *C*, cutting ring *D*, punch *E*, and shell ejector *F*. The construction of the parts and their method of operation can be readily seen from the illustration, and no further explanation is required. A plain push-through die, such as shown in Fig. 2, is employed to partially reduce the diameter of the shell. The die ring *G* is carried in the die-block *B*, in which it is secured by means of cast-iron straps and cap-screws. An interesting stripping device is used in this die. There are three strippers *H*, which are set radially in pockets or channels, equally spaced underneath die ring *G*, and which engage the end of the shell upon the return stroke of the press and strip the completely drawn shell from the punch. These strippers operate in the following manner: As the punch forces the shell downward, the strippers are pushed radially away from the center of the die, and when the upper end of the shell has passed the strippers, coil springs expand and force the ends of the strippers against punch *J*, so that upon its return stroke the shell is pushed from the punch. This

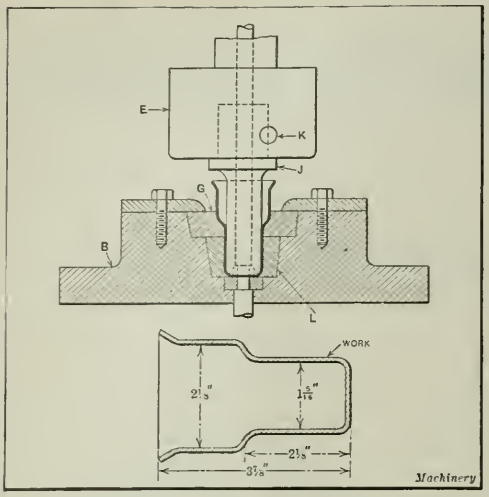


Fig. 5. Punch and Die of Similar Construction to that shown in Fig. 4

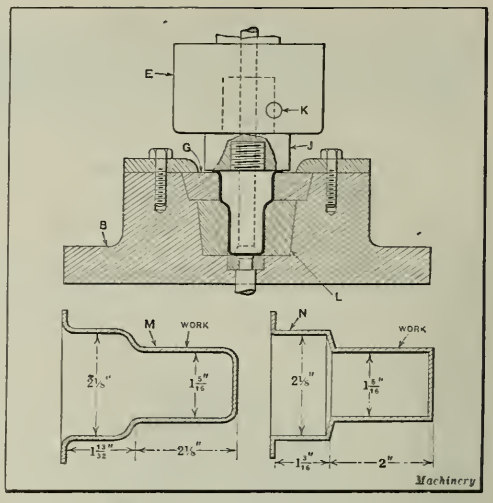


Fig. 6. Dies employed in performing the Final Forming Operations

die is so designed that it may be changed to suit various sizes of shells. To make this change, the strippers are adjusted and the punch and the die ring replaced to suit the work being formed. The punch J is supported in the machine steel punch-holder E by a $\frac{5}{8}$-inch pin K, and when it is desired to use a different size punch it is only necessary to remove pin K from holder E, insert another size punch, and again drive pin K into place. The punch-holder E has a $\frac{3}{4}$-inch hole bored in it, which permits the use of a bar for forcing the punch from the holder. This type of punch and holder is used in five of the operations that are employed in the manufacture of this piece.

Fig. 3 shows a punch and die which further reduces the diameter of the shell and also partly forms the flange. Two die rings, G and L, are used in this die. The die that is shown in Fig. 4 is used for the first operation in forming the small end of the shell. The hole in ring G is enlarged on the top in order to receive the shell and at the same time to center it in the die. This hole is made with a rounded edge over which the shell may be nicely drawn. In Fig. 5 is shown another die which is used to reduce the small end of the shell; this is constructed and operated similarly to the preceding die, and therefore needs no additional description.

Fig. 6 shows the punch and die that forms the shell to the shape shown at M. By replacing the die rings G and L with two other die rings (not shown) and by changing the punch J, this die is also used to form the shell finally to the shape shown at N. It will be noted that the shell M is longer than the shell N, which allows the metal to be upset a sufficient amount to form the sharp edges, and at the same time does not alter the thickness of the walls of the shell. The die rings G and L are tapered so as to be a good fit in the die-blocks. This construction reduces the possibility of the dies breaking under unusual strains such as would occur if the operator should put two shells into the die at one time.

The trimming die shown in Fig. 7 trims the flange of the shell. This is a plain blanking die, and has the pilot O inserted into the punch to locate the shell properly upon the face of the cutting ring D while it is being trimmed. As this pilot is concentric with the outside of the punch, it brings the flange of the shell concentric with the body.

Toledo, Ohio J. Bingham

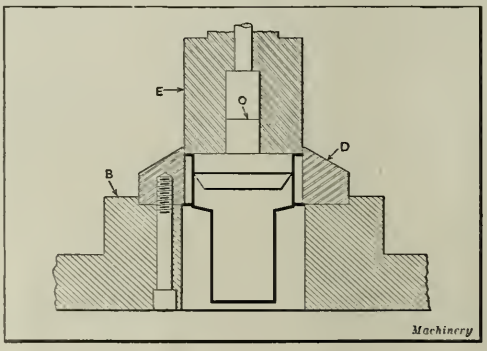


Fig. 7. Punch and Die which trim the Flange of the Shell

MAKING PROVISION FOR FACTORY ENLARGEMENT

In planning the building and operation of new shops, it is generally desired to have them so constructed and managed that the maximum amount of efficiency will result. The suggestions presented in this article were made by one of the executives of a large manufacturing concern and are ideas that were incorporated in an addition to his plant. Probably these suggestions will be of value to other executives who are planning shop enlargement.

The shop superintendent's office should be centrally located and raised above the floor so that it will overlook the entire shop. The assistants of the superintendent and the material routing department should be in an office adjacent to the superintendent's office. This location allows easy access to those in authority. The time clocks should be placed in the vicinity of the superintendent's office so that a close watch may be kept on all employes. A large number of washrooms and drinking fountains should be located around the shop so as to keep the men close to their work. If possible, the washrooms should be raised above the floor in order to save space and permit a clear view through the building.

The floor space of the shop should be as nearly square as possible, because this permits a large area to be overseen easily. It also shortens the haul of material. Moreover, it makes it possible to install a number of traveling cranes parallel to each other so as to permit the use of a crane by each comparatively small force of men, thereby eliminating loss of time in waiting for a crane. This saving in time cannot be accomplished by using two cranes on the same runway because it is impossible to prevent the cranes from becoming

congested at one end of the shop. Long craneways also require the use of crane operators which is a constant and heavy pay-roll expense.

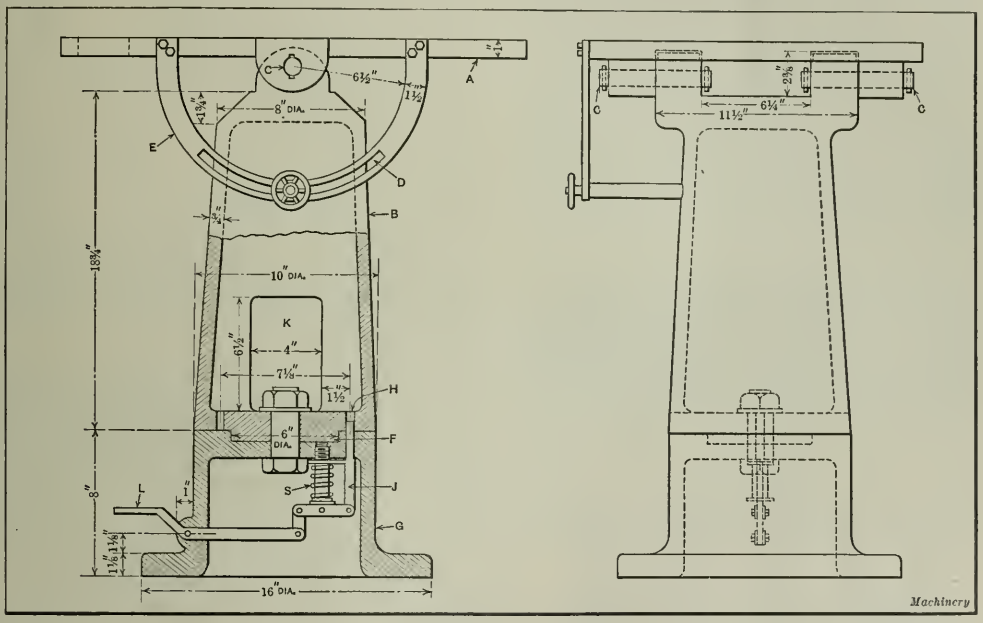
The gangways of a machine shop should be about 8 feet wide. If possible, the roof should be of sawtooth construction, but if this construction is not used there should be an abundance of skylights. All windows should extend from the ceiling to within a few feet of the floor. Storage bins should not be more than 8 feet high, because material which is stored in bins higher than this is seldom touched and is usually soon forgotten.

Probably the type of crane best adapted for yard purposes is a horizontal boom crane equipped with a self-propelled trolley that runs in and out on the boom. The crane should be so located that the trolley can run off the end of the boom to tracks inside the building. The advantages of this arrangement are that the load may be picked up inside the building and deposited in the yard without unslinging and reslinging. An automatic safety stop should be provided at the end of the boom to prevent the trolley from accidentally dropping off. A turntable is better than a switch inside a building because it requires only about half the space.

The allowance of space around other machines may be less, as their work usually comes to them in a fairly even stream.

In large plants, the shop should consist of two or more separate and distinct parts, each having its own head or general foreman and each general foreman having his own foremen. There should be no "straw" bosses or sub-foremen. None of these departments should have anything to do with each other, each arriving at a means of efficiently and rapidly producing a large total tonnage in its own way. This method will permit the same directness and closeness of authority between the shop executive and his men that exists in small shops and should be a stimulating factor of competition between the various departments.

In order to obtain the best results, a foreman should not have more than ten men under him, and each foreman should have complete authority over the work just as though it were his own shop. He should not be handicapped by interference from another foreman. In many plants, the foremen are so crowded with work because of the total tonnage and all the connecting details that must go through their hands that there is little time left for looking after other small matters. These matters are thus often taken



Stand to which Air Pumps are clamped when being repaired

There should be enough space around each machine for several days' supply of material, because a routing department generally cannot work closer than that, and in order to obtain the maximum production, machines must be crowded with work. In shops where several machines perform different operations on the same piece of work, a number of machines should be placed around one common open space. The open space is used for the storage of several days' supply of work and the output of the machines. This system saves space because the machines, which are not crowded with work, can give up their section of the common storage floor to the machines that are overcrowded. Handling expense is also saved, as the machines so arranged obtain their work from a common area, and when any machine has completed its operation on the work the piece is returned to this area where it can be easily procured by the operator of the next machine. Unnecessary trucking from one part of the shop to another is thus eliminated. Ample space should be allowed the machines where the work starts, because their supply of material is often irregularly furnished. care of by inefficient under-bosses, resulting in expensive leaks that may not be discovered for years.

Indianapolis, Ind. STUART DEAN

* * *

AIR PUMP REPAIR STAND

For performing machining operations that are necessary when making repairs on air pumps, a suitable table or holding stand will greatly facilitate the performance of the work. Such a stand is here illustrated and described. The surface plate *A* is made of cast iron. It is finished on the top and contains two sets of bolt holes, so that one plate may be used for holding two styles of pumps. This surface plate is attached to the column *B* by means of two pins *C* which pass through lugs on the two parts. This construction allows the surface plate to be tilted as required, when repairing the pumps, to any angle in either direction within the scope of slot *D* in the U-shaped arm *E*. A handwheel is provided for clamping the plate in the desired angular position.

The column *B* is of box section, and on its lower part has

a circular boss *F* which fits into a similarly located recess in the base *G*, in which it may be revolved. There are four equally spaced index holes *H* in the column and an index plunger *J* in the base. This plunger may be withdrawn from an index hole by pressing down on the foot-treadle *L*. After the column has been turned through 90 degrees, the treadle may be released, and the plunger, actuated by the expansion of the coil spring *S*, will enter one of the holes in the column. The base and column are secured together after the latter has thus been accurately indexed, by means of a bolt and nut as shown. A hole *K* is cast in the column which permits of ready access for tightening or loosening this nut.

M. K.

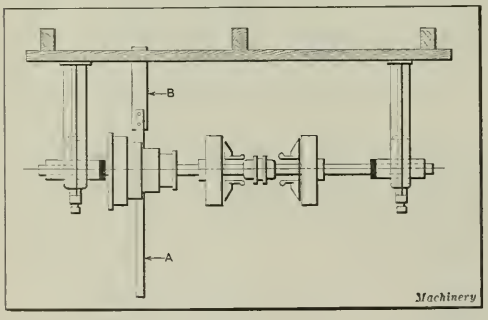
THE SOCIETY OF MECHANICAL INSPECTORS

It affords me real pleasure to note in the July number of MACHINERY, page 1100, that the American Society of Mechanical Inspectors has been formed. I have specialized in inspection work for the last five years, and urged the formation of just such a society in the technical press quite some time ago. In an article in MACHINERY, June, 1917, page 910, I advocated the formation of an inspectors' society, and it would have been of great value if formed at that time. Now the war is over and the consequent pressing demand for men with experience and ability as good inspectors is lessened. Had this society been organized before the United States entered the war, the manufacturers throughout the country would have been able to apply to some central agency or bureau, such as the society, and a great deal of time, labor, and materials, all of which were badly needed during the hostilities, would have been saved.

Stoneham, Mass. RUSSELL R. UX

BELT POLE FOR ENGINE LATHE

Shifting the belt on the cone pulley is a regular performance for a lathe operator and involves the loss of much time if an ordinary belt pole is used. It often happens, in cases where one pole is provided for a number of machines, that the operator is obliged to wait until someone else is through using the pole, or to spend considerable time trying to find one. This may occur when there is a rush job in process,



Belt Pole attached to Countershaft Joist for shifting Belt on the Cone Pulley

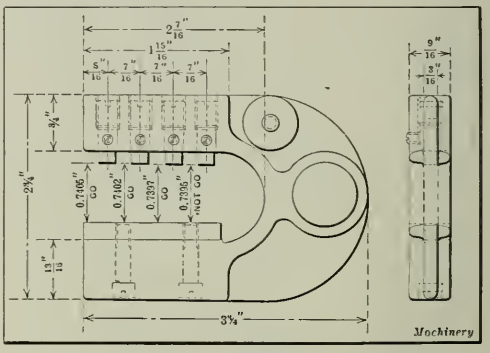
in which case the operator usually resorts to the use of his bare hands, with the probable result of injury, either by friction or by a protruding belt hook.

The accompanying illustration shows a pole which is attached overhead on the cross-beam at the rear of the lathe, thus being available at all times. It consists simply of a plain, cylindrical stick *A*, hung by a leather strap *B*. This simple arrangement will save much time in a day, being always in close proximity to the operator and at the same time reducing, if not entirely eliminating, the possibility of injury. In the event of the machine having a thread-chasing dial, in which case it would not be necessary to reverse the drive, a higher degree of lathe efficiency can be obtained by making use of the countershaft clutch pulleys for changing the speed. These clutch pulleys should be belted to pulleys on the main shaft, so as to produce a speed which will be intermediate between the speeds obtained by the two steps of the cone pulley that would otherwise be employed.

Trail, B. C., Canada JOHN HOMEWOOD

FOUR-POINT LIMIT SNAP GAGE

The limit gage here illustrated has four adjustable gaging points, and is particularly adapted for use on such work as sorting ground pins and roller bearings, which must be machined to very close limits. The general design of the gage is not unlike the standard commercial product which may be purchased on the market, the construction of which is quite well known. The body is made of cast iron, and



Four-point Limit Snap Gage for Special Use on Accurate Work

contains a hardened and ground tool-steel block as a gaging surface and adjustable gaging points which are made of hardened drill rods.

In gaging needle-bars, the operator uses the gage to sort the work as it comes from the grinding machine. The first two points gage bars which come within the larger limits, and this work is separated from that which comes within the limits of the next two points, thus making two assortments, the needle-bars in each of which are within the close limits of the gage. Of course the bars which pass through the "Not Go" gaging point—0.7395 inch—will not be used in any case. This inspection of the work after grinding separates the bars so that the amount of lapping required on the hole in which the bar fits is reduced to a minimum. It will be seen that much more time would be required if two separate gages were used. If desired, two entirely different sizes of work may be handled on this gage in like manner.

Buffalo, N. Y. H. KURZWEIL

REPAIRING A SLIDE-RULE RUNNER

When repairs are needed on slide-rules, much time is often lost by having to resort to "long hand" methods of making calculations until the rule has been sent to the nearest engineering supply house for repairs. This is especially true when engineers are engaged in field work or stationed in the smaller towns and cities. The writer has occasionally repaired slide-rules when the runner glass has been broken, by substituting a piece of celluloid cut from a triangle. The most transparent celluloid should, of course, be used when obtainable, but in case of real necessity almost any available triangle may be used. The scribing of the hair-line may be done with a safety razor blade, although other suitable means will doubtless suggest themselves. The runners which have been repaired in this manner have generally proved satisfactory in an emergency, and have saved much time.

Decatur, Ill. WARREN ICHLER

HOW AND WHY

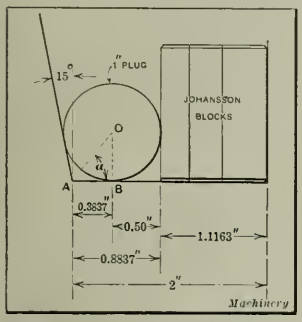
QUESTIONS ON PRACTICAL SUBJECTS OF GENERAL INTEREST

A TOOLMAKER'S PROBLEM

J. A.—Will you kindly show me how to find the correct diameter of a plug which will be tangent to the sides of a snap gage, as shown in the illustration? The 2-inch dimension and the 15-degree angle are all that are known.

ANSWERED BY ELMER C. COOLEY, SYRACUSE, N. Y.

The answers to this problem which have been published in previous numbers of MACHINERY have adhered strictly to the question asked—that is, how to find the diameter of a plug which will be tangent to the sides of the gage. The simplest and most practical way to check this gage, however, is to use a 1-inch standard plug and Johansson gage-blocks. By this method, only one computation is necessary—a fact which will appeal to the average toolmaker.



Checking a Snap Gage by Means of a Standard Plug and Size Blocks

Referring to the accompanying diagram, lay the plug in the gage against the surfaces forming the 105-degree angle.

$$a = \frac{105 \text{ degrees}}{2} = 52 \text{ degrees } 30 \text{ minutes}$$

$$AB = OB \cot a$$
$$= 0.50 \times 0.76733$$
$$= 0.3837 \text{ inch}$$

Subtracting the sum of 0.3837 inch and the radius of the plug 0.50 inch, from the known dimension 2 inches,

$$2 - (0.3837 + 0.50) = 1.1163 \text{ inches}$$

The total width of gage-blocks to use when checking this gage should then be equal to this dimension.

COMPENSATING FOR ERRORS IN A LATHE LEAD-SCREW

W. M.—Is there any way to compensate for errors in a lathe lead-screw?

A.—Errors in a lathe lead-screw may be compensated for by equipping the carriage with a special lead-screw nut, which may be turned slightly forward or backward when cutting a precision screw, in order to advance or retard the movement of the carriage and thus counteract the errors in the lead-screw of the lathe. The rotary movements of the nut are regulated according to the errors in the lead-screw, and may be controlled by a templet which causes a lever connecting with the nut to be raised or lowered as the carriage traverses along the bed. While this method of compensating for errors is simple in principle, it is not easily applied because of the difficulty of determining the location and magnitude of the local errors along the lead-screw, which should be cut as accurately as possible to begin with, if intended for a precision screw-cutting lathe. The general method of locating the errors is by comparing the movements of the carriage derived from complete turns of the lead-screw, with a very accurate scale of the kind found on some measuring machines. The templet for controlling the rotary movements of the lead-screw nut is then laid out according to the errors at different points along the screw.

PRODUCTION PROBLEM FOR THE MACHINE SHOP

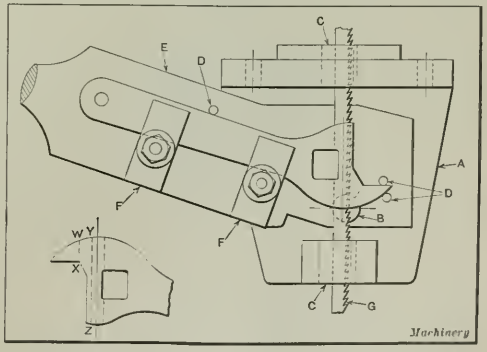
M. M. S.—What is the best method to employ, on a production basis, in removing stock from a wrench head in which the movable jaw of the wrench operates, as shown in the illustration on page 1086 in the July number of MACHINERY? The stock removed forms a slot which cuts into the previously drilled hole for the jaw rack.

ANSWERED BY GEORGE E. HIEBER, CINCINNATI, OHIO

This production problem can be solved by broaching, either as the wrench head is designed or by making a slight change. The piece would be better adapted for quantity production if the slot were made so as to run parallel with the drilled hole, as shown at *WXYZ* in the illustration. This change, which would not greatly weaken the jaw of the adjustable wrench, would permit the introduction of a pull broach having a bearing in the drilled hole. A simple work-holding fixture could then be used, insuring maximum production.

If the slot must be made as shown in the original illustration, the broach and fixture can be constructed as shown in the accompanying illustration. *A* represents the base of the fixture. This base carries the pin *B* and two broach-supporting bushings *C* located as shown. A work-holding arm *E* pivots on pin *B*, and may be swiveled by hand. The wrench is located in the holder by means of three pins *D*, and is secured in position by the clamps *F*. The points of the teeth of broach *G* are in a plane parallel with the back of the broach; the sides are taper-ground, the cutting edge being thicker than the back edge, so as to provide side clearance.

The method of performing the operation is self-explanatory. It must be apparent that even with hand feed trouble is likely to be experienced through broaches breaking due to their not being supported on the back while making the cut. The previously suggested change in the shape of the slot would eliminate this trouble.



Method of machining Wrench Slot by broaching

THE GROWTH OF CAST IRON

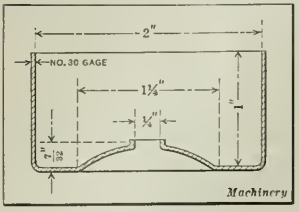
D. A. W.—Under what conditions will cast iron "grow" or increase in size?

A.—The "growth" of cast iron is the result of repeatedly heating and cooling the cast-iron parts. For instance, cast-iron annealing ovens originally 8 feet in length have grown to a length of 9 feet as the result of being kept red-hot for

prolonged periods between which they were permitted to cool. Cast-iron furnace grates and other parts subjected to alternate heating and cooling are also frequently distorted and sometimes broken because of the growth. To avoid this growth or increase in size as far as possible, white cast iron having a carbon content of about 3 per cent and a relatively small amount of silicon and other impurities should be used.

DRAWING A BRASS SHELL

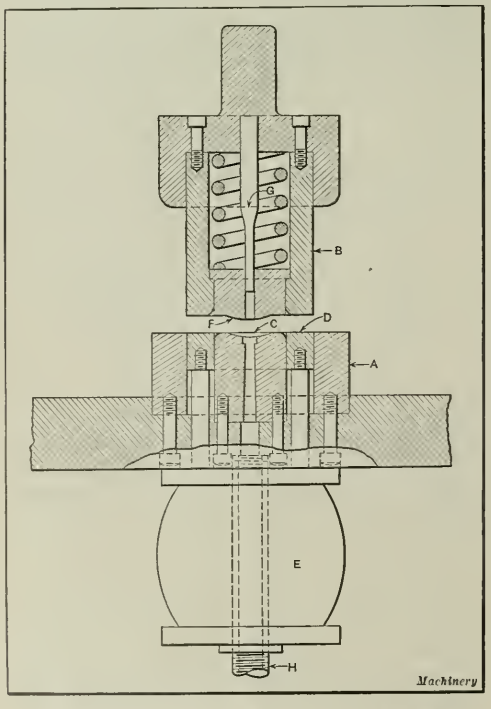
R. W.—A cup of the dimensions shown in the accompanying illustration is to be drawn. Can any reader of MACHINERY that has performed drawing operations on cups of this or similar shape furnish illustrations and descriptions of the dies that have actually been used in performing the work? The material is brass, No. 30 gage. The tools should preferably be designed for a single-action press.



Cup-shaped Brass Shell to be drawn on a Single-action Press

ANSWERED BY R. P. DEANE, HOLYOKE, MASS.

Provided the stock is soft enough to be drawn in a single operation, a combination blanking and forming die like that shown in the accompanying illustration might be employed to form the shell. The operation of the punch and die needs no detailed description, as it functions similarly to that of other drawing tools of like design. As may be plainly seen by referring to the illustration, the ring or blanking die *A* is set into the bolster plate, in which it is fastened by means of fillister-head screws. The combination blanking and forming punch *B* is similarly secured to the punch-holder, the edge of the outside diameter being made sharp while the interior edge is rounded and polished, so that it will draw the blank over the rounded edge of the forming die *C*. Die *C* is slightly cupped out at the top to the shape of the bottom of the shell to be drawn, and has a central hole, enlarged at the top, through which punch *G* operates. Between the blanking die *A* and the forming die *C* there is a combination pressure ring and stripper *D*, which has a rubber bumper attachment *E*, with supporting plates and drawing pins.



Combination Blanking and Forming Die used to make a Brass Shell

The upper part of pressure pad *F* has a shoulder by means of which it is carried in the hollow forming punch, its function being to form the concave bottom of the shell. For this purpose the pad is backed by a coil spring, heavy enough so that after the concave bottom is formed, the spring will hold the pad firmly against the shell while the punch *B* continues downward, forming the work. Before the operation is completed, punch *G* comes into contact with the shell, first forming the small boss into the enlarged end of the hole in the forming die, and then punching out the ¼-inch hole in this boss as the ram of the press proceeds to the end of its stroke. On the upward stroke of the press, ring *D*, which has been forced below the end of the shell, will be moved upward by the expansion of the bumper *E*, thus ejecting the shell. The center stud, or attachment screw *H*, of the rubber bumper, should be made of ½- or ¾-inch extra heavy iron pipe, so as to allow the punchings from the small hole to drop through the die.

PROBLEM IN MENSURATION

In a previous number of MACHINERY, a problem was presented in which it was required to determine the diameter of a circle from the two dimensions given in the accompanying diagram. The previous solutions of the problem involved the use of quadratic equations. The problem may be solved, however, by means of plane trigonometry—a subject with which toolmakers are more familiar. By the conditions of the problem, $AB = \frac{1}{4}$ inch, and $BC = 1$ inch. Therefore:

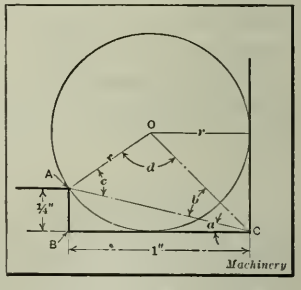


Diagram used in solving Problem

$$\frac{AB}{BC} = 0.250 = \tan a$$

$a = 14$ degrees 2 minutes 10 seconds

and

$b = 45$ degrees $- a = 30$ degrees 57 minutes 50 seconds

$AC = \sqrt{(AB)^2 + (BC)^2} = \sqrt{1.0625} = 1.0308$ inches

or

$AC = \sec a \times 1$ inch $= 1.0308$ inches

From a corollary in mensuration, page 128, MACHINERY'S HANDBOOK, $OC = 1.414r$. According to the law of sines:

$$\frac{r}{1.414r} = \frac{\sin b}{\sin c}$$

from which

$$\sin c = 1.414 \times \sin b = 0.7275$$

and

$c = 46$ degrees 40 minutes 39 seconds

Therefore

$d = 180$ deg. $- (b + c) = 102$ deg. 21 min. 31 sec.

Then

$$\frac{r}{AC} = \frac{\sin b}{\sin d}$$

from which

$$r = \frac{AC \sin b}{\sin d} = \frac{1.0308 \times 0.5145}{0.97683} = 0.5429 \text{ inch}$$

and the diameter of the circle, $2 \times 0.5429 = 1.0858$ inches.

Philadelphia, Pa. FRED J. NAAB

Standardized Gages for Interchangeable Manufacture

First of a Series of Articles Dealing with Modern Inspection Department Practice and Principles of Gage Design, Including a Complete Tolerance System for Gages, Designed Especially for Interchangeable Manufacture

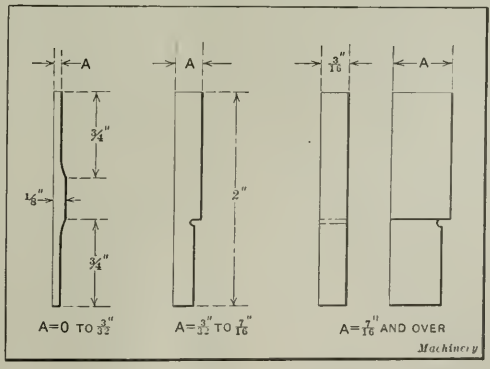
By JOHN E. COLLINS

GAGES are one of the many things that received their greatest impetus during the recent war. All the large war contracts for munitions awarded by the Ordnance Department, stipulated that all parts must pass the gages furnished by the department to the contractor for inspection. These gages were of various designs—good, bad, and indifferent. A gage that is correctly designed does not need lengthy instructions relative to its use or explanations as to the allowable limits. A gage should be so simply designed that there can be no mistake in its use. The limits should be definitely predetermined, and the allowance should be stamped on the gage itself, thereby preventing possible misunderstandings.

After the United States entered the war, a special gage division was organized in Washington, D. C., for designing all gages for materials ordered by the Ordnance Department. Many manufacturers also furnished their own working gages, made either to the designs furnished by the Ordnance Department, or to designs of their own. The experience thus gained has had an important influence upon the development of gage design and gage making. The selection of materials used for gages is more carefully considered than formerly, and the requirements as to workmanship and heat-treatment are better understood. Gages that are poorly designed and made are expensive, because they make proper inspection impossible. The production of war materials brought out the fact that a complete system of standard gages of specific designs is necessary in order to produce the best results. The lessons taught by the war are applicable to the whole machine-building trade. The present and succeeding articles are based upon these lessons, and it is the intention of the author to place on record in this series a set of standards for gages that is applicable to the production of any part for any mechanism.

Classification and Definition of Gages

Working gages are those which are used in testing the work for size during the actual manufacture of the part. This type of gage has a greater amount allowed for wear than any other type, and hence the actual tolerance on the work between the maximum and minimum gage is smaller, by the amount allowed for wear on the gage, than the actual amount specified on the drawing. As this type of gages wear, they become useless as working gages, but may then be used for inspection gages. When they have worn so that they are of no further use as inspection gages, they are either discarded or may be retained to be used as master inspection gages.



Standard "Checks" for Snap Gages

Inspection gages are used by the inspector for checking the product. These gages are generally of the same design as the working gages, except that they have a much smaller allowance for wear.

Master gages are used only for verifying inspection gages, or for checking the product in case a disagreement arises between the manufacturer and the purchaser. Under the heading "master gages" are included various gages known as "checks," "masters," and "reference gages." Master gages should, if possible, be of the same design and construction as the inspection gages, but should have practically no allowance for wear. In some cases, checks or masters are made which are complements or the reverse of the inspection and working gages, as, for example, thread ring gages which are used for plug thread gages. All snap gages gaging below ¼ inch, and those so designed that they cannot be checked by ordinary measurements, should be provided with checks that are the reverse of the inspection gage itself.

Master gages are of double importance to the manufacturer who has part of his product made outside of his plant, because occasions will arise when his own inspectors will reject work that the outside manufacturer claims to be correct. One set of masters should be kept at the outside manufacturer's plant and one at the home plant.

Gages that are used for checking other gages are sometimes erroneously termed "reference gages," but such gages should be called "checks." Reference gages, in the true meaning, are standard ring, plug, and end-measure gages, such as may be considered standards of measurement, and which are made by several prominent tool manufacturers. These gages have practically no allowance for wear, and are expected to be accurate to standard size within 0.0001 inch or less. These gages are used as ultimate standards of reference in producing other measuring instruments.

Checks perform an entirely different function in a gaging system, but are not yet used as extensively by manufacturers as they should be. Checks are simply standards for the inspection of wear of working and inspection gages. They indicate when the gages are so worn by use that they are no longer suitable for the purpose for which they are intended. Checks may be used for a considerable number of gages, but are necessary in the case of many types, such, for example, as ring or snap gages which are too small to be measured by ordinary methods. A type of standard checks for snap gages is shown in the accompanying illustration. For ring gages, a standard plug furnished with a handle is used as a check; and for profile or similar gages, a master profile of the work itself is recom-

mended, as in this way the profile of the working and inspection gages can be most readily inspected.

The terms "limit," "tolerance," "allowance," and "clearance" have been repeatedly defined in MACHINERY, and there is no need to repeat the definitions. It is expected that anyone interested in this series of articles is familiar with the meaning of these terms.

Wear and Life of Gages

The number of times that a gage may be used on the work before being worn beyond the required limits varies according to the material being gaged. Some materials, such as cast iron, have high abrasive qualities and wear the gage much more rapidly than steel, bronze, or brass. Aluminum also wears gages very rapidly. It has been found by actual trial that a gage when used on 10,000 pieces of aluminum will show a wear on the gaging surface of about 0.0005 inch. It was also found that 50,000 pieces of brass or bronze could be gaged before the wear on the gaging surface amounted to 0.0005 inch, while the gaging of from 18,000 to 22,000 pieces of cast iron produced the same amount of wear. These figures will vary somewhat, depending on the grade of finish on the work, the diameter or length of the piece, and the material of which the gage itself is made. A ground surface is the most satisfactory gaging surface from the standpoint of long gage life, as 60 per cent more pieces can be gaged before the surface will wear down to the same dimensions to which it would have worn if used on turned work.

Hardness

The actual gaging surfaces of all gages should be tested for hardness. The degree or amount of hardness should be specified on each gage drawing, and the gage should then be inspected by the tool inspection department to ascertain if the required hardness is attained. The gages are tested either by the Brinell or the scleroscope tests. When the hardening process is checked by means of the scleroscope, the note on the drawing might read, for example: "Scleroscope test 60 to 70." A description of the Brinell and the scleroscope tests and a comparison of the test numbers are given on pages 1161 to 1164 of MACHINERY'S HANDBOOK.

The exact degree of hardness desired for gages varies, but the general practice is to call for a minimum scleroscope hardness of 80. This assures that the gage will be hard enough to "stand up," and at the same time it gives the heat-treating department some leeway in the hardening process. Tool steel may be hardened until the scleroscope will give a reading of from 90 to 110, but this is too hard for gages as it makes the steel very brittle. If a gage, hardened to the maximum hardness that tool steel will attain, should be accidentally dropped on a hard surface, it would probably be broken. It is, of course, an easy matter to draw the gage slightly, thus relieving the structural stress in the brittle steel and prevent this occurrence.

Seasoning or aging the steel brings about the condition of permanency which hardened steel will reach after a period of time. This is a condition of stability caused by the stresses in the steel having adjusted themselves and become "set." The hardening of steel sets up serious stresses in the metal; therefore, all gages that are hardened should be laid away for a few months before the finish-grinding and lapping operations are performed. All stock should be annealed before machining. This is important, as most of the steel used for gages is cut from stock which has been rolled to shape. In order to remove the stresses incident to rolling, as well as to make the structure of the steel more homogeneous and soften the metal, it is best not to neglect the annealing. The saving in the cutting tools and milling cutters alone will more than offset the expense, not considering the risk of having an intricate gage crack in hardening.

Extent to which Machine Parts should be Gaged

The first determining factor in gaging depends upon the extent to which the parts are to interchange. Whether or not the parts should be interchangeable is determined by several factors: First, the quantity of parts to be manufactured, second, whether or not units or machines are to be shipped as assembled parts that have been fitted in the shop, or whether they are to be assembled afterward from parts which have no predetermined relation to one another; third, the extent to which the parts are likely to be replaced due to wear or breakage; fourth, whether the type of machine is likely to be used as a permanent type, and consequently be continually in the process of manufacture.

In considering to what extent one should go into the gaging of any machine, it is the opinion of the writer that, if a machine is to be shipped as an assembly and is not to be manufactured either continuously or in comparatively large numbers, the inspection of the parts, while in the process of manufacture, as to workmanship and fit and to insure the proper functioning of all parts affected, is all that is desirable. This will not insure interchangeability, and if a part is worn out, the new part must be made to fit, which may necessitate the shipment of the casting or material to the machine to be fitted on the spot.

There is an intermediate step between complete interchangeability and the fitting basis of manufacture. This step is that of predetermining from practice or logic what part or parts are most likely to wear and then making these parts interchangeable. This practice will permit these pieces to be carried as extra parts and assemhled without fitting. If this intermediate step seems to be the proper method, the question arises as to the extent to which it is advisable to go into the gaging problem. For instance, should the inspectors be furnished simply with standard measuring instruments (wherever such are applicable), pin gages, standard commercial plug gages and thread gages (so as to require the design of gages for only those parts for which a commercial gage is not obtainable), or should rings and plugs and special gages be designed as well? All these conditions should be definitely settled before a machine is ordered to be "gaged up."

Each gage should be marked by the manufacturer with the following: (1) The name of the part to be gaged; (2) the prescribed maximum or minimum gaging dimensions with the words "Go" and "Not Go," as the case may be; (3) if a left-hand thread gage, the word "left"; (4) the name of the manufacturer or his initials; and (5) a serial number assigned to the gage. The standard temperature for all gages should be 68 degrees F.

* * *

FOREIGN SCHOLARSHIPS FOR AMERICAN STUDENTS

The American-Scandinavian Foundation, from its headquarters in New York City, has announced the establishment of ten new scholarships, beginning with the academic year 1919-1920, for young American scientific students to complete their general study and research in Sweden, in the universities and technological schools there and under the direction of scientific specialists in industry. This scheme of scholarships is in keeping with the avowed purpose of the foundation "to draw the American and Scandinavian peoples closer in bonds of intellectual kinship," and was initiated by Axel Robert Nordvall, Swedish commissioner to the United States, and Dr. Henry Goddard Leach, secretary of the foundation. The funds necessary to maintain the scholarships have been pledged by Americans who desire to promote the interchange of scientific and technical knowledge between the two countries and wish Sweden to understand American ideals better. Similarly, funds are being raised in Sweden to send ten Swedish students to the United States for scientific and engineering studies. Each scholarship will provide $1000 for one year's study. The definition of subjects is not strictly limited, but the scholarships will be proportioned among those studies in which Swedish science offers unusual advantages,—physics and chemistry, hydro-electrical engineering and metallurgy.

The Machine Tool Trade

MOST of the machine tool manufacturers are very busy, dealers in various parts of the country reporting that they have great difficulty in securing early deliveries of many classes of machines, mentioning especially automatic screw machines, grinding machines, milling machines, shapers and presses. One of the largest machine tool companies in the country is sold out so far ahead that quotations are not made on delivery for stock orders.

Machine dealers state that they are obtaining a satisfactory volume of business from the automobile industry, although but one of the large automobile companies has placed any very big orders. One of the large automobile concerns has obtained a great deal of equipment through the purchase of government-owned machine tools. Considerable agitation is reported among labor, in some states agitators being very active, but it is believed that the more mature and conservative among the men in the shops will be able to counteract these influences. Men familiar with the conditions look for small strikes here and there, but do not expect any general or widespread labor trouble.

There is a great deal of development work still going on in the machine tool industry, machines with new features and labor-saving devices constantly being brought out. Several radical departures in designs have been made, some of which have already been described in mechanical journals, while others are not yet made public. Some of the new designs appear to be great innovations and will aid in advancing the machine tool development to a marked degree.

Foreign Trade in Machine Tools

The accompanying table shows the value of exports of metal-working machinery from the United States to foreign countries during the month of July, as published by the Department of Commerce. As will be seen, the total value of the machine tools exported amounted to about $2,380,000. England, as usual, was the biggest customer, taking nearly $1,000,000 worth of machine tools. France and Belgium were the two next best customers, France buying more than $500,000 worth and Belgium nearly $275,000 worth. Of metal-working machinery other than machine tools, France was the largest customer, England took the second place, and Belgium the third, with, respectively, about $600,000, $500,000 and $300,000 worth of machinery.

EXPORTS OF METAL-WORKING MACHINERY FROM THE UNITED STATES, JULY, 1919

Countries	Lathes	Sharpening and Grinding Machines	Other Machine Tools	All Other Metal-working Machinery
	Dollars	Dollars	Dollars	Dollars
Azores and Madeira Islands	.....	290	.....	.....
Belgium	174,435	43,278	53,284	287,041
Denmark	5,934	9,931	18,136	36,403
Finland	.....	.....	591	.....
France	107,663	174,644	235,944	612,235
Greece	333	.....	1,556	75
Italy	8,136	8,601	29,250	68,577
Netherlands	11,157	3,900	7,051	21,840
Norway	7,412	1,078	12,781	11,338
Portugal	108	110	.....	805
Russia in Europe	.....	.....	436	.....
England	335,890	100,334	558,795	481,179
Scotland	.....	.....	17,068	791
Ireland	.....	.....	1,875	.....
British Honduras	.....	.....	.....	65
Canada	27,225	17,485	50,285	86,741
Costa Rica	.....	223	.....	675
Honduras	954	.....	.....	.....
Nicaragua	.....	136	91	45
Panama	.....	.....	360	1,192
Salvador	.....	.....	18	.....
Mexico	.....	1,329	4,382	600
Newfoundland and Labrador	.....	.....	9	870
Barbados	.....	.....	108	.....
Jamaica	.....	.....	72	78
Trinidad and Tobago	358	21	.....	.....
Cuba	2,585	1,166	10,880	7,355
Haiti	.....	.....	.....	4,330
Dominican Republic	.....	.....	30	.....
Argentina	22,636	237	2,168	18,273
Bolivia	.....	.....	.....	7,805
Brazil	25,757	2,004	5,193	11,554
Chile	736	4,131	7,611	91,160
Colombia	50	233	145	96
Ecuador	.....	.....	602	183
British Guiana	200	.....	872	.....
Paraguay	.....	.....	.....	1,070
Peru	225	9,182	1,544	1,891
Uruguay	.....	.....	651	12,684
Venezuela	.....	.....	126	.....
China	555	3,046	2,007	4,777
British India	1,721	240	1,200	33,156
Straits Settlements	.....	.....	205	402
Other British East Indies	.....	666	.....	19
Spain	22,383	5,737	15,206	66,510
Sweden	19,208	29,341	10,402	66,376
Switzerland	2,343	585	405	24,441
Dutch East Indies	23,167	4,669	8,156	6,489
French East Indies	.....	.....	.....	2,912
Hongkong	.....	125	.....	.....
Japan	6,318	13,412	16,348	50,359
Russia in Asia	.....	.....	1,510	.....
Siam	.....	67	.....	.....
Australia	131	9,481	3,573	12,105
New Zealand	3,849	4,775	2,188	2,786
Philippine Islands	18,155	2,017	2,173	13,495
British South Africa	5,079	1,023	4,362	5,923
British East Africa	.....	.....	29	.....
French Africa	5,783	48	46	.....
Portuguese Africa	.....	.....	658	.....
Total	840,191	453,545	1,090,382	2,056,701 Machinery

The National Foreign Trade Council has called the attention of American exporters to the fact that correspondence from abroad indicates a difference of interpretation of the term "F.O.B. port." Foreign correspondents claim that American manufacturers and exporters misuse this term. The complaint is that American manufacturers who have quoted "F.O.B. New York" have interpreted that quotation to include merely delivery within the limits of the port of New York and not necessarily actual delivery on board the overseas vessel. The foreign contention is that the term "F.O.B. port" has only one meaning, namely, "free on board overseas vessel," at the port stated, and that a quotation "F.O.B. port" means that the purchaser has no charges to meet except those connected with ocean freight and insurance. It is evident that it would have an adverse effect upon American foreign trade if, after the American manufacturer quotes a price "F.O.B. New York," or other port, the customer still would have to pay charges for cartage, lighterage, storage, and other items which the foreign customer has understood to be included in the "F.O.B. port" quotation.

The secretary of the National Foreign Trade Council states that there is no question that the original meaning of "F.O.B. port" was "free on board ship," and that this is the general and usual interpretation among foreign buyers. It is furthermore pointed out that it is the best practice for American exporters and manufacturers to have their quotations mean "free on board overseas vessels," but in any event the quotation, whatever it is, should be unmistakably clear and explicit.

Machines for Trade Schools

On September 5, the House of Representatives passed the Caldwell bill authorizing the selling of the surplus machine tools in the government's possession to the trade, technical, and engineering schools of the country. Under this bill the secretary of war is authorized to sell at 10 per cent of their cost such surplus machine tools, now owned by the United States Government and under the control of the War Department, as are suitable for the technical and engineering schools, upon the application of these schools in writing. It is provided in the bill that if any such machines are later offered for sale by the educational institution to which they have been sold, without the consent in writing of the Secretary of War, then the title of the machines will revert to the Government.

Resumption of Trade with Hungary

The War Trade Board section of the Department of State announces that the resumption of trade and communication between the United States and Hungary has been authorized. Exports from the United States to Hungary will be controlled by individual export licenses, but such licenses will be issued freely upon application, except with respect to a number of commodities, the exportation of which will be restricted for military reasons. Imports into the United States from Hungary may be made under a general import license which permits importation without individual import license of all commodities except those specifically enumerated in paragraphs 1, 2, and 4 of the War Trade Board ruling No. 825, which may be obtained upon application to the Department of State, War Trade Board section, Washington, D. C.

Permanent Machine Exposition in New York

The opening of the permanent machine exhibition, known as the International Machine Exposition, in the Grand Central Palace, New York City, is set for October 15. The exposition will include exhibits of manufacturers and sales agencies of engine lathes, milling machines, planers, drilling machines, hand and power presses, bolt cutters, boring and turning mills, gear shapers, turret lathes, grinding machines, welding machines, automatic machines of various types, etc. Many of these machines will be shown in operation.

* * *

AMERICAN MALLEABLE CASTINGS ASSOCIATION

The American Malleable Castings Association, 1900 Euclid Bldg., Cleveland, Ohio, is endeavoring to establish standards of quality for the product of the members of the association. It has recently been announced that, in addition to the various laboratories maintained by the members of the association, a research laboratory is also maintained by the association as a whole, at Albany, N. Y., for investigation and experiment, and for the testing and analysis of the daily output of each member of the association. In this laboratory, partial tests are made, and the results, together with directions for improvement, where the need is indicated, are forwarded to the respective members. The work so far done has proved very successful in bringing up the product of the various members of the association to a high average quality. Having accomplished this result, the association is now continuing these daily tests and analyses for the purpose of grading the product of each member.

When a member's product has daily met the requirements of the prescribed standard for a period of three months, a "certificate of quality" is issued to that member, who may then designate his output as "certified malleable castings." These certificates are renewed quarterly when the quality required is maintained. A booklet published by the association on malleable iron and its production, gives some interesting information relating to the methods employed in the improvement of malleable iron castings. This booklet is distributed without charge by the association.

* * *

SOCIETY OF MECHANICAL INSPECTORS TO CONFER HONORARY MEMBERSHIP ON C. E. JOHANSSON

At a meeting to be held in the Engineering Societies' Building, Thursday evening, October 23, at 8 P. M., honorary membership will be conferred by the American Society of Mechanical Inspectors upon C. E. Johansson, the well-known originator of the gage standards, or blocks, identified with his name. As mentioned in the September number of MACHINERY, Mr. Johansson is in the United States for a few months in connection with some new devices and measuring instruments which he is introducing in the American market, and also to supervise the installation of his methods in the new American factory which will be operated by C. E. Johansson, Inc., at Poughkeepsie, N. Y.

POSTAL ZONE LAW A MENACE TO THE NATION

By Congressman FRANK W. MONDELL, of Montana, Floor Leader of the Majority Party in Congress

I am opposed to the zone system for the dissemination of news, ideas, and information because I am of the opinion that the establishment and maintenance of such a policy would, in the long run, have a most unfortunate, harmful and regrettable effect upon the American people.

Those whose views or arguments for the zone system are based primarily or largely on its effect, or alleged effect, on postal revenues, or the profits of the publishing business, fail utterly to grasp or realize the larger and infinitely more important aspects of postal systems as they affect the national life. If it be a fact that the flat postal rate on newspapers and magazines has been unduly low, that is a matter for consideration by the Post Office Committee, having in view the traditional policy of the American people. The fact that some people have been able to make a considerable amount of money in the newspaper and magazine business is, of course, one of the matters that a committee would consider in this connection, but it is by no means conclusive that a policy is wrong because some people have been able to make money under it—many having the same opportunities and privileges failed utterly.

The demand for the establishment and maintenance of a zone system is particularly lame and illogical when it is made by those who are urging a flat rate of one cent on letters. Such people to be logical should insist upon a zone rate for letters as well as papers and periodicals. Neither is the argument for a zone system strengthened by exaggerated statements of losses to the postal revenues under a flat rate. Undoubtedly the former flat rate did not wholly reimburse the postal revenues, but the most superficial examination of the matter renders ridiculous exaggerated statements of alleged losses. To the argument that publications enjoying the second-class rates are devoted more or less to advertisement, I offer the suggestion that a national dissemination of attractive advertisements is not without its educational benefits.

I have neither urged nor considered this as a party question. I urged this repeal before the previous Democratic Congress, as I shall before the present Republican Congress—not on party or partisan grounds, but on the broad platform that such a policy tends to circumscribe and provincialize our national life.

* * *

JAMES WATT CENTENNIAL COMMEMORATION

A Centenary Commemoration of James Watt, who died in 1819, was held in Birmingham, England, September 16, 17, and 18. Memorial services were held, and lectures were given dealing with the history and development of the application of science to industry, with particular application to steam engines. Visits were also made to the Soho Foundry, where some of the original buildings erected by Boulton and Watt are still to be seen, as well as to Ocker Hill, six miles from Birmingham, where an engine erected by Watt in 1776 is still in existence. This engine was regularly working until 1892, and was re-erected in its present position in 1898. The engine was working under steam during the commemoration exercises. Another engine built by Boulton and Watt is still located in the building in which it was erected, at Bordesley, about a mile from the center of Birmingham. This engine was also viewed by the visitors. It is proposed to commemorate the centenary by endowing a professorship of engineering, to be known as the James Watt Chair, at the University of Birmingham, and also to erect a James Watt Memorial Building, to serve as a museum for the remains of the work of James Watt and his contemporaries, Boulton and Murdoch. This building would also serve as a meeting place and library for scientific and technical societies in Birmingham.

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW AMERICAN METAL-WORKING MACHINERY

The New Tool Descriptions in MACHINERY are restricted to the special field the journal covers—machine tools and accessories and other machine shop equipment. The editorial policy is to describe the machine or accessory so as to give the technical reader a definite idea of the design, construction, and function of the machine, of the mechanical principles involved, and of its application.

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LeBlond Multi-Cut Lathe

THE R. K. LeBlond Machine Tool Co., Cincinnati, Ohio, is now building a "multi-cut" semi-automatic lathe on which one or more facing and turning operations can be performed simultaneously, one operator running several machines. It can be supplied with a variety of drives and equipment, adapting it for use in any industry having duplicate work of this character to perform. The work may be held on centers, arbors, or expansion or closer chucks of either the pneumatic or hand-operated type. On work that has been previously bored, reamed, and rough-turned on the turret lathe or automatic, and has to be finish-turned and faced, the multi-cut lathe finds its legitimate field. Gear blanks, cone pulleys, bevel gear blanks, pistons, steering knuckles, camshafts, transmission shafts, electric starter details, etc., are typical examples of work that may be rapidly machined.

As signified by the name "multi-cut," a number of tools are in operation at once, but these tools are all of the lathe tool type, and they are simple and inexpensive. For this reason comparatively small lots of work may be profitably run. The machine is easily and quickly set up. It is not a lazy man's lathe, but the mental and physical effort that is required to obtain a predetermined rate of production is reduced to an absolute minimum. The multi-cut is essentially a lathe. It partakes of all the characteristics of a lathe and uses lathe tools of the simplest type. It fits into a lathe department without disturbing present standards of equipment or schedules.

The multi-cut lathe is producing most efficiently when one attendant is operating two machines. The automatic operation of the turning and facing slides, and automatic trips at the end of their travel make this readily possible, the operator loading extra arbors or mandrels while the cut is in progress. Turning and facing cuts are completed simultaneously, the two sides being so timed as to finish their respective cuts together. Various combinations of relative movement between the turning and facing slides may be obtained, a simple system of change-gears, reading direct from the work diagram, controling this relationship. Due to the simple set-up and the inexpensive forms of tools that are used, small lots of work can be profitably run.

The term "multi-cut" is applied to this new LeBlond semi-automatic lathe, owing to the fact that a number of tools are in operation simultaneously. This machine affords a convenient means for the performance of turning and facing operations, and it is possible for one operator to run several machines, so that the labor cost per piece can be held within very satisfactory limits. Two sizes of machines are built, which are designated as Nos. 6 and 9. The smaller size swings 6 inches and has a capacity for holding work up to 10 inches in length between centers, while the larger size swings 9 inches and will take work up to 16 inches in length between centers. Three different styles of headstocks are built for the No. 6 machine, and four different heads are made for the No. 9 machine. Either of these heads may be supplied according to the special requirements of the user.

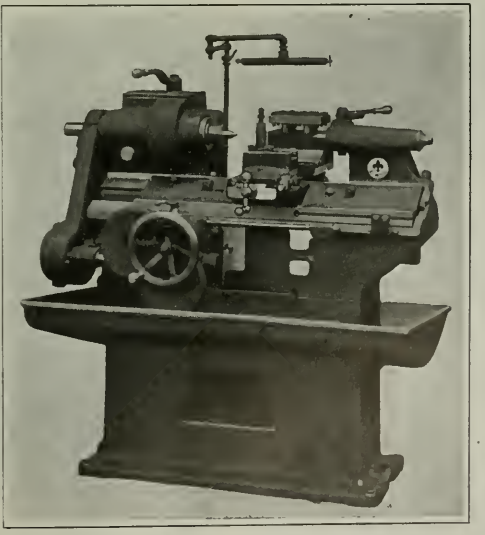


Fig. 1. LeBlond No. 6 Multi-cut Lathe equipped with a Style C Adjustable-speed Geared Headstock, Plain Facing Attachment, Quick-acting Tailstock, and Plain Turning Slide

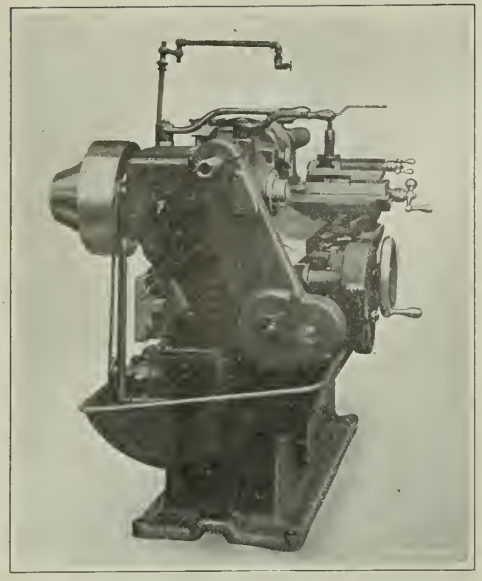


Fig. 2. Head-end View of Multi-cut Lathe with Right-angle Drive, showing Pump Drive and Draw-off Valve for Reservoir in Headstock

Selective Equipment

The multi-cut lathe is built in two sizes, namely, a No. 6 with a swing of 6 inches and 10 inches capacity between centers; and a No. 9 with a swing of 9 inches and 16 inches capacity between centers. The No. 6 size is built with three types of headstocks known as Styles A, C, and D; and the No. 9 with four types of headstocks, namely, A, B, C, and D. Either size can be furnished with a screw or quick-lever-acting tailstock, plain or universal angular facing attachment, taper attachment, compound rest, draw-in or closer chuck and collets. The No. 6 machine shown in Fig. 1 has a Style C head, and Styles A, B, and D heads are shown in Fig. 7. Owing to the varied class of industries to which the multi-cut lathe is adapted, this equipment is made selective, enabling the consignee to readily select the combinations best suited to his requirements.

Features of the Different Styles of Headstocks

The Style A headstock is a single-speed, plain back-geared headstock with self-oiling bronze bushings, ball-thrust bearing spindle, and double helical or herringbone back-gears. The spindle bearings are renewable bronze boxes, babbitt lined. A friction countershaft with an automatically operating brake is supplied as a regular equipment. This headstock is best adapted to work on cast-iron or steel parts, requiring fairly heavy reductions and no speed changes, for duplicate work in quantities and where the machines are placed in parallel lines in a regular lathe department and driven from a countershaft. The countershaft is provided with a split pulley to facilitate making speed changes when required.

The Style B headstock is a six-speed selective-geared, right-angle driven equipment. Three instantaneous changes are obtained with one lever, and a shifter knob compounds these changes through a back-gear to give six speeds. The gears are of 3½ per cent nickel-chrome steel, heat-treated and hardened. The headstock is oil-tight, and the gears and friction clutches run in a bath of oil. The spindle bearings and driving clutch are also continuously flooded with oil from this same supply. The main friction clutch is mounted in the driving pulley, where it is operating at a constant high rate of speed and subject to little strain. It is of the multiple-disk type, running in oil, with a brake operating from the clutch handle. The driving pulley shaft is located at 90 degrees to the spindle to permit of a more compact grouping of the machines. The spindle is fitted with tapered bronze boxes which are babbitt lined and provided with convenient means of adjustment for wear. The thrust is taken against ball-thrust bearings.

The Style C headstock is a fixed-speed head, applicable for quantity duplicate production. The speed may be adjusted to suit conditions by means of change-gears regularly furnished to provide three changes. A four to one back-gear is incorporated in the drive, the changes being made by simple slip-gears in the end of the head. The driving clutch, brake, spindle bearings, etc., are identical with the Style B head, and the same system of flooded lubrication for gears, bearing, and clutch is also employed. The head is provided with a right-angle drive and is intended to be driven direct from the lineshaft. When this is not feasible, a jack-shaft can be supplied at an extra cost.

The Style D headstock is a single-speed, open-belt head, provided with a lever-operated, friction starting and stopping mechanism and brake. The driving pulley is excessively large, and it is accurately balanced, permitting the application of speeds to 1000 revolutions per minute and adapting this headstock to working on brass, bronze, aluminum, and free cutting steels of medium diameters, on which very high cutting speeds may be maintained. The friction clutch is mounted in the periphery of the driving pulley and it is of the double finger wedge acting type, being adjustable for tension, and accurately balanced against all rotative forces. A brake is mounted on the spindle, bringing it to an instant stop when the clutch is released, a spring tension being provided in order to prevent accidental starting. The spindle bearings are made of bronze, babbitt lined and provided with sight-feed oilers; and the thrust is absorbed against ball-thrust bearings. This head is intended to be driven from the lineshaft, but a jack-shaft with a split pulley can be supplied if it is required.

Taper Attachment

The taper attachment consists of a rigid bracket bolted to the bed, which carries an adjustable taper guide bar and a

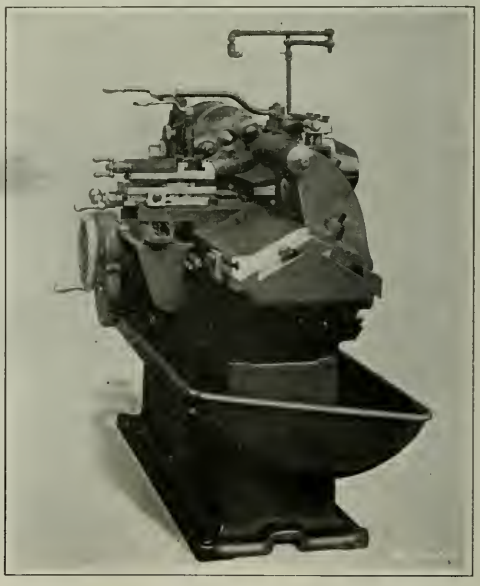


Fig. 3. Tail-end View of Multi-cut Lathe showing Taper Attachment, Right-angle Drive, and Equalizing Type of Faceplate

sliding shoe engaging the guide bar. This sliding shoe is attached to the cross-slide imparting to it an "in" or "out" movement with relation to the angular setting of the guide bar. The guide bar may be set from straight up to 4½ inches of taper per foot, on either side of center, and it is clamped in the selected position by two T-slot bolts. The taper guide bar and sliding shoe may be replaced by a form plate and roller for the automatic duplication of irregular shapes.

Plain and Universal Facing Attachments

The plain facing attachment faces diameters up to the full swing of the lathe, at right angles to the turning center. The feed of the facing slide is obtained entirely by the relative movements of flat and dovetailed slides which are accurately gibbed and made adjustable to compensate for wear. The facing rest is fed toward the center of the lathe on a broad square-lock slide, to which it is properly gibbed, and the cross-facing slide is movable along the bed and rigidly clamped to the shears in any desired position. The facing bar slide carries the swivel guide bar which is fed along the bed at varying rates of speed.

A sliding shoe carried on the facing attachment slide engages the swivel guide bar which may be set at any angle within its range, imparting a vertical motion to the shoe, which is transmitted through a rack and hardened pinion to the cross-slide. By changing the angularity of the swivel guide bar, the feed of the cross-slide is varied or timed to complete its work at the same time as the turning slide, or it may be accelerated to finish ahead of the turning slide to permit of overlapping on forming and turning tools, or vice versa. The feeds to both the turning and facing slides are tripped by the same clutch and will duplicate dimensions within close limits of accuracy. The standard tool-block furnished on these machines, is arranged for multiple tools which can be held parallel or at any angle, by reason of the spacing of the binder screws. The tool-block is adjustable to the center of the lathe and firmly clamped in position by two heavy bolts.

As its name indicates, the universal facing attachment is adapted for angular facing operations on bevel bear blanks and similar shaped pieces. When the facing attachment is used in connection with a taper turning attachment, the back and face angles of a bevel gear blank can be turned simultaneously.

The swivel block is accurately graduated to facilitate angular settings and clamped firmly in the selected position by two heavy T-slot bolts in a circular T-slot. The feed is through a pair of hardened generated miter gears to the feed-rack. Aside from this swivel feature, the universal attachment and tool-blocks are identical with the plain attachment.

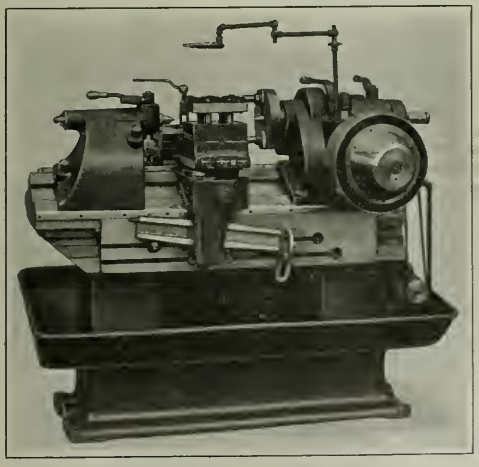


Fig. 4. Rear View of No. 9 Multi-cut Lathe showing Right-angle Drive, Universal Facing Attachment, and Quick-acting Tailstock. This Illustration shows how the Feed to the Facing Attachment is transmitted through Flat and Dovetailed Slides, the Taper Guide Bar being set at Different Angles to vary the Feed of the Facing Attachment with Relation to the Traval of the Turning Slide

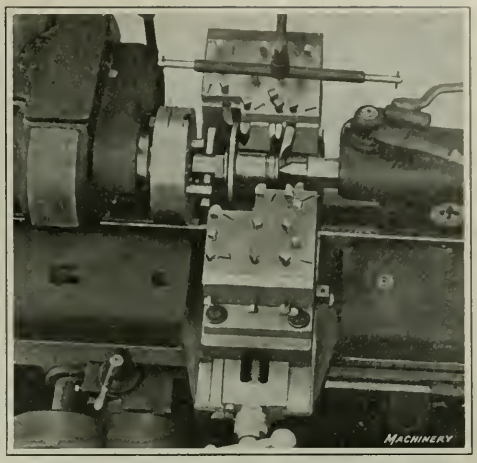


Fig. 5. Tooling of No. 9 Multi-cut Lathe for simultaneously turning and facing an Automobile Wheel Hub. Nine Cutting Tools are working simultaneously on this Job

Feed for the Turning and Facing Slides

Variations in feed for the turning and facing slides are obtained by loose change-gears applied to the feed bracket and worm box. These feeds read to 0.001 inch per revolution of spindle, and a simple direct-reading work diagram is sent with each machine to show the available change-gear combinations and the resulting feeds. The feeds of the front slide are fixed by the change-gears that are used, while the feeds of the facing slide may be further varied with relation to the feed of the turning slide by the angularity given the swivel guide bar, resulting in a practically unlimited combination of feed relations. When the machine is performing forming operations or making heavy reductions with the facing slide, it is sometimes desirable to accelerate or decelerate the rate of feed as the tool approaches the center, and this is done by replacing the swivel guide bar with a former bar and roller that are designed to suit the specific job being done.

The feed worm and wheel are mounted on fixed centers and encased in an oil-tight gear-box bolted to the bed. The feeds are tripped by a sensitive jaw clutch engaging a similar clutch mounted on the worm-wheel. The feed drive is then through changeable gears and a pinion and bull wheel to the rack on the carriage. The drive to the facing slide is transmitted by similar change-gears through the bed to the feed-rack on the facing attachment slide, on which the swivel guide bar is mounted. The feed-rack for both the carriage and facing attachment is placed in the center of the slides, imparting a smooth unrestricted feed, without any binding action. The handwheel at the front of the worm box furnishes a means of quickly returning the turning and facing slides to the starting position after the completion of each cut. The worm-wheel and clutch are running continuously in oil, and the thrust of the worm is taken against ball-thrust bearings. All of the gears that are subject to the greatest strains are made of nickel steel, heat-treated and hardened.

Features of the Bed and Carriage Design

The bed is of a special anvil section, with broad slides for the carriage and bearings for the headstock and tailstock, so disposed that the pressure resulting from the cut

tends to force the slides more firmly to a bearing. The slides are provided with narrow dovetailed guiding shears, which are taper gibbed to prevent any tendency of lifting from the bearing. The bed is provided with internal ribs and mounted on a cabinet base, in which the pan and chamber for cutting compound are cast. The pan becomes an integral part of the bed, and greatly stiffens the entire machine. The pan is provided with a strainer that separates the chips from the cutting compound, which flows back to the base of the machine. A geared rotary pump and piping for circulating the compound are supplied as regular equipment. A cover plate is provided for cleaning out the base.

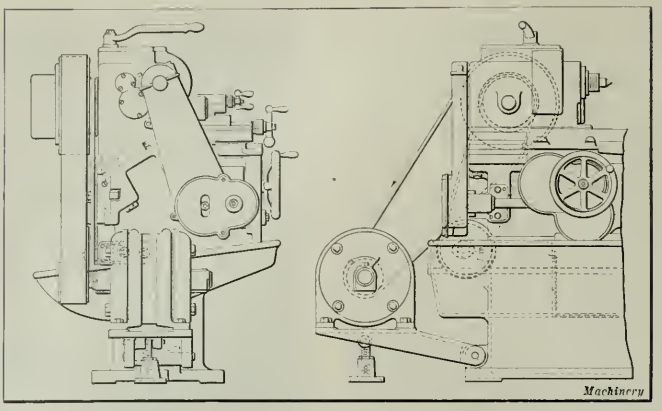


Fig. 6. Arrangement of Individual Electric Motor Drive on the LeBlond Multi-cut Lathe

The carriage has a broad slide extending practically the full length of the bed and it is scraped to a bearing for its entire length. It is provided with double tapered gibs with fine thread adjustment. The cross-slide for mounting the compound or the plain rest is cast integral with the carriage. The fact that the headstock and tailstock are located and carried by the rear shear permits the carriage to travel past them and keep the slides continuously covered. The long carriage bearing is one of the largest contributing factors to the general rigidity of the multi-cut lathe, permitting the use of gang tools, forming slides, etc., without any tendency for the carriage to climb or bind on the shears. The feed-rack is set exactly in the center of the carriage slide, resulting in a smooth and unrestricted feed.

Special Tool Equipment and Drivers

The R. K. LeBlond Machine Tool Co. is prepared to offer engineering service for the lay-out and recommendation of tool equipment, methods of chucking, etc. They will supply time estimates, design and build tools for a guaranteed output, and furnish demonstrators. The spindles on all multi-cut lathes are regularly extended for the application of air chucks, special expansion mandrels, closer chucks, etc.

Draw-in Attachmentfand Collets

A lever-operating draw-in attachment, closer, and full set of collets is supplied when required. These collets are made in sets and furnished as follows: For the No. 6 multi-cut lathe, 11 collets of ¼-, 5/16-, ⅜-, 7/16-, ½-, 9/16-, ⅝-, 11/16-, ¾-, 13/16-, and ⅞-inch capacity. For the No. 9 multi-cut lathe, 13 collets of ¼-, 5/16-, ⅜-, 7/16-, ½-, 9/16-, ⅝-, 11/16-, 3/4-, 13/16-, 7/8-, 15/16-, and 1-inch capacity.

Plain and Compound Rests

A plain block rest mounted on the cross-slide is regularly furnished, equipped with a single-screw type toolpost and an adjustable positive cross-stop. A substantial compound rest can be supplied when conditions require it. The swivel is of large diameter and graduated in degrees for angular turning or taper boring. Adjustable taper gibs are provided to compensate for wear on the slides. The T-slot bolts are large in diameter and are placed in a circular T-slot, enabling the top and swivel slides to be firmly clamped after setting.

Lever-operated Quick-acting Tailstock

A quick lever-acting tailstock is provided to permit of the quick removal and replacing of work with a single movement of the operating handle. The center is brought into contact with the work at any desired pressure by a conveniently placed lever, and further movement of the same lever locks the tailstock barrel and clamps the spindle.

Individual Electric Motor Drive

Either the Style B or C headstocks may be motor driven, as shown in Fig. 6. The motor is attached to a motor plate hinged from the cabinet base of the machine and provided with an adjustable jack for maintaining the desired belt tension. A constant-speed alternating- or direct-current motor, running preferably at 1200 revclutions per minute is recommended. It should develop 3 horsepower for the No. 6 multi-cut lathe and 5 horsepower for the No. 9 machine.

JOHANSSON ANGLE GAGES AND MEASURING TOOLS

A set of angle gages and a number of other measuring tools and devices have recently been brought out by C. E. Johansson, Inc., 245 W. 55th St., New York City. The angle gages, made in a set of eighty-five blocks, as shown in Fig. 1, are similar to the well-known Johansson standard measuring blocks in that they are made in sets and that the angles required are obtained by combinations of blocks. In this case, however, any combination for which the angle-blocks are intended is obtained by the combination of two blocks only. In the case of smaller angles, each block is provided with four different angles, one at each corner; but in the

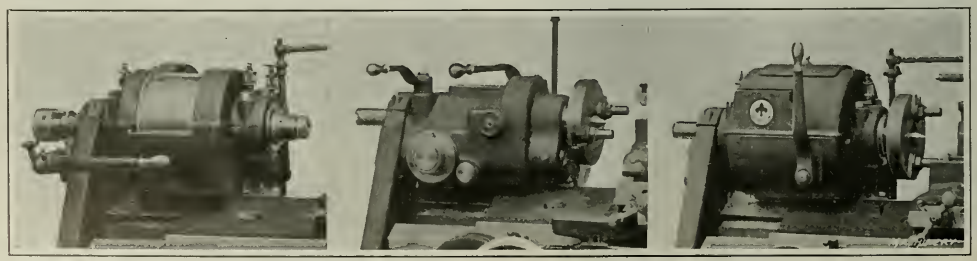


Fig. 7. Style A Single-speed Headstock with Single Driving Pulley and Plain Back-gears, and a Lever-operated Draw-in Collet Chuck; Style B Selective-speed Heads.ock with a Multi-disk Clutch and Equalizing Faceplate Drive; and Style D Single-speed Open-belt Headstock with a Lever-operated Friction Starting and Stopping Mechanism and Brake



Fig. 1. Set of Angle Gages by Means of which Combination Gages may be obtained for Every Minute up to 180 degrees



Fig. 2. Set of Gage-blocks in which Consecutive Blocks differ One-millionth Inch in Size from each other

case of larger angles, each block has but two angular measurements, one at each end. The set is so arranged that by the use of the eighty-five blocks it is possible to obtain, by minutes, every angle from 0 degree to 180 degrees; in other words, by these eighty-five blocks, it is possible to make, by combinations of two blocks, 10,800 angle gages.

The object of such a set is to save the making of a great number of individual angle gages in shops where angular measurements by means of gages need to be made, either at the bench or in the inspection department. It is stated that in the making of these gages the same care to insure accuracy is taken as in the making of the standard Johansson blocks. As seen in the illustration, a holder is provided, similar to the holder used for the standard gage-blocks, in which the gages may be assembled in order to obtain the required angle.

Fig. 2 shows a set of eleven blocks similar to the standard Johansson gage-blocks, except that, in this case, the accuracy is far greater than that required in the regular commercial blocks. In this case, each block differs from the next succeeding one by one-millionth of an inch, and it is stated that each block is accurate within plus or minus one-ten-millionth of an inch. This gage set is not intended for commercial use, because it is recognized that there is at present no commercial need for so accurate a set of gage-blocks. It is intended for scientific use where extremely accurate measurements or comparisons are to be made. Possibly in the future, even commercial manufacture will require standards of greater accuracy than those provided by the present standard gage-blocks, but, as yet, there seems to be no demand for commercial purposes for blocks of such extreme accuracy. As a scientific instrument, however, this gage set is of great interest.

Fig. 5 shows a combination micrometer consisting of two arms, a micrometer head, a holder of the standard type used for the Johansson measuring blocks, and a number of standard length blocks by means of which the range of the micrometer may be varied according to the requirements. The micrometer head is permanently assembled in one arm. This micrometer is made with three holders having capacities, respectively, up to 4, 8, and 12 inches; but the 4-inch micrometer may be made into a 1-, 2-, 3-, or 4-inch micrometer, according to whether one or more blocks of standard size are used in the holder between the two arms; the 8- and 12-inch sizes may be similarly modified. The object of this combination micrometer is to provide a means whereby any diameter or length may be measured with but one micrometer head, by substituting different gage-blocks between the arms, according to the size of the work to be measured. Another advantage claimed is that the arms are adjustable with regard to the holder, and the micrometer head may be extended out from the holder as shown in the illustration, or may be moved quite close to the holder, according to the character of the work to be measured. It is evident that for work that permits the head to be moved quite close to the holder, a very rigid tool will result; but even when the

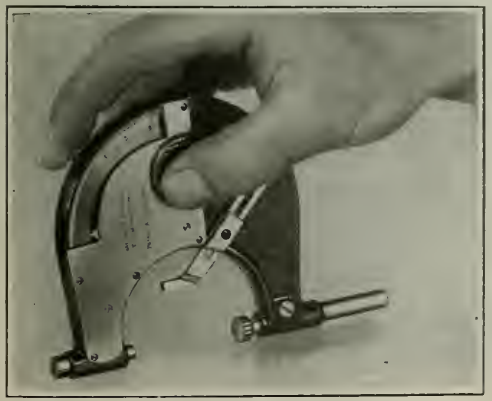


Fig. 3. Tolerance Indicator

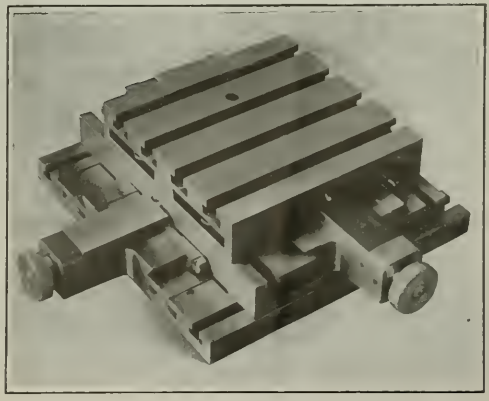


Fig. 4. Compound Slide for Accurate Spacing of Holes

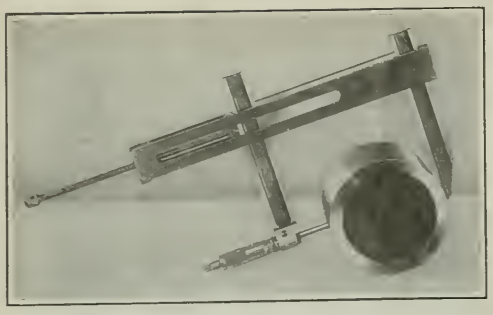


Fig. 5. Combination Micrometer

head extends quite a distance from the holder, as shown in the illustration, the rigidity of the straight arms is very great, and by making the arms of heavy section, as indicated, any tendency to spring may be obviated to a greater degree, it is claimed, than with micrometers with a bent frame.

Fig. 3 shows an instrument known as a "tolerance indicator" which presents several novel features. The object of the instrument is to indicate whether work measured is between certain predetermined limits. The anvil to the right is adjustable and set to suit the work to be measured. The anvil to the left is movable and connected with the indicating pointer. The sliding part at the top of the semicircular opening in the tool is adjustable to the diameter of the work, and acts as a stop, so that when the work is measured, the gage will be pushed over the work to just the correct point. The particularly novel feature of the instrument is that the pointer will become locked at whatever position to which it is moved by the movement of the movable left-hand anvil. It will remain locked in this position until the small knob at the outside of the frame or casing is depressed by the end of the finger, as shown, when it will snap back to the zero position. By this locking arrangement, it is possible to retain the reading of the instrument after the instrument has been removed from the work being measured; hence, work can be measured in dark or inaccessible places, and the instrument removed to a light place and the reading taken. The scale reads to 0.0001 inch. The tolerance indicator is provided with holders for the finger grip similar to those used on the regular Johansson limit gages, thereby insulating the heat of the hand from the instrument.

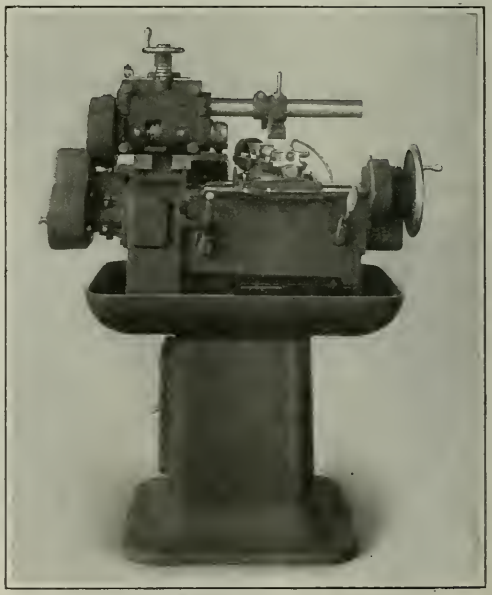
Fig. 4 shows a compound slide intended for the drilling or boring of accurately located holes. As shown, it consists of two slides actuated at right angles to each other. These slides may be set by the use of standard gage-blocks, as indicated, and in that way their position relative to each other may be very accurately determined. Then if a hole is bored or drilled in the position determined by the gage-blocks, another hole may be bored or drilled very accurately, with relation to the first hole, by simply changing the gage-blocks as required, so as to move the slides a definite amount in two directions to the location for the next hole. This slide may be mounted on any machine table, and should prove especially useful in the making of drill jigs or similar work, as well as in the drilling of holes accurately located without the use of jigs, as, for example, when only one or a few pieces of the same kind are being made of work which requires accurately spaced holes.

BARBER-COLMAN NO. 2 GEAR-HOBBING MACHINE

A small hobbing machine which is designated as a No. 2 size, has recently been added to the line of machinery built by the Barber-Colman Co., Rockford, Ill. The bed and upright of this machine are of heavy box section and are made as an integral casting. A box section design is also used for the sub-base, which contains a large oil reservoir for supplying oil or cutting compound to the hob and work. It will be seen that the machine has a horizontal work-slide, and there is provision for allowing shafts to project through the spindle. The work can be conveniently handled and clamped close to the spindle bearing. The spindle is machined from a crucible steel forging and accurately finished to size by grinding. A conical bearing supports the spindle at the front end, while the rear bearing is straight. Both of these bearings run in long bronze bushings, with provision for taking up wear by means of a hardened and ground steel thrust washer at the front and a pair of ground locknuts at the back of the tapered bushing. The hole through the spindle is 29/32 inch in diameter, this hole being enlarged to a No. 9 B. & S. taper at the front end to receive the special work-holding arbors which are securely held in position by means of a draw-in bolt.

The work-spindle slide is accurately adjusted to position by means of an elevating screw provided with a micrometer dial reading to 0.001 inch. Gear blanks that are to be hobbed on this machine are usually held on an arbor fitting in the No. 9 B. & S. taper socket of the work-spindle and rigidly supported at the outer end by means of an overhanging bracket. An overhanging steel arm carries the bracket which is provided with a quick-acting clamp handle, so that it can be quickly released and swung out of the way when the work-holding arbor is being loaded. A dowel-pin in this bracket, which fits into a locator attached to the overhanging arm, provides means of relocating it in exact alignment with the work-spindle after the work has been set up. Indexing of the work-spindle is accomplished by a hardened and ground worm and bronze worm-wheel. The case containing this index mechanism is attached to the work-slide and is completely enclosed to provide a continuous bath of oil.

To obtain the desired physical properties for the hob spindle, this member is machined from steel, after which it is hardened and finally finished to size by grinding. This spindle has a conical front bearing, supported by a bronze box, with means of compensation for wear; and both of the hob spindle bearings are mounted in a steel slide which affords a convenient means of moving the hob endwise. The design of the hob swivel and slide locates the hob close to the ways of the machine, and affords a high degree of rigidity. The swivel is in a horizontal position, which enables it to be readily set to the proper angle. A vernier reading



No. 2 Gear-hobbing Machine built by the Barber-Colman Co.

to ten minutes is provided on the swivel to facilitate accurate setting. Long guide ways are provided for the swivel slide, with gibs to afford means of taking up wear.

Depending upon the customers' requirements, the machine may be fitted with either a right-hand or a left-hand hob swivel, the former accommodating a range of spiral settings from 60 degrees right-hand to 90 degrees left-hand, while the latter accommodates a range of spiral settings from 60 degrees left-hand to 90-degrees right-hand. A right-hand swivel is furnished unless instructions are given to the contrary. An automatic belt-shifter is provided for stopping the machine after the hob has finished its work. Provision is made for quickly setting the hob swivel slide by means of a hand-wheel geared to the lead-screw. A chain-driven geared pump, with a capacity of four gallons per minute, is furnished as a regular equipment, and it is permanently attached to the machine. The coolant is strained through a chip pan and then discharged into the sub-base. Guards which completely enclose the pulleys and gears are also regular equipment.

Speed changes of the hob are secured by transposing gears in a gear-box at the end of the machine. Under average conditions, sufficient change-gears are provided to meet the requirements of high-speed steel hobs. Both the index and feed trains are positively driven, and they are varied by gear combinations in the index change-gear box at one end of the machine and in the feed change-gear box at the other end of the machine. This hobbing machine is of the constant-speed type and may be driven directly from a line-shaft or by a motor. The driving pulley is 6 inches in diameter and it is driven at a speed of 800 revolutions per minute by a 1½-inch belt. Special work-spindles can be supplied to hold work by means of spring collets or floating chucks. If so desired, this machine can be supplied with a cast-iron pan for a sub-base, which makes an ideal arrangement for a bench type of machine.

DAVIS-BOURNONVILLE NO. 2 CAMOGRAPH

For use in boiler shops and fabricating plants, to provide a means of automatically cutting hand-holes and other openings in boiler sheets, ship plates, tanks, drums, etc., with an oxy-acetylene torch, the Davis-Bournonville Co., Jersey City, N. J., has recently placed on the market a machine known as a No. 2 camograph. One of these machines is shown in Fig. 1, and Fig. 2 shows an example of a cut made by it. In this connection, attention is called to the fact that the latter illustration may be somewhat misleading. It will be apparent that a hole was punched in the metal to afford a starting point. This practice is quite generally followed, although it is not necessary to make a starting hole because the oxy-acetylene flame will soon penetrate the solid metal; but in actual practice where a starting hole is made, this hole would be placed within about an inch of the periphery of the hole to be cut, instead of at a point near the center of the hole, as shown in Fig. 2. The camograph works automatically and rapidly, the actual time of cutting a hand hole having a periphery of 12 or 13 inches in length in a ½-inch plate being about one minute. The width of kerf is only about 1/16 inch, and the cut edges are very smooth and true.

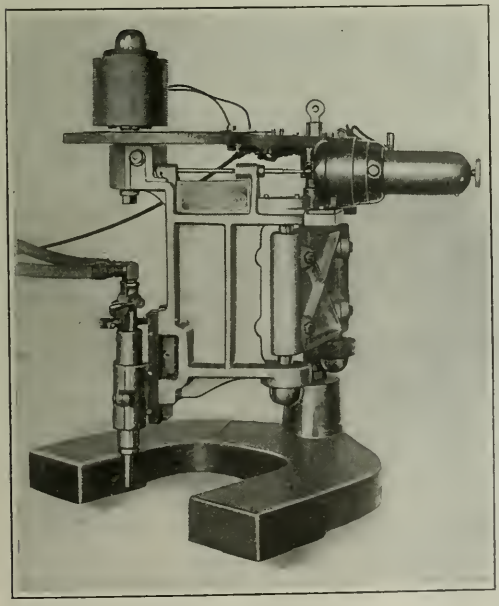


Fig. 1. No. 2 Camograph built by the Davis-Bournonville Co. for Cutting Holes in Plates



Fig. 2. Example of a Cutting Job done with the Camograph. Note the Smoothness of the Cut

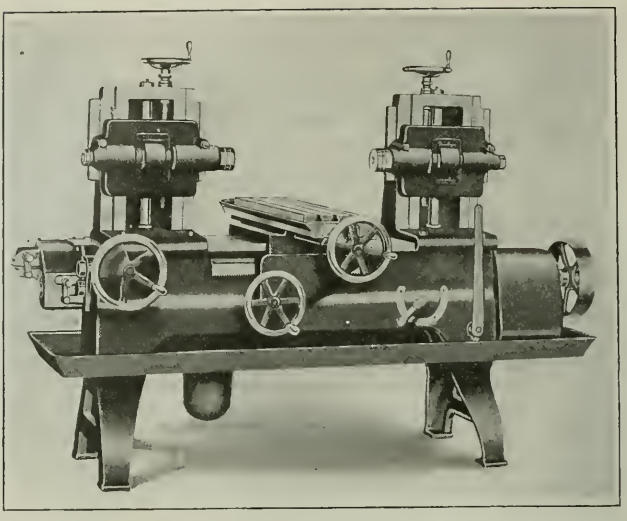
While in operation, the torch of the No. 2 camograph is mechanically traversed at a predetermined rate, thus insuring steadiness and smoothness of operation. Unlike the oxygraph machine of this company's manufacture, no tracing wheel is provided for following a paper drawing of the outline to be followed by the torch. This new machine is intended for repetition cutting, and the torch is made to follow a fixed path, the contour of which is governed by a metal form or cam. Provision may be made for cutting various shaped openings by substituting the proper cams on the machine. It will be seen from Fig. 1 that the machine consists of a base with a U-shaped opening through which the torch flame strikes the work.

At the back of the base there is a vertical post to which a double-jointed radial arm is pivoted. The cutting torch is mounted on the outer end of the radial arm which provides for movement in any direction from the entire area which can be covered by the machine. The jointed arm is made of two aluminum castings of light but rigid construction, which are mounted on ball bearings so that there is a minimum of frictional resistance. A feed roller on the outer or free end of the radial arm is surrounded by a yoke in which is mounted a guiding cam or templet which controls the movement of the torch. A unique principle of guidance is employed. The feed roller is magnetized by a powerful electromagnet, and is thus attracted to the inner face of the cam, the parts in contact being made poles of the magnet, one of which rotates and thus acts as a traction driver. A traverse movement or feed is provided by a small variable-speed electric motor mounted on the swinging radial arm.

The nominal diameter of the largest hole which can be cut with the No. 2 camograph is 7 inches, but openings other than circular, which have one dimension much larger than the other, may be easily cut. The machine has sufficient capacity for working on all thicknesses of plates that are used on the largest marine boilers. A double push-button switch provides a convenient means of starting and stopping the machine and of energizing the magnet.

W. B. KNIGHT DUPLEX MILLING MACHINE

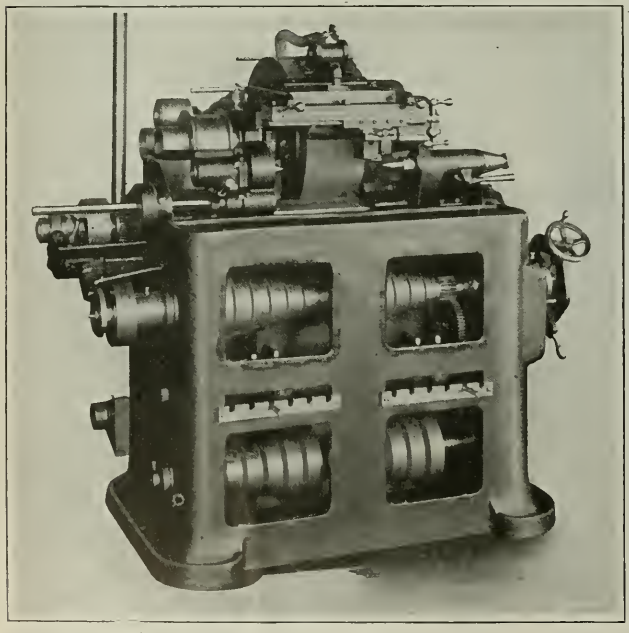
In the March, 1914, number of MACHINERY, a description was published of a duplex milling machine which had just been placed on the market at that time by the W. B. Knight Machinery Co., 3920 W. Pine St., St. Louis, Mo. Recently, this firm has developed another duplex miller which is of quite similar design to the one previously announced, except that it is of much heavier construction and of larger dimensions, and provided with a wider range of feed movements. These changes, together with improvements made in details of the design, adapt the machine for handling a wider range of work and heavier pieces than could be handled satisfactorily on the original Knight duplex miller.



Improved Type of Duplex Milling Machine built by the W. B. Knight Machinery Co.

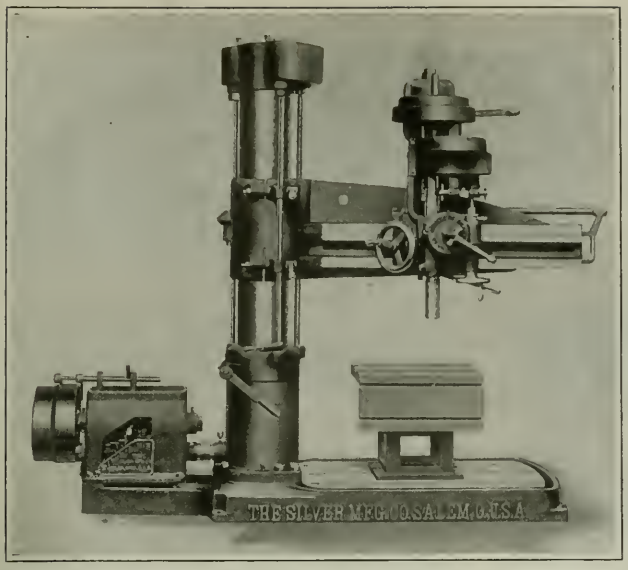
WOODS PLAIN GRINDING MACHINE

The Woods Engineering Co., Alliance, Ohio, is now building a plain grinding machine which is semi-automatic in its movements, the operator being merely required to set up and remove the work. This machine is styled a "wide-wheel automatic grinder." The work has a straight in and out movement, with a slight longitudinal movement during the grinding period. Grinding wheels may be used up to 20 inches in diameter by 8 inches face width, and the machine has a capacity for work up to 10 inches in diameter by 15 inches in length. In working out the design, a departure has been made from established practice in providing mechanism for obtaining the cross-feed movement, instead of the regular dovetail or V-slide. A rocking motion is provided. The headstock and tailstock are movably mounted on a square shaft which has journals at the ends that operate in bronze-bushed pedestal bearings. Clamped to this shaft there is an arm which carries the mechanism for making diameter adjustments in grinding. This arm is shown at the right-hand side of the machine, and near it there will be seen a handwheel which is the only one on the machine, so that it will be evident that manual labor is reduced to a minimum. A shaft running through the housing parallel with the square shaft carries a cam on the right-hand end that controls the movement of the arm connected to the square shaft, and governs the movement of the work to the grinding wheel. This camshaft has six speeds ranging from 3 revolutions per minute to 1/3 revolution per minute. One revolution of the cam completes the job. In operating the machine, the camshaft is kept running continuously, and acts as a pacemaker for the operator; but if necessary, the trip can be set to disengage the feed at the completion of each operation, or the feed can be tripped by the operator at any time during a revolution of the cam.



Plain Grinding Machine built by the Woods Engineering Co.

At the left-hand end of the camshaft there is a cam that controls the clutch pulley driving the work. These two cams are timed with each other, so that when the work moves up to the grinding wheel the clutch pulley is engaged and the work starts rotating just before it comes into contact with the grinding wheel. When the operating cycle has been completed and the work recedes from the wheel, it stops rotating and comes back into position for reloading. Six speeds for the work are obtained by a set of cone pulleys located inside the base of the machine. These pulleys are ordinarily enclosed, but the covers are shown removed to illustrate the arrangement of the mechanism. Changes of speed for both the work and camshaft are obtained by means of handles projecting through the front of the machine. The grinding wheel is



Radial Drilling Machine built in 2½-, 3- and 3½-foot Sizes by the Silver Mfg. Co.

mounted on a spindle between the bearings, and is driven by two 4-inch belts from a motor mounted on the base of the wheel-head. This head swivels on a central stud for grinding tapered work. The grinding wheels are carried on wheel centers, and in changing wheels it is not necessary to change the adjustments of the spindle bearings or to remove any pulleys. The wheel centers have a bore large enough to pass over all other parts of the spindle. A wheel-truing device is provided on the wheel guard, and the machine is entirely self-contained, even to the point of being equipped with a crane for handling the spindle when changing wheels. The floor space occupied is 6 by 6 feet, and the machine weighs 6000 pounds.

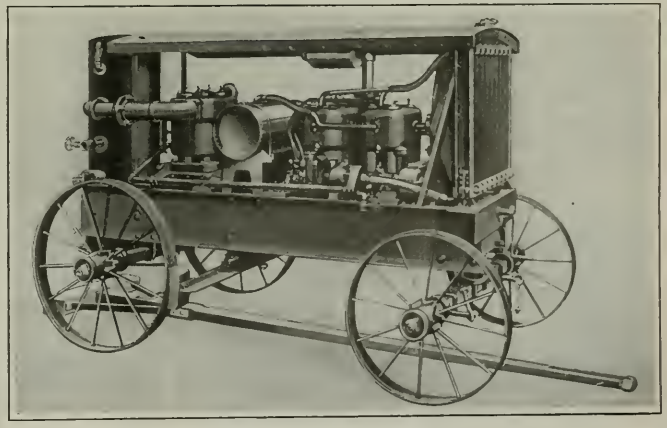
SILVER RADIAL DRILLING MACHINE

The Silver Mfg. Co., 385 Broadway, Salem, Ohio, has recently added to its line of drilling machines a radial drilling machine which is built in 2½-, 3-, and 3½-foot sizes. Simplicity of design and convenience of operation are features of these machines. The column is made of semi-steel and accurately ground to size. It is of an improved design in which the inner column or post has a wide bearing on the base and extends to the top without taper. In addition to an amply proportioned bearing at both the top and bottom, there is a middle bearing, which adds greatly to the rigidity. The outer column telescopes the post and rests on a ball bearing which facilitates easy movement of the radial arm. A clamping device is situated within easy reach of the operator, and it may be manipulated either by hand or by a foot-treadle. The arm is of pipe section and is furnished with an exceptionally wide bearing on the column. An automatic knock-out is placed at both the upper and lower limit positions of the vertical travel of the arm. Provision is made for clamping the arm to the column by two levers, which are conveniently located for the operator. A large handwheel operating through a rack and hardened spiral pinion enables the operator to run the head rapidly along the arm.

It will be noted that the design of the head is worked out in such a way that a wide bearing is afforded for the spindle sleeve. The back-gears are mounted on the head and provide two speeds, these gears being of the sliding type, so that they may be shifted while running, the change being effected by a lever located at the right-hand side of the spindle. The spindle is made of high-carbon crucible steel accurately ground to size. The spindle sleeve is bushed with phosphor-bronze, and the rack teeth are cut directly in the sleeve. A ball bearing supports the thrust load. Eight changes of feed are obtainable, these changes being arranged in geometrical progression from 0.005 to 0.040 inch per revolution of the spindle. Any available rate of feed may be obtained while the machine is running. Six changes of speed may be quickly obtained, and this number is multiplied by the back-gears on the head, giving a total of twelve speed changes. With the speed-box these cover a range of from 38 to 321 revolutions per minute and when the machine is equipped with a six-step cone pulley, the available speed changes are from 32 to 321 R. P. M.

INGERSOLL-RAND PORTABLE AIR COMPRESSOR

The Ingersoll-Rand Co., 11 Broadway, New York City, has recently introduced a portable, light-weight gasoline engine driven unit, built in two sizes, to be known as the "Imperial" Type 14 portable air compressor. These are all-steel outfits, from their sheet-steel canopy to the broad-tired steel wheels. The power plant of each consists of a duplex vertical compressor, driven at high speed by a four-cylinder four-cycle tractor type of gasoline motor. It is pointed out that the outfit, being designed especially for portable use, has had unnecessary weight eliminated, and affords maximum air power output per unit of weight. The larger machine, of 210 cubic feet capacity weighs only 6000 pounds and the 118-cubic foot unit weighs 4000 pounds. A point is also made of the fact that gasoline motor drive provides power in an economical form and in a mechanism that can be confidently entrusted to the average operator, for men familiar with gasoline engines are everywhere available and make thoroughly competent engineers.



"Imperial" Type 14 Portable Air Compressor built by the Ingersoll-Rand Co.

The compressors have cylinders cast en-bloc, with cylinder heads, valve chambers, and water jackets integral. Both intake and discharge valves are of plate type and are located directly over the cylinder bore. The crankshafts and connecting-rods are drop-forgings, and the air pistons are fitted with three-piece piston rings and, in addition, with an oil wiper ring. This latter returns all surplus oil from the cylinder walls to the crank-case, and is claimed to obviate the difficulty caused by having the air carry an excess of oil into the receiver. All bearings are die-castings of anti-friction metal. Hand-holes in the crank-case permit convenient access for adjusting the main bearings and those of the crankpins. All parts are lubricated by splash from an oil reservoir in the crank-case.

The compressors are provided with inlet unloading devices which automatically close the compressor intake when the receiver pressure rises above a predetermined limit, and permit the machine to again take up its load when the pressure has fallen a definite amount. The gasoline driving motors are of long stroke type, and operate at medium speed. They are equipped with high-tension magneto ignition, with automatic governors to maintain constant speed under all working conditions and to prevent overspeeding when idling. A splash oiling system lubricates all moving parts. The starting crank is located at the front of the machine beneath the radiator.

Both the compressor and driving motor are water-cooled by a circulating system, with a centrifugal pump, large radiator and powerful blast fan. Attention is directed to the fact that the radiators are made up of removable sections, a construction which allows the removal and repair of a damaged section without taking down the entire radiator or interrupting the use of the compressor. Each of these units is equipped complete with a receiver, safety valve, drain valves, pressure gage and service valves to which the air hose lines may be attached. When the fuel tank has been filled, lubricating oil provided, and the cooling system supplied with water, the units are ready for work. The mounting of the machines is worthy of note, particularly the swiveled front axle which moves freely in both horizontal and vertical planes. This, with the rigidly attached rear axle, gives a three-point suspension and permits the outfit to pass over inequalities of the ground without any racking effect or misalignment of the power plant. The two sizes differ in respect to the location of the air receiver and in minor details of design.

"INANOUT" DOUBLE-ACTING COLLET

The Inanout Collet Mfg. Co., Inc., 821 Lake Ave., Rochester, N. Y., has commenced the manufacture of a line of double-acting spring collet chucks. Fig. 1 shows the collet in section, and Fig. 2 shows some of the varied forms of chucks made by the company, as well as the adapters and draw-in bar used in connection with them. In principle, the chuck is very simple. In addition to the regulation closing taper that is common to all collet chucks, this chuck is fitted with an integral steel flange, on the inner face of which is a reverse or expanding taper. The outer surface of the chuck is fitted with standard sized shoulders for holding internal work.

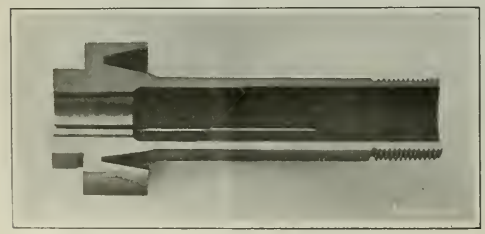


Fig. 1. Split Collet made by the Inanout Collet Mfg. Co., Inc.

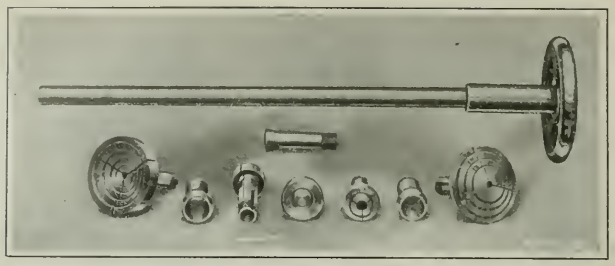


Fig. 2. Examples of Chucks made by the Inanout Collet Mfg. Co., Inc.

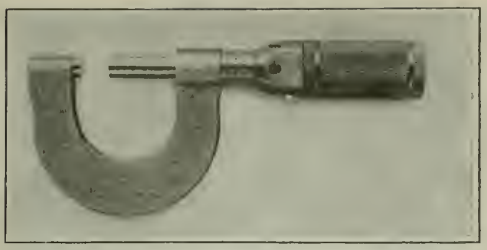
By means of adapters, which act either on the expanding tapered section or on the regulation tapered section, the collet may be expanded for gripping internal work or contracted for gripping external work, according to which adapter is used. These "Inanout" collets are made of the best tool steel, hardened and ground to standard sizes, both in the bore and at the steps used for internal gripping. As will be seen in Fig. 2, multiple step collets for special purposes may be obtained. These collet chucks are made for use in any of the standard bench and tool-room lathes, and if desired, chucks of special dimensions will be furnished for special work. Special collets may be had for holding threaded sections, either internally or externally.

ZUBAR WELDED TIP TOOLS

The idea of welding a tool shank made from inexpensive material to a cutting tip made of high-speed steel or some other expensive metal is not new to men of considerable mechanical experience. The ZuBar Mfg. Co., Inc., 5701 McMahon Ave., Germantown, Philadelphia, Pa., has recently engaged in the manufacture of welded tipped tools by a process which does not involve the use of a sufficiently high temperature to damage the steel. A process of welding is employed by which the high-speed steel tip may not only be satisfactorily hardened and tempered, but it is claimed that the physical properties of the metal are improved. Tools made by this process are produced in all standard shapes and sizes, and also special tools that it would be difficult to make from solid pieces of high-speed steel, and which as a consequence are often made of carbon steel. All tools made by this company are ground ready for use.

CENTRAL TOOL CO.'S DIRECT-READING MICROMETER

An improved type of direct-reading micrometer has recently been placed upon the market by the Central Tool Co., of Auburn, R. I. This is known as the "Jaques" easy-reading micrometer, and is sold by the Production Equipment Co., Inc., 1 Madison Ave., New York City. One of the advantages of this tool is the fact that it is so simple to read that anyone without a knowledge of the principles governing the operation of a micrometer can use it quite easily. Instead of having forty graduations on the barrel as in the case of standard micrometers, there are only ten graduations, and it is only necessary to glance at the little dial windows in order to read directly the full dimension of the work. The first decimal of the reading is taken from the barrel graduation, while the second and third decimal places are read direct from the dial. Another feature that is of value in this micrometer, is that although it is provided with a dial mechanism, giving the easy reading feature, it is very



Direct-reading Micrometer made by the Central Tool Co.

little larger than a regular micrometer, and is just as light to carry. Micrometers of this type are made in sizes up to 12 inches, either with or without ratchet stops. They may be furnished with graduations to read to 0.0001 inch. The direct-reading feature enables a micrometer of this type to be read very rapidly, as there is no delay in arriving at the desired result.

MANUFACTURERS EQUIPMENT CO'S AIR-OPERATED VISE

For use in holding work on milling and drilling machines, the Manufacturers Equipment Co., Waller and Fillmore Sts., Chicago, Ill., has recently placed upon the market an air-operated vise. It is so constructed that either a six-inch or eight-inch air cylinder can be used. Power from the cylinder is transmitted through a system of compound levers which multiply in the ratio of 2 to 1, thus affording a



Air-operated Milling and Drilling Machine Vise made by the Manufacturers Equipment Co.

powerful grip on the work. The jaws are 3½ inches high by 8 inches wide, and the power stroke of the compound levers is ½ inch. It is stated that ample power is provided to hold work under the most severe conditions of operation for which a vise of this size is adapted.

J. H. WILLIAMS "VULCAN" TOOL-HOLDER

J. H. Williams & Co., 61 Richards St., Brooklyn, N. Y., have recently added to their line what are known as "Vulcan" forged-cutter tool-holders. It is said that these holders constitute the equivalent of a solid tool, and that they meet the requirements of those who prefer solid forged tools to the regular tool-holder. The construction of the "Vulcan" forged-cutter tool-holders eliminates the high cost of the solid tool and at the same time retains many of its advantages. By merely inserting a small high-speed forged cutter, each holder is adapted for taking the heaviest cuts that are involved in the performance of any regular machining operations on lathes, planers, shapers, etc. A supply of cutters may be maintained in readiness for instant service by the man in charge of the tool-room, with a negligible amount of expense for grinding, so that the machine operator may always have an ample stock of tools ready to meet his needs. Duplicate lines of important shapes and sizes may be carried with only a slight additional investment, and this practice insures the operator against delay. The holders are all drop-forged from a special grade of steel, and so heat-treated that the maximum toughness and stiffness is obtained. They are of simple construction and consist of three parts, namely, the holder, the square-headed cam, and the locking pin, the design being such that the cutter is immovably held. The cutters are drop-forged from high-speed steel, and are finished and hardened ready for use. They are furnished in a wide range of sizes and types, such as side, diamond point, roughing, hog-nose, threading, etc.

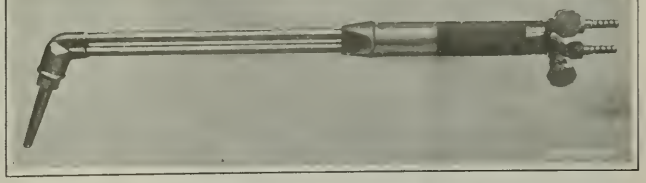


"Vulcan" Forged-cutter Tool-holder made by J. H. Williams & Co.

"AIRCO" WELDING TORCH

A new welding torch, capable of meeting the varied requirements of modern welding, has been introduced by the Air Reduction Sales Co., 120 Broadway, New York City. This "Airco" welding torch is of very strong construction, yet at the same time, it is so light and well balanced that the operator will not experience strain when welding a long job. The handle is knurled and comfortably proportioned, so that a firm grip can be secured without undue pressure. An interesting feature in this connection is a gas pressure table rolled on the upper part of the handle. Such a table is very handy for reference and this location proves a convenient and lasting place for the information. The valve handles are of octagon shape. They are easily turned and will not catch in the operator's work or clothing. Both the handles are on the left side. With this construction and with the hose connections extending straight out from the valve body, there is nothing to interfere with the proper manipulation of the torch.

All passages are so designed and the parts so assembled as to insure an easy flow of gas. The tubes between the head and handle are of hard drawn seamless brass, countersunk at both ends. The torch is silver soldered, and the valve body and butt of the handle are in one casting. The valve body will not work loose or break off. The gases are mixed at the entrance to the discharge passage of the tip, and there is no premature mixing or mixing in other than the predetermined quantities. Whenever a new tip is put



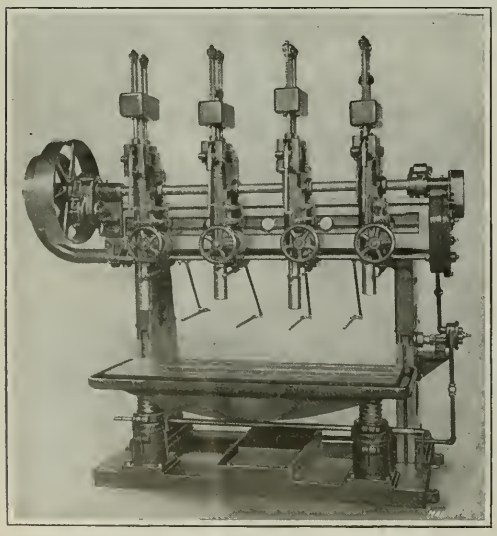
"Airco" Welding Torch made by the Air Reduction Sales Co.

in place, the mixture is automatically proportioned to the size of the tip. The mixture produced in the "Airco" torch approaches close to the theoretical proportion of one part of oxygen to one part of acetylene, effecting the maximum possible economy in gas consumption.

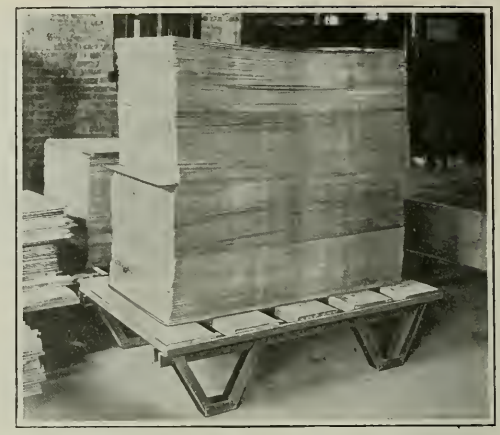
The conical projection of the head cooperates with the conical recess of the tip in a metal-to-metal seat, the tip being held securely in place by a tip nut. This practice does away with the threads on the tip as well as eliminating outside threading on the head. The tip is made of a special alloy selected after an extensive series of heat and endurance tests. The acetylene grooves are accessible and but a few seconds are required to remove carbon if cleaning becomes necessary. The torch head is drop-forged of the same material as the tip, so that both these parts are subject to the same coefficient of expansion and contraction. The manufacturers have adapted the apparatus to a wide range of work by making it in four different sizes which are adaptable for all classes of welding from sheet metal to heavy castings. Different heads are also provided for special requirements. A range of tips is available providing flames from the smallest to the largest required in general practice.

HARRINGTON MULTIPLE-SPINDLE DRILLING MACHINE

In the accompanying illustration there is shown a No. 17 multiple-spindle drilling machine which is a recent product of Edwin Harrington, Son & Co., Inc., 17th and Callowhill Sts., Philadelphia, Pa. The machine here illustrated has four spindles, but the number of spindles can be varied to meet the requirements of different consignees; also, tables can be furnished in several different types to meet the requirements of different classes of work. Where the regular frame sizes do not meet the requirements, special frames can be furnished to order, which cover a considerable range of sizes, and if desired, provision may be made for connecting adjacent heads to move them along the cross-rail in pairs. The driving pulleys transmit 12 horsepower, which is ample for efficiently driving four 1-inch drills in mild steel at all practical rates of speed and feed. Larger drills can be used where all of the spindles are not working at one time, or where light feeds are employed. It will be seen that the spindle heads are mounted directly on the face of the cross-rail on which they have independent lateral adjustment by a rack and hand-operated pinion, and they are clamped in position by bolts and a gib in the T-slot of the cross-rail.



No. 17 Multiple-spindle Drilling Machine built by Edwin Harrington, Son & Co., Inc.



Steel Legs made by the Lyon Metallic Mfg. Co. for supporting Elevating Truck Platforms

LYON ELEVATING TRUCK PLATFORM LEGS

Trouble is often experienced from several causes, where homemade wooden skids are used in handling heavy loads on elevating trucks. Such skids are likely to be very bulky and cumbersome, or else the legs are likely to be weak and to wear down, so that the skids require frequent repairing. To obviate such difficulties, the Lyon Metallic Mfg. Co., Aurora, Ill., has developed a steel skid leg of the type shown attached to a platform in the accompanying illustration. The fully loaded platform is supporting seven tons of metal which, of course, is a heavier load than could be lifted on an elevating truck.

This new skid leg consists of two feet which are welded to a steel channel that is provided with bolt holes spaced in such a way as to make it an easy matter to bolt the legs to either a wooden or steel skid. Rounded corners and a wide bearing for the feet prevent them from damaging the floor, and the channels are of ample strength to resist all stresses to which they are likely to be subjected. Another feature of these legs is that additional supplies of platforms may be carried in stock, knocked down so that they take up very little space but are instantly accessible for use. The wooden cross pieces can be drilled to fit skid legs which are punched to standard patterns. All that is necessary to have a new platform ready for use is to withdraw the required number of cross pieces from stock and bolt them to the steel legs. The platforms may be made of any width, as the cross pieces can be cut to any desired length.

"KRIESEL" BORING, MILLING AND DRILLING MACHINE

To meet the requirements of automobile repair shop work where there are a variety of different machining operations to perform, but where the quantity of any one kind of work is often insufficient to justify investment in a variety of standard types of machine tools, the Mill City Co., 823 Plymouth Bldg., Minneapolis, Minn., has recently placed upon the market the "Kriesel" multi-purpose machine, which is here illustrated and described. It is claimed that this is a complete but simplified machine for performing boring, milling, and drilling operations, and not only is its first cost much less than that of individual equipments, but the amount of floor space occupied is also far less. In addition to its application in automotive repair shops, this machine is said to be well suited to the requirements of certain classes of tool-room work. The frame and base are cast in one piece to provide a rigid construction, and the machine is of exceptionally simple design, so that its use may be readily



"Kriesel" Boring, Milling and Drilling Machine built by the Mill City Co.

mastered by men of limited experience. The provision for performing boring, milling, and drilling operations on a single machine, when combined with a reasonable amount of ingenuity on the part of the operator, will enable a machine of this type to handle a great variety of work which must be done in the average automobile repair shop. The machine weighs 1000 pounds.

MICHIGAN CYLINDER BORING AND BURNISHING TOOL

For use in garages and repair shops that are called upon to refinish cylinders of engines for Ford passenger cars and Fordson tractors, the Michigan Machine Co., Detroit, Mich., has recently developed a combination boring and burnishing tool. This equipment is designed in such a way that it locks on the cylinder block and may be operated either manually or by power. To provide for refinishing one of the bores in a cylinder block, face *A* of the tool is secured to the top of the work by means of cap-screws which enter the tapped holes in the block. Two gages *B* are made of such thickness that they enter the space between the cylinder bore and barrel *C* of the tool, thus locating the tool concentric with the bore of the cylinder. Attention is called to the fact that the portion of the cylinder bore which is engaged by gages *B* always remains accurate, because it is not subjected to the rubbing action of the piston. Locating the tool from this part of the cylinder, assures accuracy in reboring. In addition, the tool is clamped by a supporting member *D* which is secured to the bottom of the cylinder block, but this support is entirely supplementary; it performs no essential function in the operation of the tool. Gage-blocks *B* are removed, after the tool has been clamped in place.

After the tool has been set up on the work, the first step is to rebore the cylinder by means of cutter *E*, and after this has been accomplished, the burnishing head *F* provides for imparting a high finish to the work. A screw *G* will be seen extending through the middle of barrel *C*, and in the case above flange *A* there are a differential gear drive and a plain gear drive. By shifting crank handle *H* into its three successive vertical positions, provision is made for obtaining either a differential geared drive which rotates both barrel *C* and screw *G*, a plain geared drive which rotates barrel *C*, or a direct connection between screw *G* and crank *H* to provide for simply rotating the screw. In starting to refinish a cylinder, the first driving position is employed in order that both the barrel *C* and screw *G* may rotate. The differential gears are so designed that the relative motion between the barrel and screw results in imparting a downward feed movement of 1/64 inch per revolution to the boring tool *E*.

After the cylinder has been bored, the position of the driving mechanism is changed to obtain a direct-connected drive between the screw *G* and crank *H*, in order that the screw may be rotated in the opposite direction to provide for backing the boring tool up into the head; that is to say, in the position shown in the illustration. Then the clamping bar *D* is removed and burnishing head *F* is slipped into place over the barrel *C*, after which bar *D* is again replaced and the driving mechanism is adjusted to provide for simply rotating the barrel *C*. The hardened steel burnishing rollers carried in head *F* are set at a slight angle to the axis of the head, and as a result of this inclined mounting, a feed movement is imparted to the head which slides in the spline groove in barrel *C*. No screw or other positive means of transmitting power is used to accomplish the feeding of the burnishing head. The burnishing rollers are tapered at each end to prevent them from scoring the cylinder and thus damaging the finished surface of the work.

"DALTON SIX" MANUFACTURING LATHE

One of the recent developments of the Dalton Mfg. Corporation, 1915 Park Ave., New York City, is the 8-inch lathe which is illustrated herewith. The ways on the back of the lathe bed are finished square with the horizontal surface and have machined T-slots extending their entire length so that the various special attachments, which may be furnished with the lathe, can be accurately applied thereto. The length of the bed is 36 inches and with the bench type machine is set on short legs, while the floor type is supported either by standard high legs or on a high cabinet base, such as shown in the illustration. This casting, as may be clearly seen, contains drawers for tools and collets, as well as two closets in which certain special attachments, change-gears and similar parts may be conveniently kept. Each of these compartments has three removable steel shelves and the

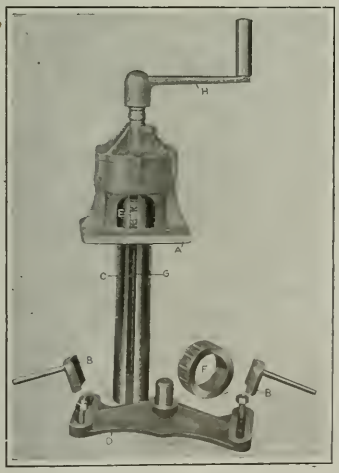
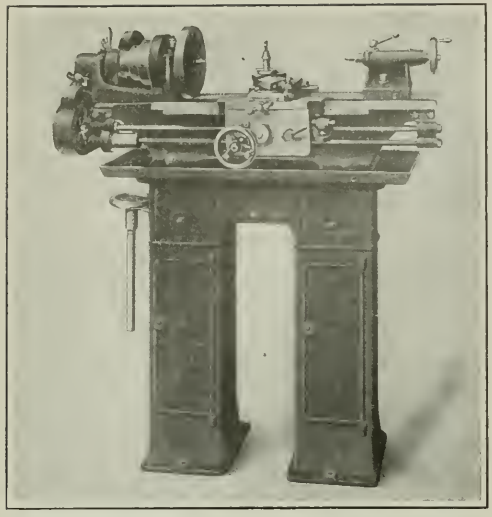


Fig. 1. Cylinder Boring and Burnishing Tool built by the Michigan Machine Co.



Fig. 2. Use of the Michigan Cylinder Boring and Burnishing Tool shown in Detail in Fig. 1



Manufacturing Lathe built by the Dalton Mfg. Corporation

drawers are made of sheet metal, electrically welded.

The headstock is of heavy web construction, well ribbed, and is equipped with bronze bearings which are lubricated by sight-feed oilers. The drop-forged steel spindle contains a large hole and is mounted in thrust ball bearings. The entire spindle is ground outside, including threads at the nose. The carriage is securely gibbed, front and back, and is provided with felt wipers for removing particles of dirt and furnishing lubrication for the ways when the carriage travels. The compound rest base is graduated 180 degrees and is clamped in a circular T-slot in the cross-slide. The compound rest is offset 60 degrees so that in performing threading operations the tool is more readily accessible to the work. Both the compound rest feed-screws and the cross-feed screw for the slide have micrometer adjustment. All bearings in the apron are separate bushings which are screwed into the casting. An oil trough is provided in the apron casting in which the feed-rod worm and gear revolve.

The tailstock is offset and has a liberally proportioned foot with a crosswise tongue which fits in the tailstock base, thus permitting side adjustment for taper turning operations. The lead-screw can be furnished either with English or metric pitch screw threads and is made from high-carbon steel. The countershaft is of special design and can be attached either to the wall or hung from the ceiling. A special countershaft is provided when the grinding attachment is furnished and operates in connection with the regular countershaft. Countershaft bearings are ring-oiled and the driving pulleys are provided with roller bearings. When the lathe is arranged for foot power or for motor drive the countershaft is not, of course, regularly furnished. For motor drive a 1/3-horsepower motor is mounted on a bracket directly above the cone pulley.

The variety of special attachments, provision for the application of which has been especially made in designing the ways, furnishes a wide range of service for performing many different classes of work. Some of these special attachments include taper attachment, quick-acting draw-in attachment, chasing dial, broaching attachment, automatic turret on bed, double toolpost, indexing attachment, milling attachment, gear-cutting attachment, Fox thread-chasing attachment, grinding attachment (both internal and external), grinder attachment for motor-driven lathe, lathe and drill chucks and various types of arbors, centers, etc.

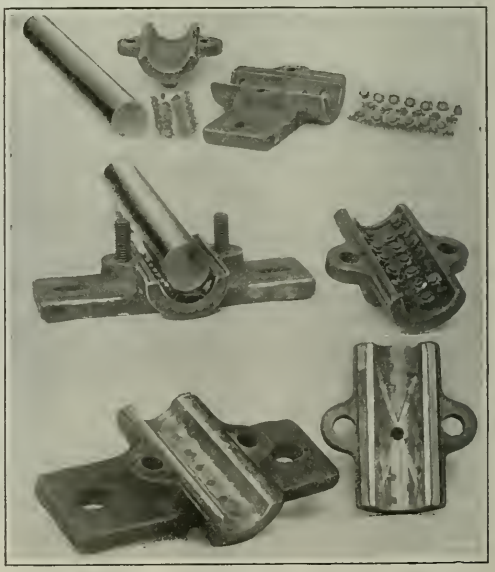
The actual swing over the bed is 8¼ inches, over the carriage 5 inches, and over the compound rest, 1⅞ inches. The distance between centers is 18½ inches, and the over-all length of the machine, when the tailstock is at the extreme position, is 45 inches. With the English lead-screw, threads from 3 to 72 per inch may be cut; while the use of the metric lead-screw enables threads having a pitch of from 0.25 millimeter to 6 millimeters to be cut. The back-gear ratio is 6.5 to 1.

RANDALL GRAPHITE SHEET LUBRICATOR FOR BABBITTED BEARINGS

To provide for facilitating the lubrication of babbitted bearings through the use of graphite, the Randall Graphite Sales Co., 711-721 Fulton St., Chicago, Ill., is making what is known as the Randall graphite sheet lubricator. The accompanying illustration shows successive steps in the process of babbitting a bearing in which one of these lubricators is to be employed. The device consists of a wire mesh on which there are mounted graphite cones which are made from an especially prepared binder and pure Ceylon flake graphite which is finely ground and air separated. The method of preparing the material is such that the graphite cones are absolutely free from cutting properties, and they are said to wear uniformly with the babbitt, showing no tendency to crumble, get soft, or wash out of the bearing.

These sheet lubricators are packed twelve sheets in a box, each sheet measuring approximately 12 by 12 inches in size, and they may be furnished with cones of 1/8, 5/32, 3/16, 7/32, 1/4, 5/16, and 3/8 inch in size, so that a selection may be made of the proper lubricator for a variety of different sizes of bearings. The graphite cones are slightly tapered, and are firmly attached by the application of hydraulic pressure to a fine bronze wire screen or fabric, the cones being located in a staggered formation. It will be apparent from the illustration that the sheet lubricator is applied at the time that the bearing is being babbitted. The lubricator is cut to the proper size and placed in the bearing housing before pouring the babbitt, after which the operation is performed in the usual way. The babbitt metal flows into place and sets firmly around the cones, making them an integral part of the bearing and enabling advantage to be taken of the well known lubricating properties of graphite.

The claim is made that babbitted bearings prepared in this way use from 75 to 90 per cent less lubricating oil, and

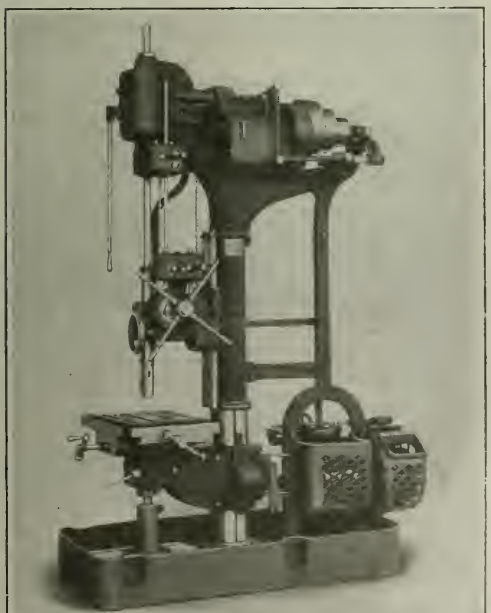


Successive Steps in applying the Randall Graphite Sheet Lubricator to Babbitted Bearings

that they will last three times as long as plain babbitted bearings. This result is due to the tendency for the graphite to fill the porous surface of the shaft and bearing, making these members absolutely smooth and reducing frictional resistance to a minimum. The graphite buttons also absorb oil and provide reservoirs which feed oil back to the bearing, a sufficient quantity of oil being made available in this way to allow the bearing to run for a considerable period of time without damage, in case the attendant neglects to oil the bearing. It is also claimed that the wire fabric of the Randall graphite sheet lubricator constitutes a reinforcement for the babbitt which greatly increases its strength and durability, thus increasing the life of the bearing. In babbitting split bearings or bushings, the sheet is crimped as shown in the illustration, thus forming a spring with the crimps against the back of the casting, while the small end of the graphite buttons fit snugly against the shaft or mandrel. This allows the metal to flow in back of the sheet. For solid bearings, the sheet is flat and simply bent around the mandrel, after which it is tied in place with a fine wire until the babbitt has been poured.

OIL-PAN FOR WEIGEL DRILLING MACHINE

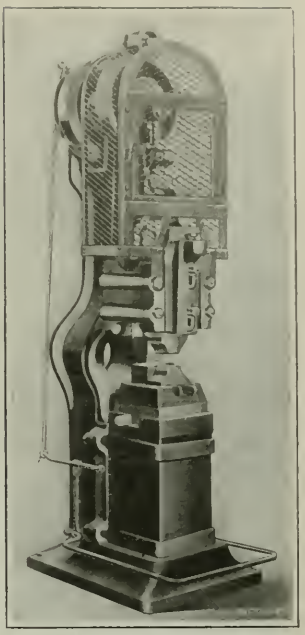
In the February number of MACHINERY a description was published of a 21-inch upright drilling machine built by the Weigel Machine Tool Co., Peru, Ind. The accompanying illustration shows a 25-inch machine of similar design, except that it is equipped with a deep oil-pan around the base. This pan is 6 inches wide by 8 inches deep, and it comes 4 inches above the top surface of the base. The pan is cast integral with the base. Where a large volume of coolant is required, this pan is of ample size to accommodate it, and the coolant can be pumped direct from the base and allowed to flow back to the reservoir without spattering on the floor. Bolts for bolting the machine down on its foundation are placed outside of the oil-pan, so that there is no danger of leakage through the bolt holes. Oil-pans of this type can be supplied on both the 25- and 21-inch Weigel drilling machines.



Weigel 25-inch Drilling Machine equipped with an Oil-pan Base

UNITED HAMMER GUARD

The United Hammer Co., Oliver Bldg., Boston, Mass., has developed a guard for use on Fairbanks power hammers, which completely covers the working parts of the machine and prevents any possibility of injury to the operator, although it leaves the mechanism accessible for the purpose of oiling or adjustment. Another feature of the guard is that it is easily attached to hammers which have already been placed in operation. This guard is furnished as a regular part of the equipment of new hammers. It will be evident that access to the mechanism for oiling or adjustment is through a door at the front of the guard.



Fairbanks Power Hammer equipped with Guard recently developed by the United Hammer Co.

CARBORUNDUM CO.'S NEW ALUMINOUS ABRASIVE

Present-day grinding operations have become such a highly specialized work that abrasive manufacturers have found it necessary to carry on constant experimental and development work, always with the idea of perfecting abrasive materials and making grinding wheels that will definitely meet the exacting needs of the grinding conditions of industry. For some time the Carborundum Co., Niagara Falls, N. Y., has felt that industry needed an abrasive which could be bonded into a wheel having extraordinary sharpness, fast cool cutting ability, uniformity and long life—a wheel that would not only have these qualities, but at the same time would be what might be termed an open "brittle" wheel so far as its structure was concerned. Such a combination of grinding virtues, it has been found, was extremely necessary in the grinding wheels that are principally used in the grinding of high-speed and casehardened steel, and for the work of surface grinding.

After a long period of research the Carborundum Co. has perfected a new abrasive material having characteristics which appear to be well suited for the grinding of reamers, cutters, hob-mills and for other small tool-room work; and in addition, this new abrasive is found to be perfectly adapted for certain cylindrical grinding operations, such as the grinding of the shanks of high-speed drills, the rollers for roller bearings and for grinding the sides of washers for thrust bearings. Still another field in which this new abrasive is destined to show marked efficiency is in the surface grinding of broad surfaces on vertical grinders, particularly where a large amount of stock is to be removed in a short time. This new abrasive material is to be known as aloxite AA. It is now being made in large quantities, and grinding wheels made from this product are available for all uses for which it is intended.

The bulk of the aluminous abrasive now used in grinding operations contains from 92 to 96 per cent of alumina, 2½ to 4 per cent of titanium oxide, ½ to 1 per cent of both iron oxide and silica, and lesser amounts of lime and mag-

nesia. Most of the alumina is present in the crystallized state, while the other impurities combined with a small portion of the alumina form a glass which functions as a matrix or cement, holding together the crystals of alumina. These crystals are composed of practically pure alumina and have all the characteristic hardness of our natural jewels, the ruby and sapphire. The shape and size of these alumina crystals and the amount of matrix present have an important bearing upon the characteristics of the abrasive, and a study of the internal structure of the abrasive is of great importance. The method now generally used for this investigation is by means of thin sections cut from a massive lump of the abrasive. A microscopic study of these thin sections shows the size and shape of the alumina crystals and their arrangement.

The amount of impurity present in the new abrasive is about 1.5 per cent or very much less than is found in the ordinary type of aluminous abrasive. This decreased amount of impurity has an important bearing on the characteristics of the abrasive grain and the wheel made from it. The cutting power is increased, due to the greater amount of crystallized alumina present. There is less fluxing between the bond and the grain, which results in a brittle wheel so necessary for rapid cutting. It also makes possible, due to the high purity of the grain, the production of wheels of very soft grade. The small amount of impurities allowed to remain in the abrasive is not objectionable but on the other hand is extremely beneficial. This impurity prevents the formation of skeleton crystals and prevents the more or less open and porous structure which is obtained when molten pure alumina is allowed to solidify. The resulting abrasive consequently exhibits a greater toughness and imparts a longer life to the wheel.

The large size of the alumina crystals in aloxite AA have an important bearing on the cutting power of the abrasive. As the grits commonly used are 20 and finer, almost every individual grit will consist of a fragment broken from a larger crystal of alumina and, due to this fact, possesses exceptional sharpness. During the process of grinding there is a breaking down of the abrasive grains in a wheel, and the character of the new grains that are formed depends largely upon the size of the alumina crystals in the original abrasive. When the alumina crystals in the abrasive are small, a rupture of the grain may mean a tearing away of a few small crystals without fracture. However, when the crystals are large and a rupture occurs in an abrasive grain, it means that a crystal of alumina has been actually fractured and that new sharp cutting points and edges have been produced. In summing up briefly it may be said that aloxite AA is composed of nearly pure alumina with just enough impurity present to produce a desirable toughness and furnish an abrasive which will have a long life when used in a grinding wheel. It has great hardness and its remarkable sharpness is due to the large size of the crystals of alumina in the abrasive. It is possible to manufacture from this high purity grain a bonded wheel of brittle nature and of soft grade. Aloxite AA wheels are uniform in grade and of open structure.

NEW MACHINERY AND TOOLS NOTES

Limit Snap Gage: American Gage Co., Newark, N. J. An adjustable "Go" and "Not Go" snap gage which is made in twenty-one sizes to give all dimensions from 0 to 12 inches.

Covered Welding Wire: Reid-Avery Co., 1436 Brandywine St., Philadelphia, Pa. A special covered electrode for use in electric arc welding, which is sold under the trade name of "Raco," derived from the initials of the company's name.

Oilless Bearing: Massachusetts Oilless Bearings Co., Worcester, Mass. A self-lubricating bearing which is known as the "Cole graphite matrix bearing," and consists of a mixture of graphite with any bearing metal alloy possessing the required physical properties for the installation in which the bearing is to be used.

Knurling Tool: Austin Tool & Machine Co., Pittsburg, Pa. A knurling tool which is so designed that it makes a full impression in any metal and is said to impose a minimum amount of strain on the machine or the work. The knurling rolls are carried on hardened steel pins mounted on two parallel bars, and the knurling rolls are impressed upon the work by means of an eye-bolt and wing-nut secured to the parallel bars.

Control Panel for Welding Unit: Wilson Welder & Metals Co., 2 Rector St., New York City. This apparatus consists of a motor-generator set and current control panel, and it is designed to produce a constant heat for electric welding. A normal voltage of 35 volts is maintained at the terminals of the generator. Three switches on the panel provide means of current adjustment between a minimum and maximum of 25 and 175 amperes, respectively.

Duplex Oiling Hanger Box: W. A. Jones Foundry & Machine Co., 4409 W. Roosevelt Road, Chicago, Ill. A hanger box in which the bearings are babbitted and accurately bored to size. The bearing is oiled by both a wick and rings which carry oil up from a reservoir in the base. Oil which works out of the ends of the bearing and is thrown off the shaft is caught in pockets and returned to the reservoir for subsequent use. Bearings of this type are made in all standard shaft sizes.

Reversing Lubricant Pump: Fulflo Pump Co., Blanchester, Ohio. A reversing centrifugal pump which is a self-contained unit, driven through the medium of internal spur reducing gearing that receives power from a belt drive. The pump is especially adapted for delivering lubricant to the cutting tools used on metal-working machinery. The pad on which the pump is located is detachable, and it can be placed in any of three positions, which facilitates the mounting of the pump on a machine.

Gang Drilling Machine: Bement Miles Works of the Niles-Bement-Pond Co., Philadelphia, Pa. A multiple-spindle machine for use in drilling steel plate frames for locomotives. This machine is designated a locomotive plate frame drilling machine, and it consists of a battery of four radial drilling machines with their arms fixed as regards vertical adjustment. These machines travel along a bed, so that the desired setting may be obtained. The work-table is mounted at the front of the bed and has provision for clamping the work on both horizontal and vertical surfaces.

Temperature Controller: Wilbride Co., Norwood, Pa. A device for controlling the temperatures of gas furnaces, lead pots, ovens, etc., where gas is used as a fuel. This device is operated by air pressure and consists of a controlling instrument and an automatically manipulated valve for the gas. The controlling mechanism consists of a galvanometer and an air motor, with a clamping mechanism for holding a plate on the galvanometer pointer at intervals of four seconds, when air is forced through an opening in the plate and causes the valve to operate the gas and air valves which regulate combustion.

Crankshaft Lathe: Crank Shaft Co. of America, Edison Bldg., Chicago, Ill. A machine capable of handling crankshafts from 7 to 10 inches in diameter and of any throw. It also machines the sides of the webs and makes provision for turning the ends of the cranks on all of the throws at a single setting of the work. An idea of the wonderful productive capacity of this machine will be gathered from the fact that it is claimed to have reduced the machining time on a certain class of crankshaft from thirty days to two days, namely, 6.7 per cent of the time required to do the work by a less suitable method.

"Both Ways" Planing Tool: Otto H. Cronau, 330 E. 87th St., New York City. A tool designed to cut on the return as well as on the forward stroke, thus making provision for greatly increasing the productive capacity of planers and shapers. The body of the tool is a drop-forging made of mild steel and pack-hardened. Two small swinging holders are carried by the tool body, each of which has a square hole broached through it to take a standard high-speed steel tool bit. The holders are pivoted and arranged in such a way that one lifts on the forward stroke and the other on the return stroke of the planer or shaper ram.

Automatic Sand-blasting Equipment: Pangborn Corporation, Hagerstown, Md. An automatic rotary table sand-blasting equipment which is designed to meet the requirements of shops which have a small volume of work to be sand-blasted, and where the pieces are of small or medium size. The rotary table is 42 inches in diameter and is half exposed outside of the dust-tight housing. Pieces to be sand-blasted are loaded, carried into the cleaning chamber and removed after they emerge from the cleaning chamber. The sand blast is of the suction type, and spent abrasive falls through the grated top of the table to be returned to the point from which the machine draws its sand. In this way the abrasive is made available for subsequent use.

Improved "Little Giant" Air Drill: Chicago Pneumatic Tool Co., 1060 Fisher Bldg., Chicago, Ill. This firm has recently made a number of important changes in the internal mechanism of its "Little Giant" air drill. An improved crankshaft and bearings are used, the crankshaft being made of heat-treated steel and supported by annular ball bearings at three points. The pinion teeth are of the stub type, assuring ample strength and a minimum amount of friction. The connecting-rods have a ball and socket bearing in the pistons, preventing side strains and undue wear on the cylinder walls. Replaceable bearings are provided to receive the crankpins, and the pistons are of one-piece construction and hardened, after which they are ground to size.

Crankshaft Milling Machines: Robert T. Pollock Co., Boston, Mass. A milling machine for finishing crankshafts, which enables a milling operation to be supplemented for the usual turning or grinding operations which are performed on this class of work. A plain multiple-spindle milling machine provides for machining the main bearings and assures bringing them concentric with the axis of the shaft. The number of spindles on the machine varies with the number of main bearings that have to be milled. A separate machine is used for milling the crankpins. It is equipped with four rotating heads for a four-throw crankshaft or additional heads where there are a greater number of throws on the work. The heads are independent of each other and each rotates on its own axis.

* * *

LIGNUM-VITAE AND SOME OF ITS MANY USES

In a recent number of the *Scientific American Supplement*, some interesting information concerning lignum-vitae is given by F. J. Record. It is stated that of all the woods in existence, true lignum-vitae is the only one that has been found equal to such service as is required for bearings for the propeller shafts of battleships, destroyers, etc. The peculiar properties of the wood which adapt it for this purpose result from the arrangement of the fibers and the resin content of the sap cells. The fibers do not run straight up and down the log, but weave back and forth in a serpentine manner, crossing and recrossing like the corded fabric of an automobile tire. The result is a material of extreme tenacity and toughness. When the sap cells cease to function, every nook and crevice becomes filled with a resin which is about a third heavier than water. The wood weighs about eighty pounds per cubic foot. There are many other uses for this valuable wood, such as rollers for casters, mallets, sheaves or pulleys, stencil and chisel blocks, dowels, wooden cogs, water wheels and block guides for band saws, etc. In building the Panama Canal, true lignum-vitae made the most serviceable railroad ties that could be obtained.

* * *

CAPITALIZATION OF AMERICAN INDUSTRIES

The total amount of capital invested in the railroads and the industries in the United States has been estimated to amount to about $39,000,000,000. This capital is distributed among the various industries as follows:

Railroads (value of roads and equipment)	$16,145,532,000
Iron and steel	4,281,998,000
Chemicals	3,034,209,000
Textiles	2,810,848,000
Food	2,174,387,000
Lumber	1,723,456,000
Paper and printing	1,433,176,000
Beverages	1,015,715,000
Metals (other than iron)	1,013,632,000
Stone, clay, and glass	987,328,000
Vehicles	803,496,000
Leather	743,347,000
Railroad repair shops	417,706,000
Tobacco	303,840,000
All other industries	2,047,842,000

It will be noted that the total investment in the industries and railroads is less than twice the amount raised by the Liberty loans during a period of two years.

FRANCE RECOVERS MACHINERY FROM GERMANY

Commercial Attaché C. P. Snow reports from Paris that the "Recuperation Service" and the "Restitution Service" of the French Ministry of Industrial Reconstruction has made a report concerning the work of identifying and returning to France of French machinery that had been carried off and made use of by the Germans. Up to the end of March the Restitution Service had shipped from Germany back to the departments in the north of France 1085 tons; at the end of May the total had gone up to 18,511 tons; and since that date substantial shipments have been made from time to time. There were also 200 carloads, with 2265 tons of machinery, shipped from Germany to Alsace, and 2980 tons found and identified in Belgium, shipped back to the original factories in the north of France. The total reshipped into the devastated regions of the north and into Alsace up to the end of May was over 21,000 tons. At that same date over 15,000 tons of identified machinery was being dismounted and loaded in Germany, and 20,000 tons more had been identified in the Grand Duchy of Luxemburg and in Germany, concerning which the representatives of the French Ministry of Industrial Reconstruction were awaiting instructions from the French manufacturers concerned.

* * *

NATIONAL SCREW THREAD COMMISSION

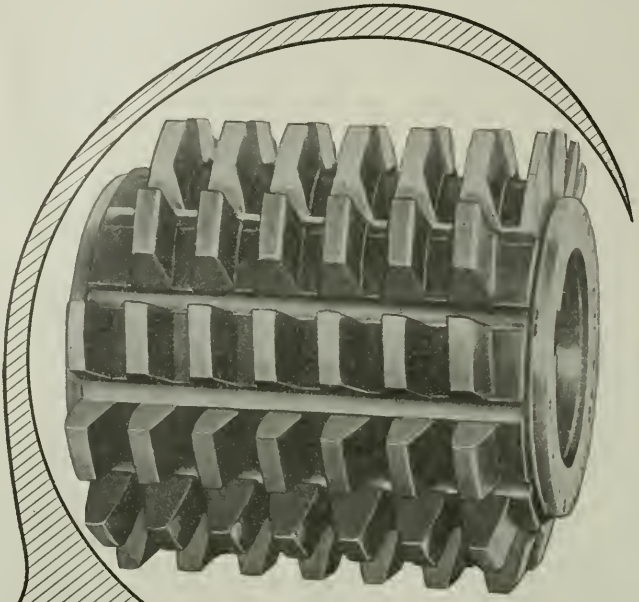
The National Screw Thread Commission has returned from Europe where it held a number of conferences in England and France on the subject of international screw thread standards. The results of the conferences and other efforts of the commission are requests from Great Britain and from France for further Anglo-American and Franco-American conferences for the purpose of arriving at an international standard for screw threads. The commission gained a broad knowledge of the art and manufacturing methods involved in screw thread production abroad, and has attained an understanding of the foreign situation to such an extent that it is felt that considerable progress has been made toward an international standard. The last public hearing in America on national screw thread standards will occur on Monday, October 6, 1919, at 10 A. M. in the Engineering Societies Building, 29 W. 39th St., New York City. The engineering bodies interested and the industries manufacturing and using screws will meet and give full and final consideration to the report. A general invitation is issued to all who are interested to attend.

* * *

The American Association of Engineers has grown so fast during the last six months that the national headquarters of the association in Chicago has outgrown its quarters. Within the next two or three weeks the headquarters will be moved from the present location at 29 S. La Salle St., to the Nepeenauk Bldg., at 63 E. Adams St., where a lease has been taken on 6000 square feet of office space. The Chicago chapter, which has over 1100 members and which is now the largest engineering society in Chicago, will take over the space vacated by the national headquarters of the association.

* * *

The University of London has announced that it will establish degrees in commerce. It is proposed to institute a three-year course of study leading to the degree of Bachelor of Commerce. The addition of a minimum of two years' practical experience in the particular trade or industry selected would qualify the candidate for the degree of Master of Commerce. The subjects of study comprise organization of industries, banking, trade and transportation, economic developments of the British Empire and of the chief foreign countries, commercial law, and statistical methods. In addition, the student will specialize on certain subjects during the second and third years, according to his own choice.



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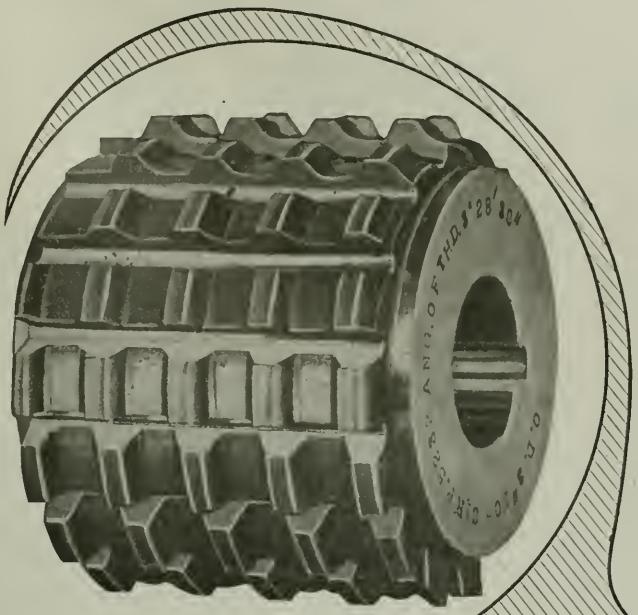
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RIGHTS CONFERRED BY PATENTS

By CHESLA C. SHERLOCK

Patent rights are so often misunderstood that it is advisable to discuss them briefly, particularly from the standpoint of the patentee. It is true that the effort necessary to secure a patent often seems to be worth more than the grant but a good invention more than pays for the trouble.

A patentee becomes the immediate possessor of three individual rights which are absolutely unassailable and in which the Federal Government will protect him for a period of seventeen years. Briefly, he has the right to prohibit others from making, using, or selling the invention during that time. These are not the only rights which the patentee acquires, but they are the principal ones. Other rights are merely incidental to these and necessary to the full enjoyment of the three fundamental rights. Among the additional rights are the right to injunction against further infringement and to recover profits on all articles already made; and the right to restrict making, using and selling the article in any manner desired.

The Right of Restriction in Making, Using and Selling an Article

These secondary rights are almost as valuable as the principal ones. Particular attention is directed to the right to restrict the making, using and selling of the article in any manner desired. This is a matter seldom understood by the patentee. No better example of the true rights of the patentee can be cited than the example of a safety razor. This razor is sold to retail dealers at about $3 with the agreement that it must be resold to the consumer at $5. Any cut in price will amount to an infringement of the patent and render the dealer liable upon that basis. Furthermore, the retailer signs a contract whereby he virtually acknowledges the validity of the patents under which the razor is made, so that he can never attack the company on that score. In the case of the blades, a similar agreement exists, but additional restrictions are placed upon the user of the blade to the extent that to resharpen the blade will be an infringement of the patent and render the purchaser of the blade liable as such. The courts have upheld this right on the part of the company making the razor, saying that the patentee has the right to restrict the making, using, and selling of his patented article in any manner he desires.

A case of interest along the same line is one in which the question of fixing resale prices through wholesalers was decided. In this case, the patentee sold his articles to wholesalers and attempted to fix the price at which retailers could sell to the general public. One of the retailers cut prices. Action was promptly started against the retailer for infringement, but the latter contended that he was within his rights and that the patentee had no right to control prices through more than one party, and that such a grant of authority would amount to restraint of trade. The court adopted the retailer's view of the matter, so it is a matter of law now that retailers can no longer be held as infringers if they cut the selling price, provided the article has not come to them directly from the patentee. Manufacturers and others owning patents can get around this decision, and doubtless will, by establishing their own branch houses and eliminating all middlemen, so that they deal directly with the retailers themselves. Then they can control the resale price to the public.

The Right of the Patentee to License Another to Use His Invention

Another very important right exercised by the patentee is that of licensing his invention to others, thereby keeping a direct hold on the article and restricting its use to his own desires. The patentee unquestionably has the right to license others to use his invention, and he may restrict them in the use of the article in almost any conceivable manner. In speaking of this matter, one court said: "Within his domain the patentee is czar. The people must take the invention on the terms he dictates or else let it alone for seventeen years. This is a necessity from the nature of the grant. Cries of restraint of trade and the impairment of the freedom of sales are unavailing, because for the promotion of the useful arts the constitution and the statutes authorize this very monopoly." This is a point seldom realized by patentees. A patent is a *monopoly*, and the most absolute monopoly that can be created in law.

A patent is personal property, and cannot be taken away from the patentee or his assigns, except by due process of law, which in this case, means constitutional decrees of the courts. A patent cannot be seized under a writ or other execution under the common law, although it may be attached by a creditor's bill in equity, in default of payment of a judgment so obtained.

The patentee must give notice to the public that the article he is selling them has been patented. He must plainly stamp each article made with notice that it is patented. He may continue to so mark the articles even after the patent has expired, but to so mark an article which has not been patented is a criminal offense, punishable by a $100 fine, one-half of which goes to the person bringing the action.

Joint Ownership of Patents Different from Joint Invention

Where several parties own a patent, an interesting situation arises. Any party may sell his rights or dispose of them in whatever manner he desires, absolutely independently from the others, even if the relative interest is unbalanced. Where a patentee so disposes of a portion of his patent by means of a license, it is interesting to note that the licensee does not become an owner of a part of the patent, even in the most limited sense of ownership. A licensee has absolutely no rights of ownership and must not be considered to have, even though the license grants him the right to make, use and sell the article in a limited sense.

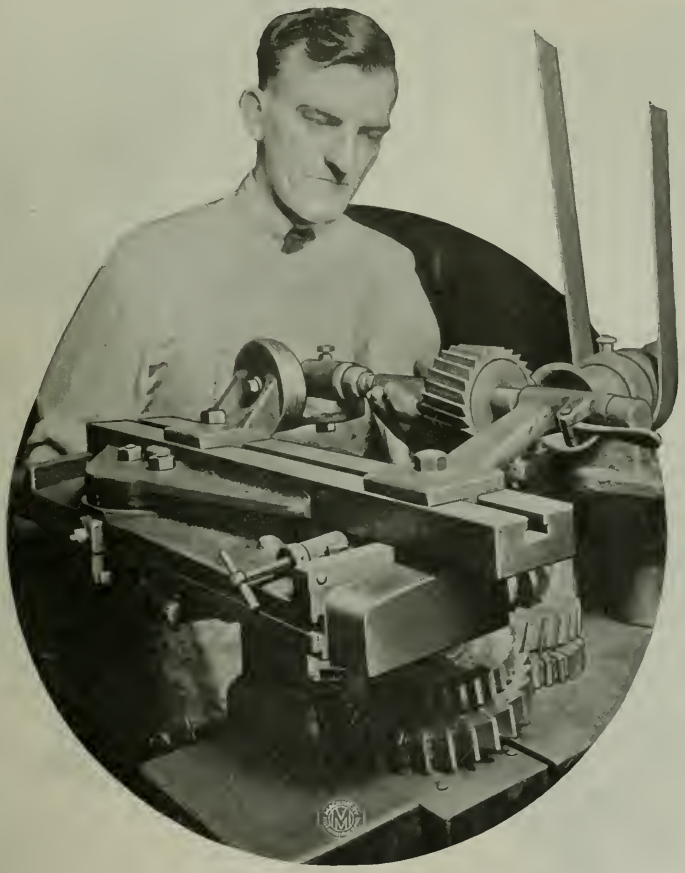
Where there are joint inventors, the patent may be taken out in the name of both, but where it is taken out in the name of two parties when one of them is in fact the sole inventor, the patent is invalid. This often arises in cases where an employe invents a new machine and the employer furnishes the money. Both feel that their own interests must be protected, so they take out the patent in their joint names. Unless the employer is an actual co-inventor, the patent as issued is invalid. It is possible for only the inventor to receive the patent in his name, but he may in turn assign all or part of it as he desires, and the employer's interest will be fully protected by entering into a contract with the employe, whereby the latter is to assign a certain portion of the patent or all of it, as the case may be, to the employer as soon as it is issued from the Patent Office. This statement concerning joint inventors must not be confused with joint ownership. There may be joint ownership in a patent, but that is radically different from joint invention.

The purpose of the Government is to grant the patent, and the monopolistic rights going with it, to the actual inventor. One man may merely have the idea of the invention and go to another and have him make the necessary machinery to carry it out, but the first party acquires the patent rights because he is deemed the real inventor. If the man hired to put the plan into execution adds minor improvements of his own, they become the property of the first party, unless they amount to new inventions in themselves. Thus the Government protects those of limited mechanical skill in their conceptions.

* * *

The American Zinc Institute recently formed, has, as one of its objects, to free zinc from its many nicknames, and is making an effort to discourage the use of such names as spelter, blende, jack, and like misnomers. The institute has now over 140 members representing practically every zinc mining and zinc smelting interest in the United States. Many trade journals, the United States Geological Survey, and the Bureau of Mines have already agreed to call zinc by its right name.

CINCINNATI
CUTTER GRINDERS



"It's the handiest little grinder I ever came across, and the best equipped with REAL attachments," said the toolroom foreman.

This Cincinnati grinder at the plant of the Consolidated Mfg. Co., Toledo, not only grinds all the cutters for more than a dozen Cincinnati millers but does a lot of tool and gage work besides. That's the kind of cutter grinder every shop wants.

Cincinnati cutter grinders are made in two sizes; the No. 1 Plain mentioned above, and the No. 1½ Plain and Universal. Both are fully described in the New Cincinnati Grinder Book—a complete treatise on cutter grinders and successful tool grinding. Write for a copy.

THE CINCINNATI MILLING MACHINE CO.

CINCINNATI **OHIO, U. S. A.**

MACHINES FOR EMBOSSING METAL SHIPPING TAGS

Thousands of freight and express shipments are lost annually due to inadequate marking of their destination. Linen and paper tags are commonly used for this purpose and it frequently happens that the tags become torn off and lost, or else are so covered with oil, grease, or dirt that they are illegible. As a result, it is impossible for the article to reach the customer and it is sent to the claim department of the express or railroad company. Often a machine manufacturer receives an order for a repair part, and after completing the part in record time, it is shipped to the customer. Then, if in some manner the tag becomes lost or unreadable during the transportation, much time elapses before the impatient customer receives the part, if he receives it at all. In many such cases the customer is likely to intimate that the article had never been shipped, and as a result business relations become strained.

Metal tags having the destination of the article stamped or embossed thereon, are a vast improvement over paper and linen ones. In order to produce such tags the machines shown in the accompanying illustrations have been developed by James H. Matthews & Co., 3946 Forbes St., Pittsburg, Pa. The machine illustrated in Fig. 1 was designed for producing a quantity of identical tags. The embossing is done by means of steel type which is set in the lower holder *A*. The holder is removed from the machine in order to set the type. The upper holder *B* contains a block of wood on which an impression of the type is made, after which it serves as a female die. This impression is made after the lower holder has been placed in position, by operating the ram several times by means of a foot-lever. The metal tags are placed on the lower holder and a completed tag is produced at each stroke of the ram. Trademarks, export symbols, or any style of printing can be set up as required. It is stated that a boy can reset the type in from five to ten minutes, and that between 4000 and 5000 tags can be embossed per day.

Fig. 2 shows a machine designed for cases where only one or two identical tags are required at a time. In this machine the tag is embossed letter by letter, the action being similar to that of a typewriter. Two or three tags can be embossed at the same time by simply placing them under each other. The machine is equipped with a device that automatically brings the tag in the proper position to be embossed. The desired type is brought into the stamping position by turning the handwheel *A* in the proper direction, after which the embossing operation is performed by pushing down a handle. Dial *B*, which contains all the numbers, letters, and other characters that can be embossed on the machine, is provided with a marker which points to a character on the dial similar to the one which is in the position to be embossed when handwheel *A* is brought into position.



Fig. 1. Machine on which a Completed Tag is produced at Each Stroke

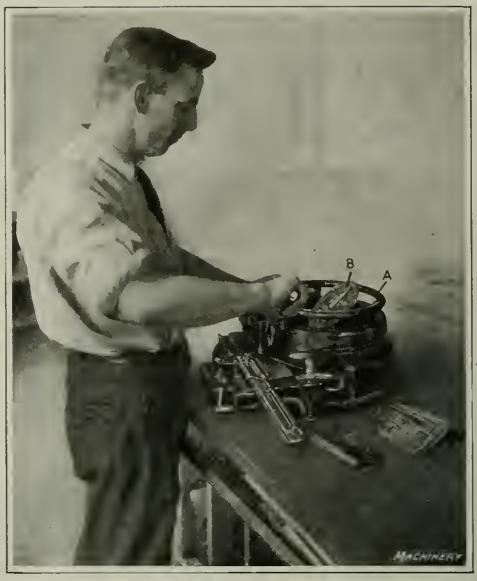


Fig. 2. Machine on which the Embossing Action is Similar to that of a Typewriter

The metal tags embossed on these machines may also be used for identifying work that is in the process of manufacture. They may be attached to material that must go through a pickling plant, an annealing furnace, or some similar treatment, and after being subjected to these conditions, the tags will still be legible. In this way, material on one order can be treated along with material on another order without danger of the orders becoming mixed.

* * *

WESTINGHOUSE COMPANY BUILDS HOMES FOR EMPLOYES

Owing to the difficulties experienced by the employes of the Westinghouse Electric & Mfg. Co. in obtaining homes near the East Pittsburg works, the company has resumed its home building activities that were postponed during the war. Forty-eight new houses are now under construction and it is expected ultimately to erect, on the tract of 109 acres on which these homes are now built, homes for 600 families. The houses are of first-class construction, built from brick with hollow tile backing, and have concrete cellars and cement porches. They consist mainly of five, six, and seven rooms, and will be sold at cost on easy terms to the employes of the company. In the past the Westinghouse company has constructed a great number of homes for its employes and also owns a number of homes and apartments which are rented to the men in the plant. An effort is made, however, to have the men acquire their own homes, and this, without question, is one of the best steps toward assisting the workers in becoming stable, self-respecting men and home-owners who cannot easily be swayed by unsound economic doctrines. If all manufacturing enterprises of a size large enough to warrant the undertaking would attempt to do this, they would render a great public service.

It Is a Pleasure to Produce a Boring Fixture Like This



Forty-two holes up to 4″ diameter and averaging 4″ deep—and dimensions, any one hole to any other, all check up within 0.001″. This fixture is a good example of the work done by the Gem City Machine Co. Dayton—it is a good example also of what we mean when we talk about *Lucas Boring Machine Precision.*

LUCAS MACHINE TOOL CO. NOW AND ALWAYS OF **CLEVELAND, OHIO, U.S.A.**

FOREIGN AGENTS: Alfred Herbert, Ltd., Coventry. Societe Anonyme, Alfred Herbert, Paris. Societe Anonyme Belge, Alfred Herbert, Brussels. Allied Machinery Co., Turin, Barcelona, Zurich. Benson Bros., Sydney, Melbourne. V. Lowener, Copenhagen, Christiania, Stockholm. R. S. Stokvis & Zonen, Rotterdam. Andrews & George Co., Tokyo.

NEW BOOK ON DRILLING PRACTICE

MODERN DRILLING PRACTICE. By Edward K. Hammond. 230 pages, 6 by 9 inches; 137 illustrations. Published by THE INDUSTRIAL PRESS, 140-148 Lafayette St., New York City. Price, $2.50.

The material published in this book was collected by the author, as associate editor of MACHINERY, and comprises a study of drilling practice in a great number of plants throughout the United States. A number of important changes have been made during recent years in the methods of drilling holes in interchangeable manufacture. A great increase has been made in the speed at which twist drills are driven. Various types of universal or special multiple-spindle drilling machines and auxiliary drill heads are more generally used than formerly, and semi-automatic drilling machines are also successfully employed. All these developments in drilling practice have been introduced with a view to increasing production; and in preparing this book, the author's object has been the same. The methods described are those that have been thoroughly tried out under actual manufacturing conditions.

In addition to the description of methods for obtaining maximum production by drilling machines, many associated subjects, such as the proper grinding of twist drills, are dealt with, because of their great importance. Different types of drills, drill sockets, and drill chucks are also described, and speeds and feeds for drilling are dealt with in detail.

All mechanics are familiar with the various types of drilling machines generally used in machine shops. On this account nothing beyond a brief description of the essential features of each type has been included, because detailed descriptions would be of no practical value in a book of this kind. Examples of good practice in operating each type of machine are completely illustrated and described, however, giving information concerning the material, the size of holes being drilled, the speed and feed at which the operation is performed, and the rate of production which is obtained.

The book is divided into ten chapters, headed as follows: General Types of Drilling Machines and Their Application; Multiple-spindle Drilling Machines of Standard and Special Design; Automatically Controlled Drilling Machines of Special Design; Speeds and Feeds for Drilling; Types of Drills and Drill Sockets; Types of Commonly Used Drill Chucks; Drill Grinding; Drilling Machines Applied to General Manufacturing Operations; Jigs, Fixtures, and Special Tools for Drilling Machines; Deep-hole Drilling.

The book should be of considerable value to men responsible for the production obtained in the drilling department of a machine shop, whether in the capacity of superintendents, mechanical engineers, or foremen, as well as to drill press operators who are anxious to increase their knowledge of modern drilling methods. Designers and draftsmen engaged either in drilling machine design or in the design of jigs and fixtures for work performed by drilling, will also find considerable information of value to them in this book.

* * *

A. S. M. E. SEPTEMBER MEETING

The New York section of the American Society of Mechanical Engineers held its regular monthly meeting at the Engineering Societies' Building, 29 W. 39th St., New York City, September 17, at which meeting the subject of "Industrial Unrest" was dealt with in an address by Dr. William M. Leiserson, who gave a review of the present conditions in the industries with particular relation to labor difficulties. A number of other speakers joined in the discussion.

OBITUARIES

OTTO A. RUEMELIN, works manager and second vice-president of the Pawling & Harnischfeger Co., Milwaukee, Wis., died September 1. Mr. Ruemelin had been associated with the Pawling & Harnischfeger Co. for thirty years, having started in the shop as an apprentice. After several years as journeyman, he was promoted successively to the foremanship of various departments. His energy, ability, and kindly nature made his rise rapid from assistant superintendent to superintendent and finally to works manager, which position he held since 1912.

PERSONALS

H. F. HIMES, formerly with the Dimler-Himes Tool Co., Dayton, Ohio, is now manager of the Dayton branch of the Wayne Machinery Co., 18 W. 2nd St.

HERCULES SMART, formerly manager of the New York office of the Illinois Tool Works, Chicago, Ill., has been appointed manager of the company's Detroit store, succeeding D. J. Rice.

MARSHALL J. ROOT, formerly president of the Seneca Falls Mfg. Co., Inc., Seneca Falls, N. Y., has disposed of his interests, and is now vice-president of the Fairbanks Co., New York City.

H. M. THOMAS, for many years superintendent of the Anderson Engine Co., 4036 N. Rockwell St., Chicago, Ill., is now production engineer of the United States Tractor & Machinery Co., at Menasha, Wis.

ERWIN L. MALONE has been appointed Cleveland district representative of the Hess Steel Corporation, Baltimore, Md. His headquarters will be located temporarily at the Cleveland Athletic Club, Cleveland, Ohio.

H. C. JONES, for several years connected with the Lodge & Shipley Machine Tool Co., Cincinnati, Ohio, as special European representative, has entered the sales organization of the J. R. Stone Tool & Supply Co., 997 Woodward Ave., Detroit, Mich.

JOHN M. HOWETT, formerly of the Cincinnati and Chicago offices of the Pratt & Whitney Co., has opened a sales office at 16 W. 2nd St., Dayton, Ohio, to handle a full line of machine, production, and small tools under the firm name of John M. Howett.

E. V. WENZELL, for more than ten years demonstrator and sales representative for the Norton Co., Worcester, Mass., has become affiliated with the Modern Tool Co., Erie, Pa., as western representative, and will be stationed at the company's Chicago store and office, 32 N. Clinton St.

S. E. WEAVER, for several years manager of the Union Twist Drill Co. in eastern Pennsylvania and the southern territory has joined the sales force of the Davidson Tool Mfg. Corporation, 118 Maiden Lane, New York City, and will represent that company in a similar capacity in his old territory.

GEORGE W. CRANE has been made president of the Seneca Falls Mfg. Co., Inc., Seneca Falls, N. Y., succeeding Marshall J. Root. Mr. Crane was formerly associated with the Pierce, Butler & Pierce Mfg. Corporation, manufacturer of boilers and radiators and jobber of plumbing supplies, as assistant sales manager.

ROBERT K. GREAVES, for several years connected with H. Boker & Co., Inc., as manager, has been made sole United States agent for Sanderson Bros. & Newbould, Ltd., Sheffield, England, manufacturers of high-speed tool and alloy steels. Mr. Greaves will be located at Machinery Hall, 549 W. Washington Blvd., Chicago, Ill.

HARRY M. GILES has been appointed general superintendent of the South Philadelphia works of the Westinghouse Electric & Mfg. Co., succeeding Oscar Otto, who was killed in an automobile accident. Mr. Giles has risen from the ranks in the organization, and has been, for a number of months past, superintendent of marine erection.

HARRY J. LINDSLEY, who has been western sales manager of the Bound Brook Oil-less Bearing Co., Bound Brook, N. J., for the last seven years, and WILLIAM F. JENNINGS, who has been eastern sales manager for the last five years, have been made vice-presidents and will continue to serve the company and its customers the same as in the past.

L. T. FREDERICK has recently become associated with the Chicago Mica Co., Valparaiso, Ind., as consulting engineer and production manager. Mr. Frederick was formerly process engineer of the Westinghouse Electric & Mfg. Co., East Pittsburg, Pa., and has had a wide experience in the manufacture and application of all lines of electric insulation.

W. L. KERLIN, who was in the United States Army Service as Major in the Mobile Ordnance Unit on the French front and who previously had considerable experience in the machinery and machine tool line, is now representing the P. W. V. Automatic Machine Corporation of Fitchburg, Mass., in the company's New York City office at 143 W. 40th St.

H. EARL SWEITZER has become connected with the Allsteel-equip Co., Aurora, Ill., as sales manager in charge of sales and advertising. For the past year Mr. Sweitzer has been assistant sales manager, and previous to that was advertising manager for several years with the Appleton Mfg. Co., Batavia, Ill., manufacturer of farm implements and tractors.

A. L. DELEEUW has resigned his position with the Singer Mfg. Co., Elizabethport, N. J., and has opened an office in the Singer Building, 149 Broadway, New York City, in a consulting engineering capacity. Mr. DeLeeuw will devote himself to planning the buildings and equipment of industrial plants, and will make a specialty of machine shop problems with a view to securing economical production.

SCREWS

MACHINE, WOOD, CAP, SET, LAG, ETC.

We Have the Assortment and the Quantity

Let us figure on your next specifications. We have managed to "take care" of some very large concerns both in price and delivery.

HAMMACHER, SCHLEMMER & CO.

HARDWARE, TOOLS AND SUPPLIES

NEW YORK SINCE 1848 4th AVENUE and 13th STREET

DR. THOMAS M. LEGGE, chief medical inspector of factories, in Great Britain, has been invited by Harvard University to give a course of lectures under the auspices of the school of public health of Harvard University and the Massachusetts Institute of Technology, and the division of industrial hygiene. Dr. Legge will lecture in Boston during November on the following subjects: Twenty Years' Experience of the Notification of Industrial Disease; Twelve Years' Experience of Workman's Compensation Act and Industrial Diseases; Medical Supervision in Factories; Industrial Poisons and their Prevention; Anthrax; Fumes and Gases; and Industrial Fatigue.

A. A. SCHNEIDER, formerly with the Raw Materials Department of the Midvale Steel & Ordnance Co. and the Cambria Steel Co., has been appointed manager of the newly created Raw Materials Division of the American Steel Export Co., 3004 Woolworth Bldg., New York City. Prior to entering military service in 1917 as a Lieutenant of the Field Artillery, Mr. Schneider for several years had been assistant to H. F. Black of the Midvale Steel & Ordnance Co. and the Cambria Steel Co., and has had a wide experience in the raw materials and metals trade. He will handle imports, exports, and domestic sales of pig iron, manganese, chrome and low-phosphorus iron ores, ferro-alloys, coal, and coke.

COMING EVENTS

October 1-4—Eighth annual safety congress of the National Safety Council in Cleveland, Ohio. Offices of the council, 168 N. Michigan Ave., Chicago, Ill.

October 15-16—Annual convention of the National Machine Tool Builders' Association in New York City; headquarters, Hotel Astor. General manager, Charles E. Hildreth, Worcester, Mass.

October 30—Monthly meeting of the Rochester Society of Technical Draftsmen, in Rooms 131-137 Sibley Block, 328 Main St., E., Rochester, N. Y. Secretary, O. L. Angevine, Jr., 547 Arnett Blvd., Rochester, N. Y.

February 2-6, 1920—First annual mechanical inspection equipment exposition and convention of the American Society of Mechanical Inspectors at the Hotel Astor, New York City. Secretary, Henry F. Winter, 35 W. 39th St., New York City.

May 12-15, 1920—Seventh national foreign trade convention in San Francisco, Cal. Secretary of the National Foreign Trade Council, O. K. Davis, 1 Hanover Square, New York City.

BOOKS AND PAMPHLETS

Exercises in Lettering—Slant Gothic. By George G. Greene. 31 pages, 2½ by 5 inches. Published by the Bruce Publishing Co., Milwaukee, Wis. Price, 10 cents.

This little book is one of a vest pocket series containing instructions for lettering. It comprises sixteen exercises intended to train the student to produce slant Gothic lettering neatly and rapidly.

Constitution and Metallography of Aluminum and its Light Alloys with Copper and with Magnesium. By P. D. Merica, R. G. Waltenberg, and J. R. Freeman, Jr., of the Bureau of Standards. 15 pages, 7 by 10 inches. Published by the Department of Commerce as Scientific Paper No. 337 of the Bureau of Standards, Washington, D. C. Price, 10 cents.

Laboratory Experiments with Direct Currents. By Professor F. E. Austin, 152 pages, 4½ by 7½ inches. Published by F. E. Austin, Hanover, N. H.

The subject matter that is presented in this laboratory manual is the result of the author's experience in the organization of electrical laboratories and the teaching of laboratory courses during a period of over fifteen years. The experiments outlined are designed for students in technical and industrial high schools, as well as those pursuing shorter courses in higher institutions of learning. Questions and problems to be worked out accompany each experiment. The matter covers use and care of millivoltmeters, milliameters, and wattmeters; curve plotting; measurement of resistance; mapping magnetic fields; arc lamp measurements; experiments with potentiometer; measurement of permeability; testing ammeters; and testing shunt generators and motors and direct-current motors.

Dyke's Automobile and Gasoline Engine Encyclopedia. By A. L. Dyke. 960 pages, 6½ by 9¾ inches. Published by A. L. Dyke, St. Louis, Mo. Price, $5.

This is the tenth edition of a comprehensive encyclopedia covering the automobile and gas engine field. The book has been revised and many new subjects are presented in this edition. Included in the new material is information on how to make electric tests of the starting motor, generator, battery, coils, magnetos, etc. The book covers every detail of construction and repair of automobiles and gas engines, and deals with tractors, motorcycles, airplanes, and airplane engines. The automobile instruction section was prepared with the idea of presenting in clear, simple form the principles upon which gasoline engines and automobiles are built and operated, and explains in detail all that must be understood in order to operate and care for any make of car or gasoline engine. To make clear the modern details of an automobile and its parts, it seemed necessary to illustrate and describe the early types of cars and gradually work up to the more modern types. The subjects covered are Automobile Assembly; Drive Systems; Steering Assembly; Axles, Differentials and Bearings; Clutches, Universal Joints, and Transmissions; Engines; Carburetion; Cooling and Lubrication; Ignition—Coil and Battery; Ignition—Magnetos; Electric Systems; Operation, Care, etc.; Tables, Specifications, etc.; Tires; Troubles and Remedies; Repairing and Adjusting; and Miscellaneous. The supplements of the book treat of the Ford and Packard Cars, Airplanes, and the Liberty Engine; Wiring Diagrams. The index covers thirty pages.

NEW CATALOGUES AND CIRCULARS

Link-Belt Co., Chicago, Ill. Circular of Link-Belt motor trolley hoists.

Callis Co., Clinton, Iowa. Price list of "Use-Em-Up" and standard types of drill sockets and sleeves.

Peter A. Frasse & Co., Inc., 417 Canal St., New York City. Price list of Frasse cold-finished screw steel and shafting.

Belt-Grip Pulley Co., Buffalo, N. Y. Circular of "Belt-Grip" leather pulleys, leather buffing wheels, and leather rim truck casters.

Detroit Heating & Lighting Co., Detroit, Mich. Circular advertising the Detroit laboratory burner and the Detroit combination gas machine.

United Machine & Mfg. Co., Canton, Ohio. Circular giving dimensions, weights, prices, etc., of "United" standard cast-iron surface plates.

Gisholt Machine Co., Madison, Wis. Circular advertising the Gisholt "Periodograph" for automatically recording workmen's time in the shop.

W. M. & C. F. Tucker, Hartford, Conn. Catalogue 6 (revised edition) covering the complete line of oil-hole covers and cups made by this company.

W. J. B. Slide Ruler Clip Co., 43 Center St., Springfield, Mass. Card advertising the "Safety First Mechanic's Friend"—a clip for holding slide-rules.

Frank E. Fitts Mfg. & Supply Co., 88 Purchase St., Boston, Mass. Circular describing an emery grinder for grinding tools, which is operated by a foot-treadle.

McInnes Steel Co., Ltd., Corry, Pa. Catalogue of McInnes hammered tool steels, listing the various grades and recommending the heat-treatments to be employed.

Stromberg Electric Co., 8 W. 40th St., New York City. Circular entitled "Prosperous Times Are Ahead," advertising Stromberg time recorders for cost keeping.

Liberty Tool Co., Munsey Bldg., Baltimore, Md. Circulars illustrating dolly bars, headiog attachments, portable drilling machines, rivet furnaces, and heating torches.

Oliver Machinery Co., Grand Rapids, Mich. Circular advertising the Oliver swing cut-off saws, which are made in many different sizes and styles for different classes of work.

Philadelphia Belting Co., Sixth and Spring Garden Sts., Philadelphia, Pa. Circular advertising "Superpacking"—a leather packing for hydraulic and pneumatic machinery.

E. S. Jackman & Co., Chicago, Ill. Circular listing the uses for which "Blue Chip" high-speed tool and die steel and Firth-Sterling special tool and die steel are adapted.

Smalley-General Co., Inc., Bay City, Mich. Bulletin D, showing typical operations performed on thread milling machines of this company's manufacture, and giving time studies for each.

Green Engineering Co., East Chicago, Ind. Circular containing a reprint of an article, "Characteristics of Illinois Coal and How to Burn It," which gives data on chain grate performance.

Sohm Electric Co., 143 W. Austin Ave., Chicago, Ill. Circular descriptive of the Sohm keyless clocks made in types especially adapted for shops, factories, and industrial use in general.

National Lathe Co., 15 W. Second St., Cincinnati, Ohio. Catalogue O, illustrating and describing the National line of engine, turret, and gap lathes of the geared-head and cone-head types.

St. Louis Machine Tool Co., St. Louis, Mo. Catalogue 16, illustrating and describing the company's line of grinding, polishing, and tapping machinery, and giving specifications for the different sizes.

Richards-Ford Train Control Co., Inc., 403 Drovers and Mechanics Bank Bldg., Baltimore, Md., is desirous of obtaining catalogues of transmission machinery, conveyors, power plant machinery, pumps, etc.

S. F. Bowser & Co., Inc., Fort Wayne, Ind. Folder illustrating and describing a Bowser battery storage system for lubricating oil. These outfits are sold in one, two, three, or four units as required.

Ajax Metal Co., Philadelphia, Pa., has opened a branch office in Cleveland, Ohio, located in the Schofield Building. L. E. Purnell is district manager. The Pittsburg office of the company has been discontinued.

Skelton Tool Co., 406-408 Ash St., Syracuse, N. Y. Folder entitled "Where's Yours Coming From?", describing two new tools produced by the company—the Porter elevating toolpost and the Porter boring-bar.

Goulds Mfg. Co., Seneca Falls, N. Y. Circular entitled "From Paraffin to Paper Pulp and from Tanning Liquor to Tar," advertising Goulds triplex, centrifugal, deep-well, vacuum, rotary, and other types of pumps.

Duntley-Dayton Co., 1416 Michigan Ave., Chicago, Ill. Circular giving information about the Duntley air drill with detachable power unit, which is made in two sizes, having capacities of ¼ and ⅜ inch, respectively.

Wellman-Seaver-Morgan Co., E. 70th St. and Central Ave., Cleveland, Ohio. Bulletin 27, describing the W. S. M. automatic ore unloaders in operation on the Great Lakes. Copies of the bulletin are sent free upon request.

Pangborn Corporation, Hagerstown, Md. Circular entitled "How am I to Know?", reproducing a number of letters of recommendation of Pangborn service as applied to the selection, arrangement, and installation of sand-blast equipment.

Colonial Steel Co., Pittsburg, Pa. Tool Steel Treating Book, containing directions for the heat-treatment of high-speed steel and carbon tool steel. The book also includes lists of tools, and grades of Colonial steel best adapted for their use.

Milliken Bros. Mfg. Co., Inc., Woolworth Bldg., New York City. Catalogues 10 and 11, descriptive of Milliken all-steel fireproof buildings, which are constructed under the standardized truss unit system. Copies of the catalogues will be sent free upon request.

National Tube Co., Frick Bldg., Pittsburg, Pa. Bulletin 7 entitled "Manufacture and Advantages of National Welding-scale Free Pipe," comprising a treatise on the manufacture of seamless steel pipe, illustrated with views showing steps in the process of manufacture.

New Departure Mfg. Co., Bristol, Conn. Circulars 114 FE, 115 FE, 116 FE, and 117 FE, descriptive of the use of ball bearings in motor-driven pumps, canvas cushion wheels, electric breast drills, and bearings for wheels of sand mixing machines, respectively.

Electric Furnace Co., Alliance, Ohio. Booklet 13-B, containing a reprint of a paper entitled "Resistance Type Electric Furnaces for Melting Non-ferrous Metals," presented by T. F. Baily before the June meeting of the American Institute of Chemical Engineers, Boston, Mass.

James H. Matthews & Co., Pittsburg, Pa. Catalogue of Matthews "Quantitag" and "Unitag" machines for embossing metal tags by the use of steel type. With these machines, durable tags can be quickly and easily embossed with any desired marking, which it is practically impossible to obliterate.

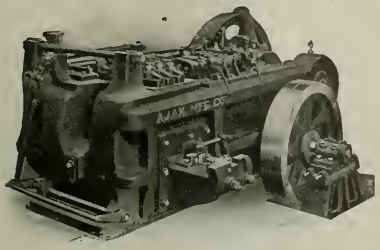
Gisholt Machine Co., Madison Wis. Catalogue comprising reprints of advertisements showing work done on Gisholt turret lathes, grinders, and boring mills, and containing information concerning the history and activities of the company. Folder ATL1, illustrating three jobs performed on Gisholt automatic turret lathes, and giving production time.

Westinghouse Electric & Mfg. Co., East Pittsburg, Pa. Circular 7149, entitled "Electric Arc Welding," describing the field of application of the electric arc welding process and methods employed in modern practice. The book contains much instructive material relative to the process of electric welding and includes sketches showing the correct methods of making various types of welds.

Allied Machinery Co. of America, 51 Chambers St., New York City. Catalogue (Section 11901) of the automatic threading lathes for external and internal thread cutting manufactured by the Automatic Machine Co. of Bridgeport, Conn. Catalogue (Section 14301) of horizontal boring, drill-

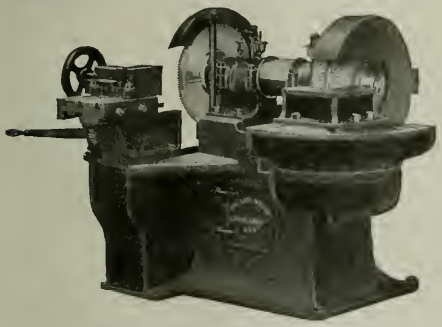
AJAX

(Trade Mark Registered)



Ajax Steel Bed Upsetting and Forging Machine

An indispensable machine for the Forge Plant, for the production of all kinds of car and locomotive forgings, giving maximum production and minimum maintenance cost.



Ajax Hot Saw and Burring Machine

These tools are rapidly developing to be a very essential part of the forge shop equipment for economical production in connection with Upsetting Forging Machines. Finished forgings are sawed from the hot bar and the flash is hot milled or the stock can be prepared preparatory to upsetting.

Machines That Reduce Forge Shop Costs

Ajax Machines like these are saving thousands of dollars yearly in the forge shops of leading railroads here and abroad.

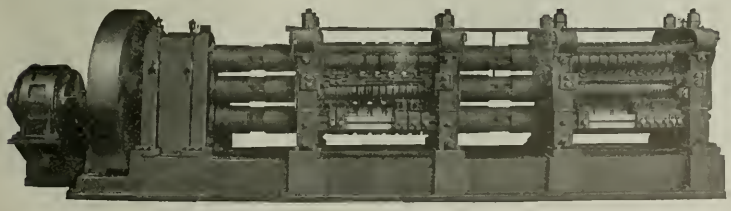
Over two-thirds of the forging machines in the world are Ajax-made.

Their value for rapid production of forgings of all kinds has been definitely proven by years of hard practical service.

There is an Ajax Machine which exactly suits *your* forge shop problems. Send us samples or blue prints and we will give you detailed figures on how much an Ajax Machine will save you.

THE AJAX MFG. COMPANY
Cleveland, Ohio

1369 Hudson Terminal, New York City
621 Marquette Building, Chicago, Illinois



Reclaiming Rolls

By re-rolling scrap pieces of iron and steel bars to form good stock of smaller size, rolls of this type are saving railroad companies and large factories many thousand dollars yearly.

Makers of

Automatic Feed Rivet and Bolt Headers, Hand Feed Rivet and Bolt Headers, Continuous Motion Heading Machines, Bulldozers, (High Speed and Standard), Hot Sawing and Burring Machines, Axle Upsetting Machines, Reclaiming Rolls, Universal Forging Machines, Hot Pressed Nut Machines, Taper Forging Rolls.

ing, and milling machines of the table type, manufactured by the Lucas Machine Tool Co. of Cleveland, Ohio.

Hyatt Roller Bearing Co., Metropolitan Tower, New York City. Engineering bulletin 125, treating of the construction of Hyatt roller bearing haugers for use on lineshafting, and giving list prices for the various sizes. The bulletin also gives transmission data on the size of shafting for transmitting different horsepowers, proper speed of lineshafting, and other related information.

American Stainless Steel Co., Oliver Bldg., Pittsburg, Pa. Circular describing the properties and uses of "Stainless" steel, which is said to withstand the action of the most common corrosive agents without the development of permanent erosion or a stain, and also to withstand high temperatures while exposed to air or other gases without scaling or pitting. These properties adapt the steel for such uses as cutlery, acid-handling machinery parts, furnace parts, etc.

J. T. Slocomb Co., Providence, R. I. Catalogue 16, covering the complete line of tools manufactured by the company, which comprises inside and outside micrometers and center drills. This catalogue also includes a publication of the company known as the "Measuring Book," which contains suggestions regarding accurate and economical measuring by the use of micrometer calipers. The Measuring Book contains, in addition, instructions for reading the micrometer, making proper allowances for various classes of fits, and other information of interest and value.

Taft-Peirce Mfg. Co., Woonsocket, R. I. Bulletin 107, illustrating and describing Simmons unit-pole magnetic chucks and their application for holding a wide variety of work. Bulletin 108, entitled "Take it to Taft-Peirce," containing a description of the Taft-Peirce contract service and plant. Bulletin 109, giving dimensions and price lists of Taft-Peirce plug, screw, and snap gages and milling cutters. Bulletin 110, illustrating and describing Taft-Peirce production and inspection tools, including taper gages, sine bars, V-blocks, equalizing jaws, parallels, adjustable knees, angle-irons, etc.

Clark Equipment Co., Buchanan, Mich., has issued a publication entitled "Putting Mettle into Metal" which should be of interest not only to users of twist drills but also to those who believe that a factory should be artistic in appearance and should have beautiful surroundings as well as other provisions for the comfort and happiness of the employes. The book contains a description of the plant in which the "Celfor" twist drills are made, and the illustrations show how the grounds have been beautified by trees and gardens. Other views show the activities of the company in providing for the diversion and welfare of its employes, among which may be mentioned the organization of a theater and orchestra, the construction of attractive homes for the employes, and the establishment of an up-to-date hospital. Various steps in the process of manufacture of "Celfor" twist drills are also illustrated.

TRADE NOTES

Scully-Jones & Co., 647 Railway Exchange Bldg., Chicago, Ill., have been appointed sales representatives for the Wetmore expanding reamer in the Chicago district, embracing Illinois, southern Wisconsin, Iowa, and northern Indiana.

Dickey Steel Co., Inc., Woolworth Bldg., New York City, has been appointed sales representative for the New York and Philadelphia district of the Worcester Pressed Steel Co. of Worcester, Mass., manufacturer of hot- and cold-rolled strip steel, and light and heavy metal stampings.

Davidson Tool Mfg. Corporation, 118 Maiden Lane, New York City, maker of "Davidsonized" high-speed steel milling cutters, has opened a factory sales office and stock-room in the Garfield Building, 804 Woodward Ave., Detroit, Mich., for the convenience of its Michigan customers. Alexander Hart, Jr., is in charge of the new office.

Rickert-Shafer Co., 612 W. 12th St., Erie, Pa., manufacturer of thread-cutting tools and machinery, is erecting a two-story brick and steel addition to its plant that will double the present floor space. The addition will be given over to the manufacturing of the company's expanding die-head and will be ready for occupation December 1.

Weber & Scher Mfg. Co., 24 Scott St., Newark, N. J., manufacturer of dies, jigs, fixtures, gages, special machinery, and appliances has recently organized an engineering department. The company is desirous of obtaining catalogues for its files covering small tools, machine tools, appliances, equipment, stock parts, materials, and supplies.

Driver-Harris Co., Harrison, N. J., is now selling its wire rope products direct to the trade instead of through its former selling agents. The company has increased its facilities to include all grades of rope in 6 by 7, 6 by 12, and 6 by 19 construction, such as drilling cable, elevator rope, haulage rope, sand lines, etc., in all sizes up to ¾ inch.

American Cement Machine Co., Inc., Keokuk, Iowa, desires to obtain catalogues of manufacturers and jobbers in iron, steel, and mill supplies. The company is enlarging its plant and putting in additional machinery and it would appreciate two copies of the latest catalogues from manufacturers in these lines, together with price list, for use in its engineering and purchasing departments.

Victor Tool Co., Waynesboro, Pa., has recently appointed the J. R. Stoue Tool & Supply Co., 997 Woodward Ave., Detroit, Mich., its exclusive agent for the state of Michigan to handle the company's entire line of self-opening die-heads, collapsible and adjustable taps, reamer-holders and nut facing machines. A stock of these tools will be carried in the Detroit office in order to serve the trade promptly.

Buerk Tool Works, 38-42 Pearl St., Buffalo, N. Y., has started in the business of making tools, dies, jigs, fixtures, and special machinery. Hans Buerk, manager and sole owner, was connected with the Pierce-Arrow Motor Car Co., Buffalo, N. Y., for ten years as supervisor of tools, and for the past two and a half years has been factory manager of the Columbus Die, Tool & Machine Co., Columbus, Ohio.

T. P. Walls Tool & Supply Co., Inc., 75-77 Walker St., New York City, has been made eastern agent for the Advance Tool Co. of Cincinati, Ohio, whose line includes milling cutters, gear-cutters, reamers, end-mills and lathe mandrels. The company has also been made agent for the Maxf Grinding Wheel Works of Chester, Mass., whose line includes all shapes and sizes of grinding wheels for various machines and operations.

Robert K. Greaves & Co., 549 W. Washington Blvd., Chicago, Ill., is a concern which has recently been formed by Robert K. Greaves, who for several years was manager of both the eastern and western offices of H. Boker & Co., Inc. Mr. Greaves has been appointed the sole United States agent for Sanderson Bros. & Newbould, Ltd., Sheffield, England, and will carry a large stock of that company's high-speed tool and alloy steels in all grades.

Independent Pneumatic Tool Co., Chicago, Ill., manufacturer of "Thor" pneumatic and electric tools, exhibited at the American Railway Tool Foremen's Association's convention in Chicago, August 27 to 29, a complete line of "Thor" pneumatic and electric tools for drilling, reaming, tapping, flue-rolling, wood-boring, chipping, calking, beading, and driving rivets. Among the new devices exhibited was the "Thor" hose coupling. The exhibit was in charge of F. J. Passino.

Carborundum Co., Niagara Falls, N. Y., has opened branch offices and a warehouse in the Burkhardt Building, Second and Larned Sts., Detroit, Mich. The Detroit branch is under the management of Anthony Dobson, who will have charge of the Detroit sales district. The new offices and warehouse are opened with a view to giving quicker and better service to the users of the company's products in the Detroit district; and a complete stock of carborundum and aloxite grinding wheels, carborundum and aloxite paper and cloth, and other carborundum products will be carried.

Globe Foundry Co., Sheboygan, Wis., has been incorporated by G. F. Honold, Gus A. De Wilde, Jr., and Fred Leicht. The company will engage in the manufacture of machinery and will operate a foundry for casting gray iron and other metals. A tract of land 200 feet square in extent has been purchased, and plans are in progress for erecting a building of brick and steel construction. When completed, the new building will be devoted exclusively to foundry work, while the foundry building of the present Globe company, which latter concern is absorbed by the new company, will be converted into a machine shop.

Burton, Griffiths & Co., Ltd., 1-3 Ludgate Square, London, England, which have been associated with the Birmingham Small Arms Co., Ltd., for many years as that company's sole representatives and agents for the sale of high-speed steel twist drills, milling cutters, etc., have exchanged shares with the Birmingham Small Arms Co., Ltd., thus making the interests of the two firms synonymous. The name and management of the business will be the same as heretofore, but this alliance will enable the company to extend its business to other spheres and to execute more important contracts than it has been able to undertake in the past.

Twin-O-Matic Machine & Tool Co., Inc., 160-168 John St., Brooklyn, N. Y., has recently been incorporated to undertake the manufacture of automatic double-end centering machines. The officers are E. R. Ramay, president and general manager; A. S. Pinkus, treasurer; and M. L. Burridge, secretary. Spacious quarters have been engaged and up-to-date equipment installed in a modern, concrete, fireproof building. In addition to double-end automatic centering machines, the company will also design and manufacture special and automatic machinery, in which line Mr. Ramay has had many years' experience. The company solicits circulars and periodicals for reference purposes.

F. H. Niles & Co., Inc., Woolworth Bldg., New York City, announces the following additions to its force: G. B. Goodman, who for several years has represented the Hisey-Wolf Machine Co. in the East, will take charge of the portable tool department of F. H. Niles & Co., Inc. This company handles not only the Hisey-Wolf line of electric machine tools but also the Canton pneumatic hammers and drills manufactured by the Pittsburg Pneumatic Co. in the East. F. H. Crawford has been appointed secretary of F. H. Niles & Co., Inc., and J. E. Haetten, sales manager. This company, which supplies machine tools and foundry equipment, is experiencing, in general, a constantly increasing demand for its products, and is taking the necessary steps to insure the proper maintenance of its sales service.

Westinghouse Electric & Mfg. Co., East Pittsburg, Pa., announces that it has awarded its four annual war memorial scholarships of $500 each, after competitive examinations, to Herbert S. Pahren, Cincinnati, Ohio, employed as order clerk in the Cincinnati office of the Westinghouse company, who will take an engineering course at the University of Wisconsin; Arthur Marthens, East Pittsburg, Pa., of the cost department of the company, who will take an electrical engineering course at the Carnegie Institute of Technology; Paul O. Langguth, of Wilkinsburg, Pa., a draftsman in the engineering department of the company, who will take an electrical engineering course at the University of Pittsburg; and Andrew P. Leasak, of Turtle Creek, Pa., employed in the production department of the company, who will take a mechanical engineering course at the University of Pittsburg.

Electrolytic Oxy-Hydrogen Laboratories, Inc., announces the formation of a sales and manufacturing company under the name of the Electrolabs Co. This will give the company an opportunity to enlarge its organization and to meet the increasing demands of its business. The Electrolytic Oxy-Hydrogen Laboratories, Inc., will continue in charge of the laboratories and will maintain a technical supervision over the work of the new company. The general offices and works of both companies have been moved from Dayton, Ohio, into larger quarters at 2635 Penn Ave., Pittsburg, Pa. The facilities for production of the new plant will be considerably increased. The general sales offices will continue to be located at 15 William St., New York City, and branch sales offices have been opened in the Morris Bldg., Philadelphia, Pa., and in the Merchants Exchange Bldg., in San Francisco, Cal. I. H. Levin will continue in charge of the technical and research work and D. J. Tonkonogy in general charge of sales.

Duff Mfg. Co., Pittsburg, Pa., manufacturer of lifting jacks, announces several changes in its production and engineering departments. W. C. Epstein, until recently in charge of the Production Engineering Division of the Bureau of Aircraft Production at New York, has been appointed general superintendent. Before entering the government service Mr. Epstein was associated with the American Brake Shoe & Foundry Co. of Chicago, Ill. E. M. Webb, recently discharged from the army as first lieutenant of the Ordnance Corps, is now shop superintendent. Mr. Webb was stationed at the Rock Island Arsenal in charge of experimental work, including the development and testing of the French 75-millimeter recoil mechanism. Before being commissioned, he was assistant to the production superintendent of the American Tool Works Co., Cincinnati, Ohio. John Kopf has been appointed manager of the engineering department. Before joining the Duff Mfg. Co. he was connected with the Bureau of Aircraft Production at Dayton, Ohio.

American Car & Foundry Co., 165 Broadway, New York City, has recently made a number of changes in its organization. James M. Buick, formerly vice-president and general manager, has assumed the direction of the sales division of the company and will be known as "vice-president in charge of sales." The office of general manager has been abolished. The production division will be directed by William C. Dickerman, who will be designated as "vice-president in charge of operations." He will be assisted by Frederick A. Stevenson, who will be head of the manufacturing section and will have charge of production in the car plants, rolling mills, and foundries. The engineering, improvement and research, and patent and industrial relations sections will also be under Mr. Dickerman's supervision. The headquarters of both divisions will be at the general offices of the company in New York. Both Mr. Dickerman and Mr. Stevenson have been connected with the company since its incorporation in 1899, having advanced from apprenticeships in the shops to their present positions of responsibility.

Foote-Burt Co., Cleveland, Ohio, manufacturer of single- and multiple-spindle drilling machines, and specialist in the design and manufacture of complete equipments for quantity production, especially for the automobile industry, has been reorganized. A. W. Foote, president and treasurer, and S. G. Burt, secretary, have retired. The Burt estate, representing the preferred stock interest, has been retired. G. E. Randles, formerly vice-president, becomes president, T. H. Doan, Jr., vice-president, W. S. Quinlan, secretary, and S. E. Gross, treasurer. The board of directors consists of the president, vice-president, and secretary, with J. R. Blakeslee and S. L. McCune. The company has been an Ohio corporation since 1906, at which time Mr. Randles joined it, and has been its active head for the past ten years. Prior to this it was a partnership for fourteen years of A. W. Foote and P. H. Burt. This reorganization contemplates the erection of a large modern plant at St. Clair Ave. and the Belt Line Railway, the purpose of which will be to take care of the large and constantly increasing demand for its product. Refinancing and reorganization has been through the medium of the Foote-Burt Machine Co., and the Maynard H. Murch Co., investment brokers.

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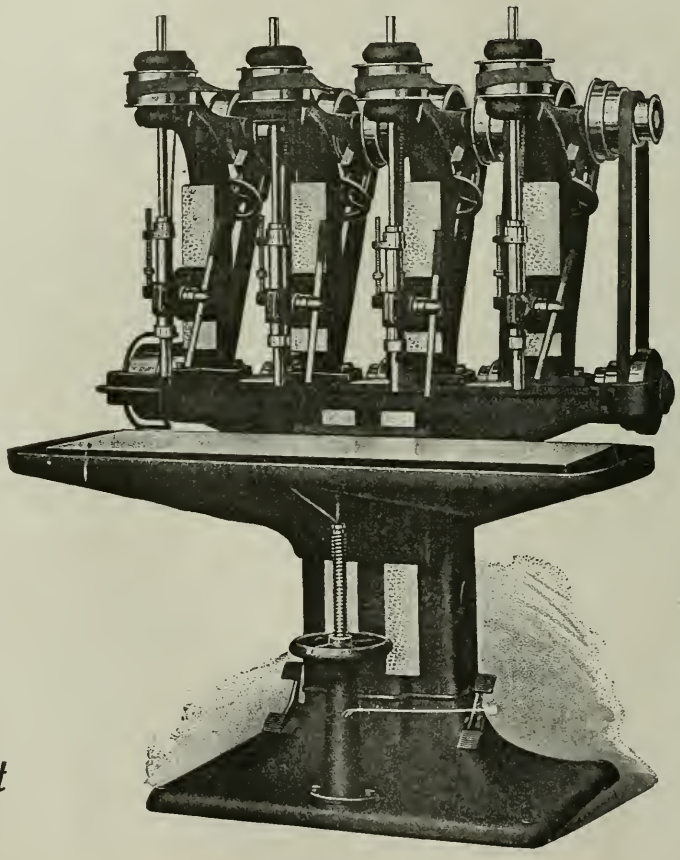
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Polishing Methods



By EDWARD K. HAMMOND

In polishing parts of metal products, there are a variety of types of equipment and kinds of abrasives which may be used. Attainment of successful results in polishing different metals is dependent upon the use of a suitable type of wheel or belt charged with abrasive material of the proper kind and coarseness to meet the requirements of the work. This article gives detailed information concerning the wheels, belts, and abrasives used by two companies which have had wide experience in the performance of polishing operations.

IN manufacturing various metal products, any of several different reasons may make it necessary to polish some of the parts. This may be done in order to improve the appearance of the surface of the metal from which a piece is made, it may be done for the purpose of preparing the work to receive some such finish as nickel plate, or certain other reasons may make it necessary to perform a polishing operation. The kind of surface that is finally produced before the product is shipped to the user will depend very largely upon the conditions under which it is to be used. For instance, machinists' scales, squares, micrometers, etc., are ordinarily finished by simply polishing the steel in order to give a uniform surface of good appearance, and one on which the graduations and figures may be easily read. Another common method of finishing is to polish the surface of the metal and then apply a coat of lacquer, in order to avoid deterioration through rust or corrosion of the metal. Still another commonly used method of finishing a polished surface is to apply a coat of nickel plate or some form of chemical treatment. Where any of these general methods is employed, the final finish produced on the work is accomplished by either electrolytically depositing nickel or some other metal, or by the action of chemical reagents upon the surface of the work. Regardless of the kind of finish that is applied to the metal, it is highly important to have a uniformly polished surface and one which is chemically clean, because in the presence of grease or any other foreign matter adhering to the surface that is to be treated by one of these methods, it will be found impossible to apply the nickel plate or the chemical treatment with sufficient uniformity to produce work of a satisfactory appearance.

Condition of a Polished Surface

The best idea of the results that are obtained through the performance of successive polishing operations will be obtained by examining the surface of the work under a magnifying glass, after taking each of the steps in polishing. Any machined surface of the work will be found covered with a series of ridges and scratches running in the direction in which the piece was passed under the cutting tool. Their coarseness will naturally vary according to the care which was taken in performing the final machining operation, but in any case it will be found impossible to produce work which will not show such defects when examined through a powerful lens. The purpose of a polishing operation is to rub down these ridges, in order that the surface may be brought to a condition approximating a perfect plane. Where the work is examined in each of the successive stages through which it passes in machining and

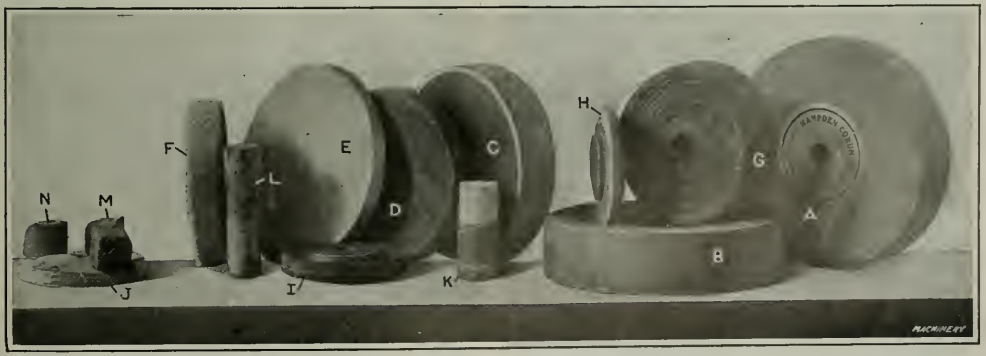


Fig. 1. (A) Corundum Grinding Wheel; (B) Set-up Wheel with Leather Segments mounted in Steel Frame; (C, D and F) Various Types of Set-up Wheels with Leather Face mounted on Wooden Disk; (E) Plain Felt Wheel; (G) Rag Wheel with Abrasive glued to the Polishing Surface; (H) Polishing Wheel with Face trued up to conform to Contour of Work; (I and J) Sheepskin Wheels, to be charged with Flour of Emery, Rouge, etc.; (K, L, M, and N) Grease and Fine Abrasive Material prepared in Sticks for Application to Polishing Wheels

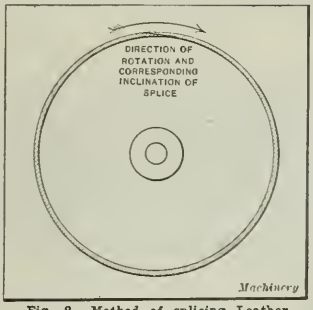


Fig. 2. Method of splicing Leather Face on Set-up Wheel

polishing, it will be quite evident that the coarseness of the ridges and valleys is reduced at each step; but in this connection, attention is called to the fact that even where the greatest care is taken in performing the final polishing operation, it is never possible to produce a surface which is not covered with a mass of scratches that will be perfectly visible if the work is examined through a glass of sufficient strength. While performing a series of polishing operations, it is the general practice to gradually reduce the coarseness of the abrasive that is used, so that the surface of the work not only approaches a perfect plane, but also has the scratches brought down to a size which represents the minimum that can be attained under the best conditions.

TABLE 1. METHODS USED BY ROYAL TYPEWRITER CO. FOR PERFORMING POLISHING OPERATIONS

Kind of Work to be Polished	Operation No.	Type of Polishing Wheel	Kind of Abrasive Used to Charge Wheel	Coarseness of Abrasive
Rough castings to be japanned	1	Grinding wheel	Carborundum	No. 30 medium grade
	2	Leather-faced set-up wheel	Emery	No. 36
	3	Loose rag wheel	Emery	No. 60
Irregular shaped work to be japanned	1	Rag wheel sewed to circumference	Emery, glued to face of wheel	No. 60
	2	Loose rag wheel	Emery	No. 90
Small iron castings	1	Leather-faced set-up wheel	Emery	No. 36
	2	Loose rag wheel	Emery	No. 60
Bronze castings	1	Loose rag wheel	Emery	No. 150
Steel stampings	1[1]	Loose-rag wheel	Emery	No. 150
German silver	1	Tumbling barrel	No. 0 pumice and water for 24 hrs.	
	2	Wooden-lined tumbling barrel and steel balls	10 lbs. white soap chips and 2 pails of water to a barrel; 10 hrs.	
	3	Nickel-plating barrel for 3 hrs.		
	4	Wood-lined tumbling barrel and steel balls	10 lbs. white soap chips and 2 pails of water to a barrel; 3 hrs.	
	5	Steam-heated tumbling barrel	Heated sawdust to dry work	
Work to be nickel-plated	1	Leather-faced set-up wheel	Emery and buffing grease	No. 150
	2	Leather-faced set-up wheel	Emery and buffing grease	No. 200
	3	Leather-faced set-up wheel from Operation 3, with grease wiped off	Emery	No. 200 (This operation "fines" work and produces a high polish.)
	4	Tampico brush	"Emery paste" (a mixture of tallow or paraffin and emery)	No. 150 emery (This operation rounds corners of work so that nickel-plate will not wear off.)
	5	Leather-faced set-up wheel	Emery greased with beeswax	Flour of emery
	6	Loose rag wheel to buff copper-plated surface	Lime	
	7	Loose rag wheel to polish nickel-plated surface	Lime[2]	

[1] Stampings must be carefully washed to remove all traces of grease before polishing.

[2] If the nickel is too rough to buff well, charge wheel with "white diamond" or rouge. Note: The above recommendations refer to the polishing of well-machined parts. Rough or imperfectly machined pieces would require different treatment.

Adopting Methods of Polishing to Suit the Work

All experienced mechanics know that abrasives are made in standard grades of coarseness which cover a wide range and that grinding wheels charged with these abrasives are held together by bonding mediums which may be selected to produce wheels conforming to various standards. In the polishing room, grinding wheels are used for the performance of a first operation where the work is of such a nature that there is a considerable amount of excess metal to be removed from the surface which is to be polished. After the preliminary operation has been performed with a grinding wheel, there are a variety of methods of performing subsequent operations. The usual practice is to employ a series of "set-up" wheels, each of which is charged with a finer abrasive than that used in making the wheel previously used, and then to obtain a final polish through the use of a rag wheel or a brush wheel, charged with some such abrasive as powdered chalk or rouge. Success in polishing depends largely upon the selection of proper grades of abrasive for performing the rough, intermediate and final polishing operations. Detailed information in regard to suitable classes of abrasives to employ for the performance of polishing operations on cast iron, steel, copper, brass, bronze, nickeled surfaces, copper-plated surfaces, and other classes of work, will be obtained by reference to Tables 1 and 2. The directions given refer to the polishing of well machined parts, and not to roughly machined pieces.

TABLE 2. RECOMMENDED PRACTICE IN POLISHING ON ABRASIVE BELT MACHINES

Kind of Work to be Polished	Operation No.	Abrasive Used to Charge Belt	Coarseness of Abrasive
Cast iron	1	Crystolon	No. 70
	2	Crystolon	No. 120
	3	Crystolon	No. 220 (for work to be nickel-plated)
	4	Crystolon	No. 220, greased (for work to be lacquered without nickel-plating)
Steel	1	Alundum	No. 70 to 90
	2	Alundum	No. 120 to 150
	3	Alundum	No. 220 (for work to be nickel-plated)
	4	Alundum	No. 220, greased (for work to be lacquered without nickel-plating)
Brass	1	Alundum	No. 320
	2	Felt belt charged with Tripoli	
Copper	1	Crocus	
	2	Felt belt charged with Tripoli	

Machinery

NOTE: The above recommendations refer to the polishing of well machined parts. Rough or imperfectly machined pieces require different treatment.

Method of Making Polishing Wheels

Mention has been made of the fact that where there is a lot of excess metal to be removed from the work to be polished, a preliminary operation is performed with a regular grinding wheel of suitable grade and grain. Such a wheel only requires an occasional dressing with a diamond or some other type of wheel-truing device in order to remove the glaze from its surface and expose a fresh layer of abrasive which has sharp cutting edges. A grinding wheel is only used in this way where the surface to be polished is very rough. Next in order of use in reducing



Fig. 3. Applying Glue to the Face of a Set-up Wheel



Fig. 4. Rolling Glued Set-up Wheel in Abrasive

a rough surface to a final polish comes the so-called "set-up" wheel, which may be made in either of two general ways. A common form of construction is to make the wheel of a wooden disk with a leather surface attached to its periphery. Where this form of wheel construction is used, the leather is glued to the wheel and the ends are spliced on an angle, according to the method commonly employed for making an endless leather belt with a cemented joint. It is also highly important for the lapping of these splices to be arranged as shown in Fig. 2, so that the work runs over the top of the lap without a tendency to catch the edge of the leather and open the splice. A patented form of set-up wheel is made by Devine Bros., of Utica, N. Y. The body of this wheel is made of sheet metal instead of wood, and it is of somewhat the same general form of construction as a steel belt pulley. The leather surface around its periphery is built up from laminations of leather laid edgewise, and secured to the wheel by lugs provided at the bottom of each leather segment.

Regardless of the way in which the body and leather surface at the periphery of a set-up wheel are constructed, the same general practice is employed in preparing a wheel of this type for the performance of a polishing operation. It is necessary to provide an abrasive cutting surface on the leather, which is done by first mounting the wheel on a mandrel, and revolving it as shown in Fig. 3, so that a coat of glue may be applied to the leather. Then, while the wheel is still carried on the mandrel, it is transferred to a shallow trough filled with abrasive of the desired coarseness, and the wheel is rolled as shown in Fig. 4, so that the glue-covered surface may take up the abrasive, which adheres over the entire cutting face of the wheel. It is then necessary to allow a sufficient length of time for the glue to dry, so that it will hold the abrasive securely in place on the wheel.

Before this set-up wheel can be used for the performance of a polishing operation, it must be trued in much the same way that a regular grinding wheel is trued, a diamond or



Fig. 5. Truing down the Face of a Polishing Wheel



Fig. 6. Applying Water to Set-up Wheel before scrubbing off Abrasive



Fig. 7. Rack used in Polishing Room of Royal Typewriter Co., for storing Polishing Wheels. Each Workman has a Set of Wheels and is assigned Storage Space for them on this Rack

one of the commercial types of wheel-dressing tools being used for the purpose; and the conditions under which the polishing wheel is to be used will naturally govern the way in which the dressing is done. Many wheels are trued up with a flat face, where polishing is to be done on broad surfaces, and others are dressed to a contour corresponding to the outline of the surface on the work that is to be polished. When a new set-up wheel is to be used for the first time, it is slowly rotated on the grinding stand and a stick of hard wood is pressed against the abrasive face of the wheel. The purpose of this treatment is to break up the foundation of glue beneath the abrasive, thus bringing the face of the wheel into a condition where it will yield under pressure and adapt itself to slight irregularities on the work to be polished. A wheel made in this way has a face which is slightly elastic, because the leather foundation to which the abrasive is secured acts as a cushion, and also because the coating of glue and abrasive put on the face of the wheel is not subjected to pressure, as in the case of a grinding wheel, and so is left in a somewhat springy condition. As a result, the set-up wheel is able to conform, to a certain extent, to the shape of a piece of work which is pressed against its face.

Method of Preparing Glue for Securing the Abrasive Material on Set-up Wheels

Any good quality of glue may be used for securing the abrasive to the face of a set-up wheel. It will usually be found most satisfactory to buy this glue dry and prepare it for use at the plant. The first step is to allow the glue to steep in cold water over night, a sufficient amount of water being mixed with the glue to bring it to about the consistency of dough. The glue-pot is provided with an upper compartment in which the glue is placed and heated by steam in order that it may melt and run down into a lower compartment. Too much care cannot be exercised in preparing the glue, because the use of a satisfactory quality of glue has an important influence in determining the quality of the polished surfaces that are produced by the wheel. The glue must be smooth and quite free from lumps, so that it may be spread evenly over the leather face of the wheel on which the abrasive is to be applied. The consistency of the glue should be varied somewhat, according to the coarseness of the abrasive to be used. Very fine abrasives are best held by thin glue, while a thicker glue will be required to hold coarser grained abrasives on the wheel.

Preparing Set-up Wheels for Subsequent Use

Everyone who has had experience in operating grinding machines knows that the wheels must be dressed to remove the glaze which forms on the surface of the wheel, and to expose a fresh layer of abrasive with sharp cutting edges. Repeated dressing of this kind causes a substantial reduction in the diameter of the wheel. The same reasons which require a grinding wheel to be dressed make it necessary to give similar attention to a polishing wheel; but as the covering of abrasive on such wheels does not have much depth, it will be evident that it soon becomes necessary to apply a fresh cutting surface to the wheel. This is done by first removing the worn-out abrasive, and then applying a new cutting surface according to the method which was described for preparing a new set-up wheel. For removing the worn-out abrasive, the wheel is mounted on an arbor, as shown in Fig. 6, and this arbor is placed in the bearings of a special stand, beneath which there is a tank filled with water. The machine operator then dips up a panful of this water, and pours it slowly on the set-up wheel, as it is revolved, and proceeds to scrub the face of the wheel with a piece of broken grinding wheel. In this way the accumulation of abrasive and glue is removed, after which the wheel is scrubbed with a cloth to clean the leather surface. It is then covered with glue and rolled in a trough of abrasive of the proper grade, in just the same way that a new wheel is prepared.

In the polishing room of the Royal Typewriter Co., in Hartford, Conn., it is the practice to have all of the work of preparing wheels done by men who give their entire time to this job, and hence acquire a greater degree of dexterity than would be possible if each polisher were required to prepare his own wheels for subsequent use. The life of a polishing wheel is quite limited, and so each man is furnished with several wheels, in order that he can send one of them to be re-surfaced and start using another wheel



Fig. 8. Second Operation in polishing Royal Typewriter Frames

without delay. Each of the men in the polishing room is furnished with a regular set of wheels, and racks are provided on which each man is allowed a definite amount of space marked with his time-clock number. Fig. 7 shows one of these racks, and also an arbor press that is used by the polishers to force the arbor into or out of the wheel, at the time they are starting or completing the work of re-surfacing.

Felt and Rag Wheels for Final Polishing Operation

As their names imply, felt wheels and rag wheels are made of the materials from which they are named. Both of these types of wheels are built up by sewing together disks of felt, or round pieces of cloth. There is a considerable variation in the practice of making wheels of this type, although the general method of procedure is uniform in all cases. In the case of cloth wheels, the usual method is to make up bunches of cloth of about ¼ inch in thickness, with all of the pieces of cloth in a bunch securely sewed together for a distance of about 2 inches from the center. From this point to the periphery, the individual pieces of cloth which make up one of these bunches are left loose. A rag wheel is made by assembling together on an arbor the proper number of bunches to give the required face width. It will be quite apparent that when a rag wheel is at rest, it would not have sufficient stiffness to enable the periphery of such a wheel to perform a polishing operation; but when the wheel is driven at a rotative speed which corresponds to a peripheral speed of from 5000 to 7500 feet per minute, it will be apparent that the action of centrifugal force on each of the cloth disks composing such a wheel causes these disks to stiffen up and gives them plenty of resiliency for polishing the work. Felt and rag wheels used for the performance of final polishing operations are usually charged with some very fine abrasive such as rouge. Detailed information concerning the abrasives to use on different polishing jobs is presented in tabular form.



Fig. 9. Polishing Small Parts of Royal Typewriters. The Polishing Wheel is so shaped as to conform to the Contour of the Work

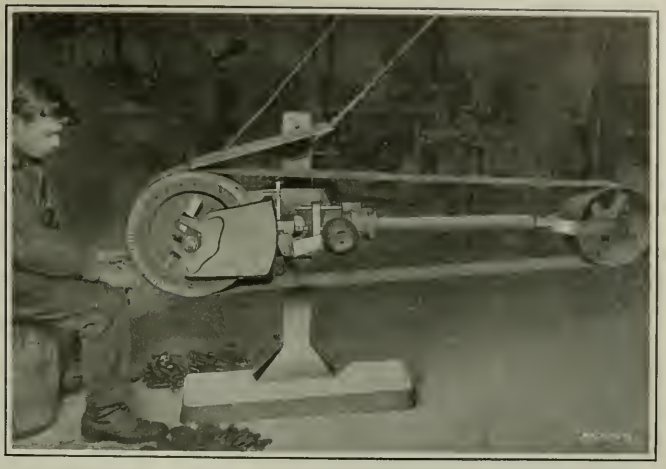


Fig. 10. Abrasive Belt Type of Polishing Machine with a Leather Wheel to support the Polishing Belt

Importance of Keeping the Work Clean while Polishing

In one of the preceding paragraphs, attention was called to the fact that where a polished surface is to be nickel-plated or subjected to some method of chemical treatment, it is necessary to have the work perfectly clean before such a treatment is applied. This point is reiterated at this time, in order that the previous statement in regard to the importance of cleanliness may not be confused with another condition which must be fulfilled if successful results are to be obtained in the performance of polishing operations, namely, that the greatest care must be taken not to allow grease or dirt to drop on the polishing wheel or work while the operation is being performed. Where this precaution is not followed great trouble will be experienced through having long smears produced across the polished surfaces, which will quite destroy the appearance of the product. An explanation of the way in which such defects are produced may well be given in connection with a description of the action of a polishing wheel. During the preliminary operations in polishing, where coarse abrasives are used, the individual grains of abrasive cut off chips of metal; but in performing the final operations by wheels charged with the very finest abrasives, the action is believed to be one of rubbing down the surface of the metal to a uniform level, instead of actually removing chips.

At the high speeds at which a polishing wheel is driven, it is the theory of experienced polishers that the wheel has a tendency to remove the tops of the microscopic ridges on the work, to which reference has been made, and press the metal so removed down into the spaces between adjacent ridges, thus reducing the work to a plane surface. If any grease or dirt drops on the wheel or work, it will be apparent that this shifting of the metal over the surface of the work will result in amalgamating the foreign matter with the metal, thus producing a smear of unsightly appearance. A distinction must be drawn, however, between the undesirability of having grease drop on the work, and a quite general practice in polishing rooms of applying grease to the surface of the polishing wheel in order to produce a very smooth finish. One kind of grease used for this purpose consists of a mixture of two parts of hide scrapings to one part of paraffin, although a perfectly satisfactory grease may be bought under the commercial name of "buffing grease," or "buffing tallow." The reason that applying this grease to the wheel does not produce the smears on the work, to which reference has been made, is due to the fact that the grease is uniformly distributed over the wheel and work, instead of being applied merely at one point. It is

the practice to use a greased wheel for the final polishing operation, as experience has shown that the application of grease to the wheel results in rubbing the work down to a smoother polish than could be obtained from the application of an ungreased abrasive wheel to the work. This practice of greasing the wheel gives it a more uniform cutting action, and prevents the abrasive from making visible scratches on the work. As a result, a greased wheel is able to produce a higher polish.

Abrasive Belt Polishing Machines

So far, this discussion has been concerned with the use of circular wheels for the performance of polishing operations. However, there is another type of polishing machine which is constantly increasing in popularity as it becomes more generally known to the trade. This is the abrasive belt polishing machine which is built in a number of different types. They all operate on the same basic principle, namely, of having a belt charged with abrasive driven over the surface of the work, which is held in contact with the abrasive belt through the application of pressure. Two general principles are employed by the Blevney Machine Co., of Greenfield, Mass., for supporting the endless abrasive belt used on these machines, which consists of a fabric charged with an abrasive of a suitable coarseness. This belt would not be strong enough to withstand the pressure with which the work must be applied to the abrasive, unless the belt was properly supported. These two methods of support consist of either having the abrasive belt run over a leather faced wheel which is built up of segments of leather placed edgewise, or of having the abrasive belt backed up by a corrugated leather belt. Machines equipped with these two types of support for the belt are shown in Figs. 10 and 11, respectively.

How Cuttings are Cleared from the Abrasive Belt

Experiments conducted in the laboratories of the Norton Co., of Worcester, Mass., have shown that the abrasive belts used on these polishing machines cut elongated chips from the metal, and that they do not remove the material in the form of dust. It is important to provide for clearing the cuttings from the abrasive belt, because if this were not done, the belt would soon become so heavily charged that it would fail to operate efficiently. The arrangement of the laminated leather wheel or the corrugated leather belt provides for such elimination of cuttings. The way in which these results are accomplished is best shown by the diagrams Figs. 12 and 13, which show enlarged views of a section of the laminated wheel and of the corrugated leather belt, respectively. In the case of the wheel, Fig. 12, it will be apparent that the leather laminations show a tendency to bend backward when the work is pressed against the belt carried by them. This backward bending of the corrugations causes small spaces or pockets to develop beneath the belt, which allow the belt to be depressed sufficiently to form the required amount of chip clearance between the belt and the work. In this way, provision is made for carrying the chips along beneath the work, without causing them to be deeply embedded in the texture of the belt; and as soon as the belt and chips pass out from under the work, the tension on the belt causes it to straighten out with a snap, and in this way throw the chips clear of the belt.



Fig. 11. Abrasive Belt Type of Polishing Machine with a Corrugated Leather Belt to support Abrasive Belt

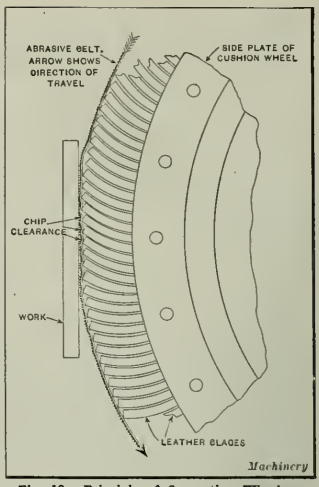


Fig. 12. Principle of Supporting Wheel on Machine shown in Fig. 10

After one of these laminated wheels has been used for some time, a tendency will be shown for the leather laminations to take a permanent set in the direction in which they have been bent backward. If allowed to develop without correction, the amount of this set would assume objectionable proportions; and to overcome trouble from this source, provision has been made for lifting the complete unit consisting of the leather cushion wheel, with its spindle and bearings, out of the support in the frame, allowing the operator to reverse the leather wheel on its spindle and replace the unit with a minimum amount of labor. By adopting this practice, it will be apparent that the laminations which were formerly bent backward are now leaning toward the front, so that when pressure is applied to the abrasive belt and laminations, they will first be pulled over to the center point and then back to the position indicated by the diagram. Reversals of the wheel can be made with very little loss of time.

The corrugated leather supporting belt, shown diagrammatically in Fig. 13, functions essentially the same way, in so far as clearing the chips from the belt is concerned. It will be apparent from the diagram that the corrugations in this belt enable clearance pockets for the chips to be formed between the abrasive belt and the work; and after the belt passes out from under the work, its tension causes the belt to straighten out with a snap and throw the chips clear in the same way that this result was accomplished by the laminated leather wheel.

Attachments for Abrasive Belt Polishing Machines

For use on the abrasive belt polishing machines built by the Blevney Machine Co., Greenfield, Mass., a number of different attachments are made, which facilitate the performance of polishing operations on various special classes of work. Machines equipped with many of these special devices have been illustrated and described in the New Machinery and Tools section of MACHINERY, so that it is unnecessary to enter into a complete description at this time. It may not be out of place, however, to state that these special attachments include feed-rolls for automatically passing cylindrical shaped rods and tubing across the face of the abrasive belt; racks for use in connection with the feed-rolls, to provide for supporting the long pieces of cylindrical work; multiple work-carrying fixtures for holding a number of small or medium sized pieces of work in

contact with the abrasive belt; and various forms of work-rests for holding a single piece of work while the polishing operation is performed on it.

Coarseness of Abrasives Used on Polishing Belts

In Table 2 there are presented recommendations for the performance of polishing operations on abrasive belt machines. The data in this table give a general outline of practice for polishing several of the most commonly used metals. While a general table recommending the abrasive to be used in polishing will be of assistance to an operator using abrasive belt machines, a knowledge of the work in hand, the kind of metal to be finished and its condition preparatory to finishing is necessary before the selection of the proper abrasive can be made. For instance, rough castings or imperfect parts require a different treatment from well machined pieces, such as articles of steel that are nicely machined and ground and require only the very finest polish, for which one operation would probably be adequate. The table is made up for well machined parts, such as might be produced on an automatic screw machine—pieces that have been given a fairly good finish and which must subsequently be polished.

Crystolon and alundum are recommended as cutting abrasives for ordinary finishing, but where the finest polishing is required and it is necessary to color, such as on nickel and brass work, there are various compositions such as tripoli, crocus, white polishing composition, Vienna lime and rouges. Tripoli is made with cutting, polishing and coloring qualities, and is used on steel, cast iron, brass, etc., for fine polishing. Crocus is especially suited for the smooth finished surface on cast iron and steel, and is sometimes used on brass, although it has a tendency to discolor this metal. Crocus is used a great deal by stove manufacturers for finishing cast iron, also on steel parts such as are used on sewing machines, automobiles, bicycles, etc.

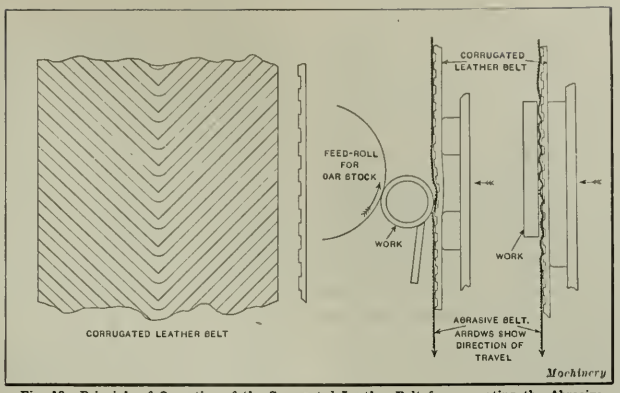


Fig. 13. Principle of Operation of the Corrugated Leather Belt for supporting the Abrasive Belt used on the Machine shown in Fig. 11

White polishing composition is used for the polishing of nickel or brass after plating, and in some cases solid metal which is not plated. This composition is used to good advantage on heavy nickel-plated work which is both cut and polished at the same time, after which a final polish or color is given with a composition such as Vienna lime. White composition can also be purchased for polishing and coloring all metals where a high color is required and for extra fine polishing of silver. Vienna lime is used in different grades, and it is necessary to know what class of work is to be polished before any particular grade can be recommended. It is used for nickel polishing. Rouges are used for both coloring and polishing, and are made in red and black colors, the former more generally for steel and the latter for horn, rubber, celluloid, and sometimes metals.



Fig. 14. Close View of Polishing Operation performed on a Machine of the Type shown in Fig. 10

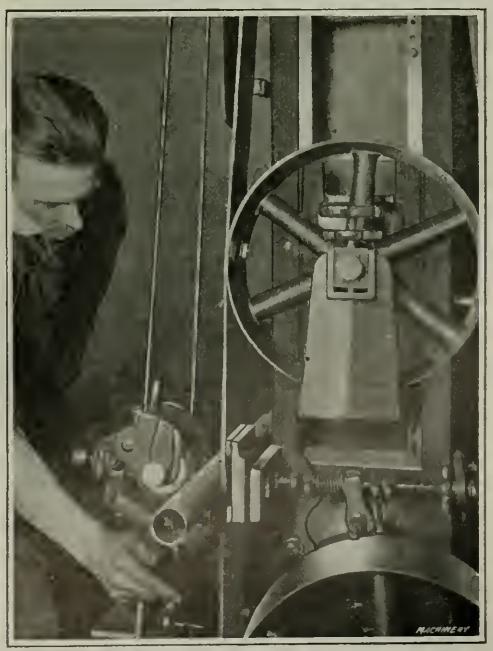


Fig. 15. Close View of a Polishing Operation performed on a Machine of the Type shown in Fig. 11

It will be well to present a few supplementary suggestions concerning the preparation and use of abrasive polishing belts. In every case, the abrasive must be fine enough for each operation, so that it does not produce scratches on the work; otherwise, time will be lost in removing these scratches before any really effective polishing can be done. The coarsest abrasive recommended in Table 2 is No. 70 which is for use on cast iron or steel. For very rough work, however, it may be found more desirable to take the preliminary cut with a belt carrying No. 46, after which an intermediate cut will be taken with a belt carrying No. 90, followed by a finishing cut taken with a No. 180 belt. Where a very fine finish is required, the work will be given a fourth operation, and the belt used for this purpose will be No. 220 greased. It is common practice to rub down used belts with an old file or stone and then grease them for the final polishing operation. In this way, the effective use of the belts is greatly increased. After all of these pieces have had the third operation performed on them, the abrasive on the No. 180 belt will be rubbed down and the belt will be greased ready for performing the final polishing operation. It will, of course, be understood that the recommendations made in Table 2 are only a statement of average practice. On some classes of work, such as polishing flat-irons, very satisfactory results have been obtained through taking the preliminary cut with a belt charged with No. 90 alundum, and then finishing the work with a No. 220 greased belt. One well-known firm obtains good results by polishing the work with a belt charged with either No. 70 or 100 alundum, and then using the same belts for a finishing operation, after they have become too badly worn for use in taking the preliminary cut. The abrasive is rubbed down with a file stub or piece of stone, and the belt is greased to adapt it for performing the final polishing operation. On all classes of polishing operations, regardless of whether they are performed on abrasive belt machines or polishing stands, the selection of abrasives and methods of procedure must be based on judgment acquired through the actual performance of polishing operations under the conditions that exist in the shop where the work is to be done.

Methods of Electroplating

To those who are not familiar with the lay-out of industrial plants in which a lot of electroplating and polishing work has to be done, it may appear that the presentation of suggestions for the performance of electroplating operations are out of place in an article dealing with methods of polishing. It will usually be found, however, that there is a very close relationship between the polishing and electroplating departments of a factory, because the work has to be passed back and forth between these two departments in order to perform successive plating and polishing operations. In Table 1, information is given concerning the types of wheels and abrasive materials to use for polishing work preparatory to nickel-plating and for producing a satisfactory surface on the nickel or other metal which is electrolytically deposited on the work. To supplement this information, the following outline is presented of methods of plating which are employed at the plant of the Royal Typewriter Co.

On large flat surfaces it is the usual practice to first polish the surface that is to be nickel-plated and then apply a coating of copper, in order to protect the work against rust or corrosion. The copper is applied to the work by dipping it into a boiling solution of copper sulphate, after which the work is buffed with a loose rag wheel charged with powdered lime, to produce a uniform surface on which to deposit the nickel. Next, the work is "flashed," which is the name applied to the process of dipping the polished copper-plated parts into the electroplating bath, in order to roughen the surface of the copper very slightly and provide an anchorage for the nickel-plate. To obtain satisfactory results in the performance of nickel-plating operations, it is highly important to have the work perfectly clean before it is placed in the electroplating bath. For this reason, the next step is to clean the copper-plated parts in a hot solution of "Wyondotte special," which is made up by adding 5 gallons of the Wyondotte compound to 50 gallons of water. This solution is used at a boiling temperature. If the work is at all greasy, a hot solution of whale oil soap is next used to wash off the grease. In any case, the work is next dipped in a 5 per cent solution of muriatic acid which is used cold, after which it is thoroughly washed in cold water.

After being washed, the work is placed in a cold electroplating bath containing a 20 per cent solution of nickel cyanide, care being taken to maintain the strength of this bath constant by adding nickel cyanide as the solution becomes weakened through the withdrawal of nickel that is deposited on the work. The bath is maintained at a specific gravity of from 6 to 8 degrees Baumé; and when the gravity drops below 6 degrees Baumé, the strength is increased by adding nickel salt. The length of time required for nickel plating is two and one-half hours, if the work is to be buffed, because it is necessary to have a deposit of nickel about 0.001 inch in thickness. Six amperes of electric current are delivered to the plating bath under a potential of from 2½ to 3 volts. The work is washed in cold water, after being removed from the electroplating bath. If it is only required to produce a "white" nickel-plated surface, that is, without buffing the nickel, the work is only left in the bath for one and one-half hours, because none of the nickel so deposited is removed by the buffing wheel. If the nickel deposited on the work is too rough to be buffed well by a wheel charged with lime, it should be polished with "white diamond," or rouge, if white diamond fails to give the desired results. Where a very high finish is not required, it is unnecessary to buff the copper plate on which the nickel is deposited.

* * *

GOVERNMENT SURPLUS STEEL

The War Department authorizes publication of the following statement from the office of the Director of Sales: The Director of Sales announces that the War Department held as surplus in October, approximately 400,000 tons of iron and steel. This aggregate embraced raw, semi-finished and finished steel, also alloys, and iron and steel scrap. All of this surplus is now being offered for sale either by negotiations, or under sealed bids. The greater part of the surplus, or 391,617 tons, is held by the Ordnance Department. The comparatively small balance is distributed between Purchase and Storage Division, Air Service, Chemical Warfare Service and the Signal Corps. The surplus stocks of iron and steel are widely scattered throughout the country, the larger tonnages being located east of the Mississippi at those plants which were engaged, during the period of the war, in the manufacture of munitions. The War Department is now prepared to pass promptly on all offers made for these iron and steel stocks, and to expedite delivery. Inquiries relative to these surplus stocks should give specifications of the materials desired, and should be addressed to Chairman, Ordnance Salvage Board, Ordnance Department, Munitions Bldg., Washington, D. C. or to the nearest of the district ordnance offices located throughout the country.

* * *

In 1913, Germany exported to Italy more machinery than all other nations combined. The United Kingdom took the second place; Switzerland, third; France, fourth; Austria-Hungary, fifth; and the United States sixth. In 1918, the United States took the first place, with the United Kingdom second, and Switzerland third. Nearly all of the machines imported from the United States were in the machine tool class, valued at nearly $30,000,000, at normal exchange. Although there is a considerable depression in all industries in Italy at present, there is great industrial activity in view, provided some of the difficulties relating to unfavorable exchange, labor unrest, etc., can be overcome.

ERROR IN LEAD OF SPIRAL GEARS

By NIKOLA TRBOJEVICH

When hobbing spiral gears on an ordinary hobbing machine, two sets of change-gears are employed to produce the required lead of the helix—the so-called index-gears and the feed gears. In practice, change-gears can very seldom be found which will give the exact theoretical ratio, and usually a more or less close approximation to the theoretical figure must be used, this discrepancy constantly affecting the lead and the angle of the gears. It is generally known that but a slight error in the gear ratio will cause a considerable change in the lead of the gear. It will be of interest to know in just what proportion these two errors are to each other, and also to know more about the factors which enter into and control the errors. Assuming that the feed gears are exact, a condition which is always easily fulfilled, a simple fraction may be chosen for the feed which can accurately be expressed by a train of gears.

The formula for finding the index-gears on a hobbing machine is:

$$R = \frac{KL}{N\,(L - F)} = \frac{\text{driver}}{\text{driven}} \qquad (1)$$

where R = ratio of index-gears;
K = a constant;
N = number of teeth in gear;
L = lead of gear;
F = feed per revolution of gear.

The value of the constant K depends upon the make of the gear-hobbing machine. For a Gould & Eberhardt machine it is 60; for a No. 12 Barber-Colman, 30, etc.

In Equation (1), R and L are the variables. We differentiate with respect to L:

$$dR = \frac{K}{N} \times \frac{L - F - L}{(L - F)^2}\,dL = -\frac{K}{N} \times \frac{F}{(L - F)^2}\,dL \qquad (2)$$

where dL = the error in lead, and
dR = the error in ratio.

As the feed is usually very small in comparison with the lead (in many cases only about one-tenth of 1 per cent of the latter), we shall commit no appreciable error by substituting L^2 for $(L - F)^2$ in Equation (2):

$$dL = -\frac{N}{K} \times \frac{L^2}{F}\,dR \qquad (3)$$

Let us now analyze Formula (3):

1. Provided the hand of the hob is the same as that of the gear, a ratio *greater* than the theoretical figure will make the lead *shorter*, and a *smaller* ratio will make the lead *longer*.

2. The error in lead, dL, increases very rapidly with the square of the lead on large gears having comparatively small helix angles. A fairer comparison is obtained, however, by considering the relative error, that is, the *error per inch of the lead*:

$$\frac{dL}{L} = -\frac{N}{K} \times \frac{L}{F}\,dR$$

Even then, the error is still proportional to the lead.

3. A more accurate lead may be obtained on hobbing machines of similar construction, having a greater constant K. As K is usually equal to the number of teeth in the index- or table-worm gear, a machine having a large index-gear will produce a more correct lead.

4. A coarse feed will give a more accurate lead than a fine one, other things being equal.

The Error in the Angle

On all spiral gears, the following formula holds good:

$$\sin a = \frac{PN}{L}$$

where a = the helix angle, and
P = the normal circular pitch.

Consider a and L as variables, and differentiate with respect to a:

$$\cos a\,da = -\frac{PN}{L^2}\,dL = -\frac{\sin a}{L}\,dL$$

from which

$$da = -\frac{\tan a}{L}\,dL \qquad (4)$$

Example Demonstrating Application of the Formulas

In the following example, the figures for which are taken from a problem in toolmaking which actually arose in practice, the use of the formulas deduced in this article will be demonstrated. It was desired to hob a spiral gear of the following specifications: 6.6759-inch lead, 12 teeth, left-hand gear, left-hand hob, 45-degree helix angle, 0.015-inch feed, constant 60, on a Gould & Eberhardt machine.

$$R \text{ (theoretically)} = \frac{KL}{N\,(L - F)} = \frac{K}{N} \times \frac{1}{1 - \frac{F}{L}}$$

$$= \frac{60}{12} \times \frac{1}{1 - \frac{0.015}{6.6759}} = \frac{1}{0.199551}$$

The *actual* index-gears were:

$$\frac{89}{37} \times \frac{75}{36} \frac{\text{driver}}{\text{driven}} = \frac{1}{0.1995505}$$

$$dR = \frac{1}{0.199551} - \frac{1}{0.1995505} = -\frac{0.0000027}{0.1995} = -0.000013$$

It will be noted that all formulas are presented in forms by which we are enabled to obtain the required accuracy without much "long-hand" figuring, and to do practically all the work on a 20-inch slide-rule.

Substituting the values in Formula (3):

$$dL = -\frac{12}{60} \times \frac{6.676^2}{0.015} \times -0.000013 = 0.0075 \text{ inch}$$

That is, the actual lead is 0.0075 inch longer than it should be theoretically, in spite of the fact that the gear ratio was accurate to within five places.

The error in angle—see Equation (4)—is

$$da = -\frac{\tan a}{L}\,dL = -\frac{0.0075}{6.676} = -0.0011 \text{ radian}$$

and the actual angle of helix is therefore 0.063 degree less than it should be, or 44 degrees 56 minutes. The foregoing example shows that in problems of this and of a similar nature, an extraordinary accuracy is required in calculating the index-gears.

* * *

USE OF BARIUM-CHLORIDE IN ELECTRIC HARDENING FURNACES

More than ten years ago electric hardening furnaces using barium-chloride were introduced for the heating of high-speed steel for hardening. These did not prove as successful at that time as had been expected on account of the manner in which the barium-chloride seemed to attack the high-speed steel. Recently built furnaces utilizing this principle have, however, been successfully employed for heating ordinary carbon steel for hardening and also for tempering purposes. One of these furnaces is used in the South Philadelphia works of the Westinghouse Electric & Mfg. Co. It consists of an outer shell, a cast-iron cylinder packed with fire-brick, and a layer of asbestos. The current is supplied by two pairs of electrodes built into the opposite sides of the walls of the inner chamber. Carbon rods are placed between these electrodes to complete the circuit when starting the furnace. After the current is turned on, the barium-chloride melts and completes the circuit without the aid of the carbon rods, which are removed. The furnace throws off very little heat—a feature which is appreciated in the hardening room.

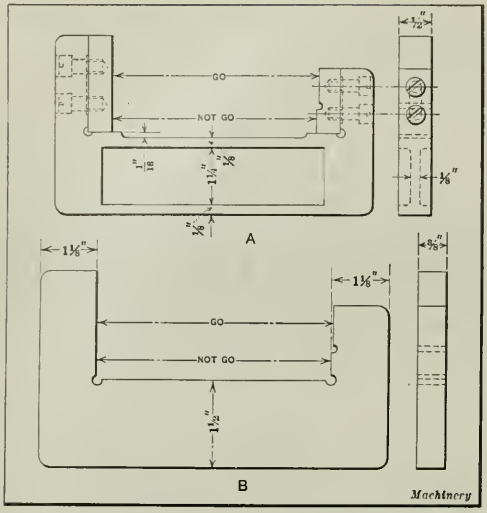


Fig. 1. Standard Snap Gages for testing Length

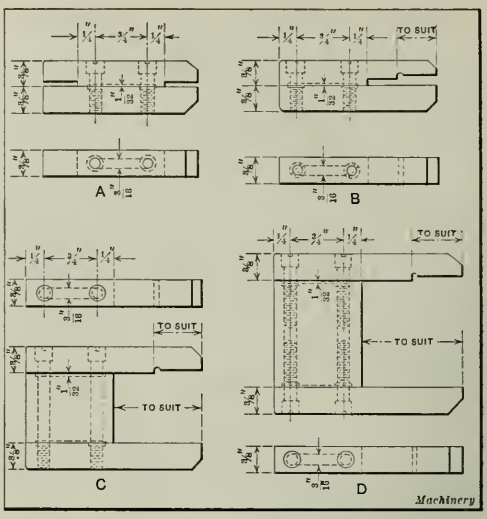


Fig. 2. Standard Snap Gages, Two-piece Construction

Snap, Plug and Ring Gages

By J. E. COLLINS

IN the October number of MACHINERY, the general requirements in gage-making were dealt with in the article entitled "Standardized Gages for Interchangeable Manufacture."

The present article will deal more in detail with snap, plug, and ring gages, giving exact information as to methods of construction and proportions, tolerances, etc. The article is based upon the practice of the Gage Division of the Ordnance Department during the war, and embodies the experience and knowledge gained in this department during a long period of development, until the principles here laid down finally crystallized into a standardized system.

Snap Gages

There are two distinct types of snap gages in common use —the built-up type and the plate type. The built-up design is far superior, but is more expensive. The plate type is machined to the correct outline from a single piece, and is therefore simpler and less expensive to make, as no fitting together of parts is required when gages are made this way.

The standard snap gages illustrated in this article are designed for gaging diameters or lengths of work from 0 to 3 inches. For gaging diameters over 3 inches, snap gages are generally of the C-type and may be purchased directly from gage manufacturers, either in the rough state or completely finished. The C-type of gage is illustrated in Fig. 3 from which a good idea of its general proportions may be had. The size shown when obtained in the rough forging has an opening *A* between the gaging surfaces of 2 5/16 inches. This opening can be finished to gage work up to 3½ inches in size. Snap gages for gaging dimensions greater than 3 inches are considered special, and are made in both plate and built-up designs. Two gages illustrating these types are outlined in Fig. 1. The built-up design *A* has a machine steel body and hardened and ground tool steel gaging surfaces, while the type shown at *B* is made from one piece of pack-hardened machine steel, with ground gaging surfaces.

The gages shown in Fig. 2 are standard types of two-piece and three-piece construction. The designs *A* and *B* are used for either lengths or diameters from 0 up to and including ⅛ inch. The gage shown at *C* may be used for either lengths or diameters between ⅛ and 1 inch, while at *D* is shown a design that may be used for gaging lengths from 1 to 3 inches.

A "Go" and "Not Go" gage is required for nearly all classes of inspection that involve the use of a snap gage. These gages should be of the plate design and should be made of tool steel, hardened, seasoned, ground, and lapped. The corners of the "Go" end should be chamfered to provide ready recognition. All snap gages, for use on work below ⅛ inch, should be made of two parts so as to facilitate the lapping operation. It is difficult to lap out a very narrow snap gage; the best method has been found to consist of employing a milling machine and a brass lap charged with diamond dust. The following grinding allowances for lapping are recommended:

Opening, Inches	Allowance, Inch
3/16 to 1	0.0002 to 0.0004
1 to 3	0.0004 to 0.0007
3 to 6	0.0007 to 0.001

In Fig. 4 the dimensions for a complete set of double-end single-step snap gages are given in tabular form. These dimensions cover all sizes required in taking measure-

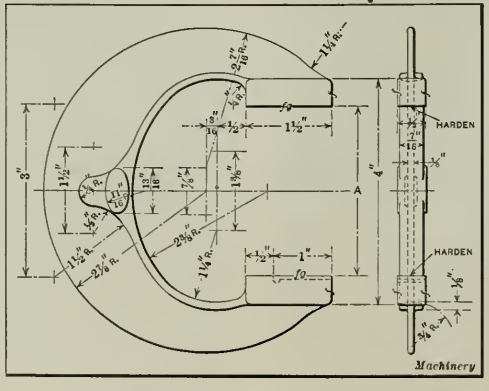
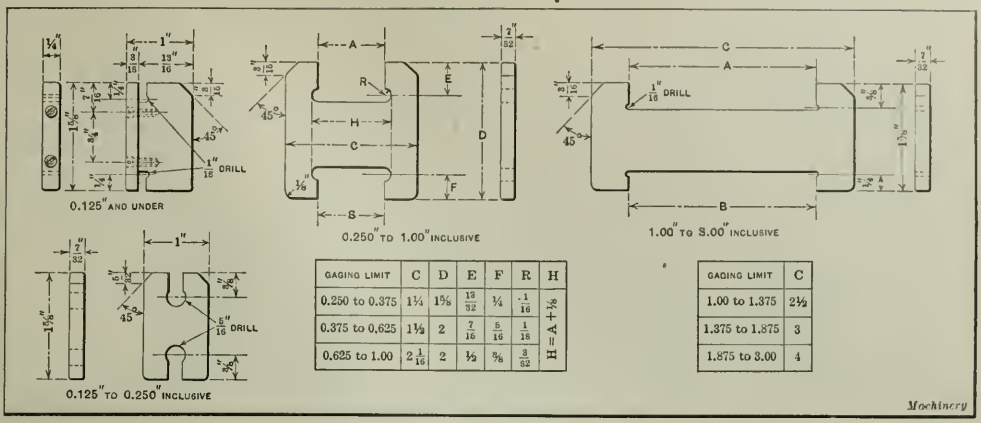


Fig. 3. Standard C-type Snap Gage



GAGING LIMIT	C	D	E	F	R	H
0.250 to 0.375	1¼	1⅝	13/32	¼	1/16	H=A+⅛
0.375 to 0.625	1½	2	7/16	5/16	1/16	
0.625 to 1.00	2 1/16	2	½	⅜	3/32	

GAGING LIMIT	C
1.00 to 1.375	2½
1.375 to 1.875	3
1.875 to 3.00	4

Fig. 4. Double-end, Single-step Snap Gages

ments up to and including 3 inches. This type is used for the same purpose as the gages shown in Fig. 5, but is made with the "Go" and "Not Go" gaging surfaces at opposite ends of the gage instead of at one end. There are cases where it would be impossible to use single-ended two-step gages on account of the fact that the first step projects over the work and meets interferences on the work, which would prevent the "Not Go" step from coming in contact with the surface to be gaged. Therefore, by making the "Go" and "Not Go" gaging surfaces on opposite ends of the gage this obstacle is overcome.

In Fig. 5 a set of single-end, double-step, length snap gages is shown, with all the necessary dimensions for making them. Fig. 6 illustrates the design of single-end, double-step snap gages, having a range for gaging diameters from 0 up to and including 3 inches. The single-end, single-step snap gages shown in Fig. 7 are used for measuring maximum or minimum lengths only, and are intended for special cases where a two-step snap gage is not necessary. Single-end, single-step snap gages, such as shown in Fig. 8 are designed for gaging diameters from 0 up to 3 inches. This type is sometimes used in connection with ring gages.

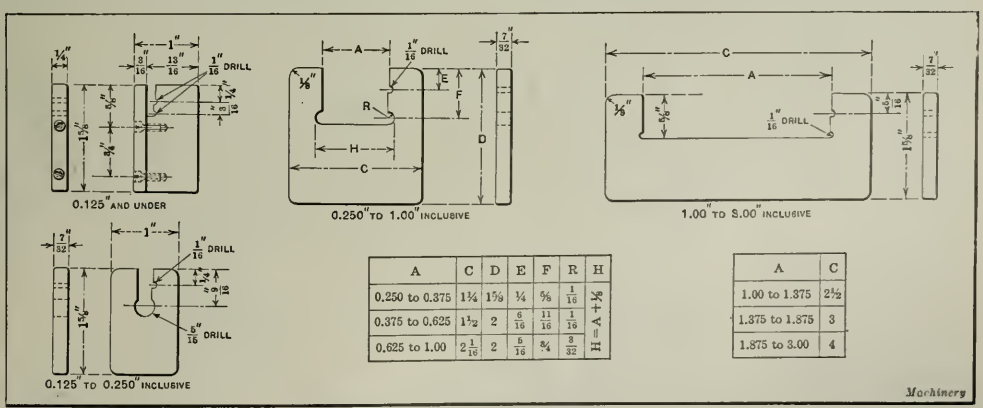
Plug Gage Design

Some standard method of proportioning plug gages such as shown in Table 1, should be established so that all gaging plugs for a given diameter will be uniformly proportioned. Draftsmen have different ideas of the correct proportions to which plugs should be made, and if no standards are established, a large assortment of plugs of various lengths for the same gaging diameter is soon accumulated. As the "Not Go" plugs are not intended to enter the work, they should be quite short, thereby saving material and reducing the cost of manufacture. Plug gages up to and including 2 inches in diameter should be made of hardened tool steel, but the larger sizes may be made of machine steel, pack-hardened.

Operations on Plug Blanks prior to Lapping

The blanks for plug gages should be roughed out and annealed. This practice should always be followed when making large gages, so as to prevent warping or cracking in hardening. The grinding allowance should be from 0.010 to 0.020 inch, or even more, according to the size of the gage. After hardening a plain gage, the measuring end should be drawn until water will boil on it. The handle end may be drawn to a straw color.

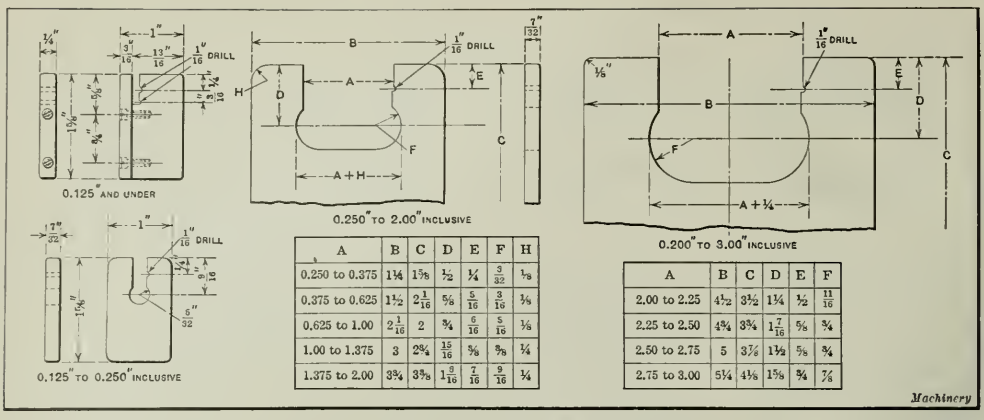
Before grinding, the centers should be thoroughly cleaned. After the work is rough-ground, it should be laid aside and given time to season. The allowance for final grinding should be from 0.003 to 0.006 inch, according to size. When less than 0.002 inch of metal is allowed for finishing, the gages are likely not to "clean up" because of the warping while seasoning. Work which is ready for lapping should also be laid away until actually wanted in order to give it time to swell, which often increases the size 0.0001 or 0.0002 inch. If accurately ground, 0.0002 inch will be enough finish allowance for lapping. After a little experience, the roundness of the work can be judged by the sparks from the wheel. When the work is mottled it is an indication that the wheel is out of balance.



A	C	D	E	F	R	H
0.250 to 0.375	1¼	1⅝	¼	5/16	1/16	H=A+⅛
0.375 to 0.625	1½	2	6/16	11/16	1/16	
0.625 to 1.00	2 1/16	2	5/16	¾	3/32	

A	C
1.00 to 1.375	2½
1.375 to 1.875	3
1.875 to 3.00	4

Fig. 5. Single-end, Double-step Snap Gages for Lengths



A	B	C	D	E	F	H
0.250 to 0.375	1¼	1⅝	½	¼	3/32	⅛
0.375 to 0.625	1½	2 1/16	5/8	5/16	3/16	⅛
0.625 to 1.00	2 1/16	2	¾	6/16	5/16	⅛
1.00 to 1.375	3	2¾	15/16	⅜	⅜	¼
1.375 to 2.00	3¾	3⅜	1 3/16	7/16	9/16	¼

A	B	C	D	E	F
2.00 to 2.25	4½	3½	1¼	½	11/16
2.25 to 2.50	4¾	3¾	1 7/16	⅝	¾
2.50 to 2.75	5	3⅞	1½	⅝	¾
2.75 to 3.00	5¼	4⅛	1⅝	¾	7/8

Fig. 6. Single-end, Double-step Snap Gages for Diameters

Lapping the Gages

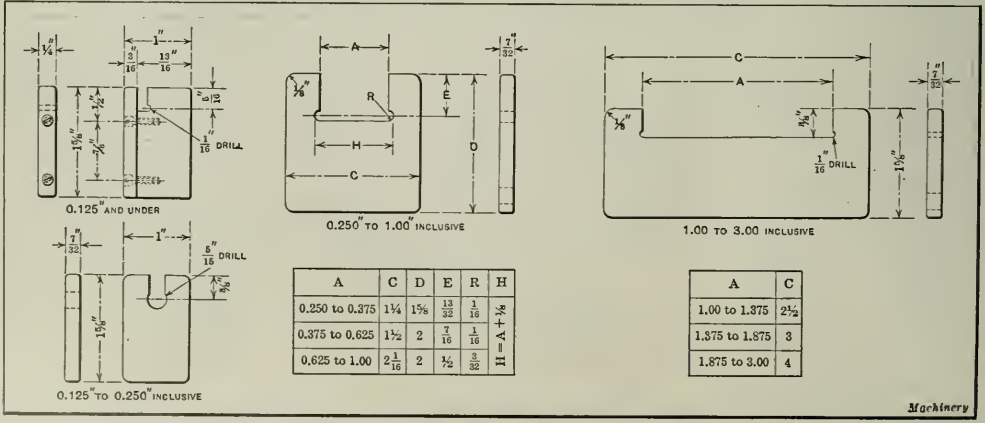
For a lapping compound, washed flour of emery should be used. It may be prepared by mixing one part emery with five parts lard oil in a clean can. After stirring, allow the mixture to stand for about ten minutes and then carefully pour off the oil, which rises to the surface, into another clean can. The emery that is suspended in the oil at the expiration of ten minutes in most cases will be found suitable; however, if a finer abrasive is required, the oil should be allowed to stand longer before pouring it off. If there is a large amount of work to be done and a fine finish is not required, five minutes will be long enough for the emery and oil to stand. Keep the mixture covered while it is not actually in use or when working near a dry grinding machine, as any coarse particles which are deposited in the oil will scratch the gage. A little kerosene used on the lap will prevent it from gumming.

All laps for small work should be made of brass; for large work cast iron should be used. For a gage from 1½ to 2 inches long, a lap about ¾ inch long should be used. Laps should always be shorter than the work. On the average lathe, the slowest speed available with the back-gears out will be found about right for lapping gages of ordinary size. Care should be taken to see that the work does not revolve at too great a speed. The tailstock should be used only for heavy gages, as it prevents the lap from being readily removed.

In performing the lapping operation, the gage is chucked and the sharp corners removed with an oilstone, and then the gage is wiped off lengthwise with a soft cloth, and measured to ascertain the amount of metal that must be removed. The lap is then put on and the tension screws adjusted for a snug fit. If it is found that the work is tapered, it should first be lapped straight. With each revolution of the work, the lap should be moved about ¾ inch axially back or forth. If the lap is properly tightened and is moved rapidly from place to place, the highest points will be taken off first. This does not occur, however, when the speed of the work is too high, when the lap is loose, or when it is moved leisurely at a rate of about 1/16 inch per turn of the work.

Care should be taken not to lap too much near the end of the gage. About five or six times back or forth up to within ⅛ inch of the end, to each time over the end, is about right. The reason for not lapping the end as much as the rest of the gage, is to avoid tapering it; this may also be caused if the lap is not removed quickly. The removal of the lap will usually reduce the end of the gage sufficiently, even if it has not previously been lapped off as much as the rest of the gage. It does not require so much skill to remove the first 0.0001 or 0.00015 inch as it does to remove the last 0.00005 inch. The man who does light gage lapping should not do heavy lapping, as it destroys the delicate touch necessary for the former class of work. For removing spots which sometimes project above the surface of the gage, a narrow lap about ¼ inch wide should be used.

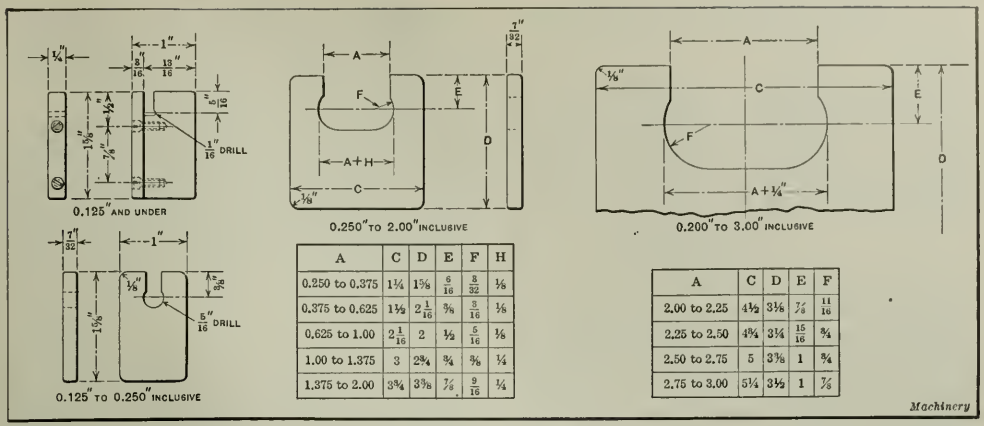
In order to produce a high finish on the gage, the lap is dried; the gage which is being lapped is allowed to dry for a few moments before dry-lapping to produce the desired



A	C	D	E	R	H
0.250 to 0.375	1¼	1⅝	13/32	1/16	H = A + ⅛
0.375 to 0.625	1½	2	7/16	1/16	
0.625 to 1.00	2 1/16	2	½	3/32	

A	C
1.00 to 1.375	2½
1.375 to 1.875	3
1.875 to 3.00	4

Fig. 7. Single-end, Single-step Snap Gages for Lengths



A	C	D	E	F	H
0.250 to 0.375	1¼	1⅝	5/16	3/32	⅛
0.375 to 0.625	1½	2 1/16	⅜	3/16	⅛
0.625 to 1.00	2 1/16	2	½	5/16	⅛
1.00 to 1.375	3	2¾	¾	⅜	¼
1.375 to 2.00	3¾	3⅜	⅞	9/16	¼

A	C	D	E	F
2.00 to 2.25	4½	3⅛	⅞	11/16
2.25 to 2.50	4¾	3¼	15/16	¾
2.50 to 2.75	5	3⅜	1	¾
2.75 to 3.00	5¼	3½	1	⅞

Fig. 8. Single-end, Single-step Snap Gages for Diameters

finish. When doing this, care should be taken to have the lap a tight fit and to lap quickly, going back and forth rapidly over the gage; otherwise the lap is likely to score the work. A high polish may also be obtained by using machine oil when only about 0.00005 inch of metal remains to be lapped. The sharp corners should finally be slightly stoned off.

Although gages are usually made of tool steel, good results may be had with machine steel, pack-hardened; and if properly carburized, these gages will last longer than tool steel gages, although they are likely to show soft spots here and there. Pack-hardened gages act somewhat like high-speed steel on the grinding wheel, and also require more time for lapping to size.

Plug Gage Handles

Plug gage handles are an important item, and should be made up in standard sizes. Handles may be made round and knurled, or they may be made from hexagon bar stock. If round handles are preferred, there should be a flat milled on one side, or a plain band turned to provide a place for stamping identification numbers or initials. In Table 2 are given the dimensions for a complete set of removable hexagon handles for plugs up to 2 inches in diameter. Handles should be made of either machine or cold-rolled steel and should be left soft.

Standard Ring Gages

Ring gages are used for measuring external diameters of work. They are made up in standard sizes which are available in the market, but special sizes are usually made by the manufacturer in his own tool-room. Table 3 gives all the dimensions for a complete set of standard blanks for measuring diameters up to 6 inches. For diameters larger than 6 inches it is best to use snap gages entirely, as they are not so heavy.

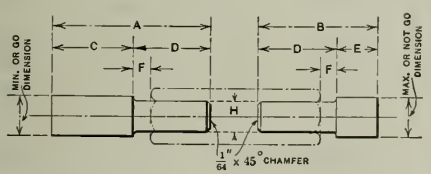
Ring gages are sometimes used in conjunction with snap gages, a minimum snap gage being used with a maximum ring gage. This practice is advisable on work larger than ¾ inch in diameter. It is evident that a workman could easily force a snap gage over work which is so much out of round or eccentric that it would not permit a maximum ring gage to pass over it. With this system, the ring is used as a check on the minimum snap. This method represents very good practice for gaging diameters.

Rings for gaging work up to ½ inch should be made to fit a standard plate-holder such as shown in Fig. 9. Such a holder should be made of a convenient size to fit the hand and will keep both the "Go" and "Not Go" rings together and convenient for use. Ring gages should be made from a grade of tool steel containing not less than 1 per cent carbon—hardened, seasoned, ground, and lapped. The maximum or "Go" ring gage should be distinguished from the minimum or "Not Go" gage by a pronounced chamfer on the outside diameter. The outside diameters of both rings should be knurled.

Making Ring Gages

In making ring gages, great care should be taken to clamp the work lightly when grinding the hole. When gripped in the chucks, one should be able to remove the gage from the

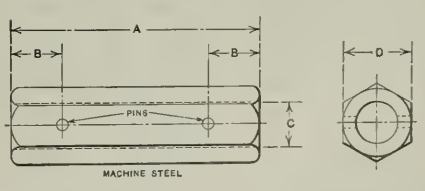
TABLE 1. DIMENSIONS OF PLUG GAGE BLANKS



Diam. of Plug	A	B	C	D	E	F	H
0 to 0.125	1 5/8	3/4	7/16	1/2	1/4	1/8	1/8
0.125 to 0.250	1 3/4	15/16	1/2	1 1/16	1/4	1/8	5/32
0.250 to 0.375	1 5/8	1 3/16	13/16	13/16	3/8	3/16	1/4
0.375 to 0.500	2	1 1/2	1	1	1/2	1/8	5/16
0.500 to 0.625	2 7/16	1 13/16	1 1/4	1 3/16	5/8	1/4	7/16
0.625 to 1.00	2 13/16	2 1/4	1 7/16	1 1/2	3/4	1/4	1/2
1.00 to 2.00	2 5/8	2 3/8	1 1/4	1 5/8	3/4	1/4	5/8

Machinery

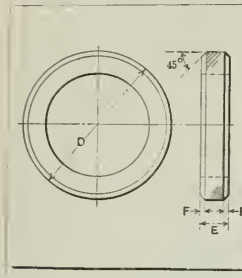
TABLE 2. PLUG GAGE HANDLE DIMENSIONS



Use for Plugs Diam. from	A	B	C	D	Pins
0 to 0.125	1 5/16	7/32	1/8	1/4	1/16 × 1/4
0.125 to 0.250	1 1/2	1/4	3/32	5/16	1/16 × 5/16
0.250 to 0.375	1 7/8	3/8	1/4	7/16	3/32 × 7/16
0.375 to 0.500	2 1/4	7/16	5/16	9/16	3/32 × 9/16
0.500 to 0.625	2 5/8	1/2	7/16	11/16	3/32 × 11/16
0.625 to 1.00	3	5/8	1/2	13/16	1/8 × 13/16
1.00 to 2.00	3 3/8	11/16	5/8	1	1/8 × 1

Machinery

TABLE 3. RING GAGE BLANK DIMENSIONS



For Work	D	E	F
Under 0.750	1½	5/8	1/8
0.75 to 1.00	2	5/8	1/8
1.00 to 1.50	2¾	3/4	1/8
1.50 to 2.00	3½	3/4	1/8
2.00 to 2.50	4	3/4	1/8
2.50 to 3.00	4½	7/8	3/16
3.00 to 3.50	5¼	7/8	3/16
3.50 to 4.00	6	1	3/16
4.00 to 4.50	6½	1	3/16
4.50 to 5.00	7	1	3/16
5.00 to 5.50	8	1⅛	¼
5.50 to 6.00	8½	1⅛	¼

Machinery

chuck by hand. Plenty of material should be left for lapping, as ring gages have a tendency to become misshapen after a few weeks' seasoning, or to become out of round owing to soft spots. The lapping allowance for ring gages should be 0.001 inch for work from ¼ to 1 inch in diameter; 0.0015 inch for work from 1 to 2 inches in diameter; and 0.002 to 0.003 inch for work from 2 to 3 inches in diameter. No lapping allowance is necessary for small gages for use on work under ¼ inch in diameter, as these gages can be lapped directly to size immediately after hardening.

The material for laps for small ring gages should be brass, but for large gages cast iron is preferable. The cast-iron arbor bushings which are used in lapping are reamed with a standard taper pin reamer, ¼ inch taper per foot. One end of the arbor is made straight so that it may be securely held in the chuck. The arbors may be either hardened and ground all over, or if preferred the ends only may be hardened to preserve the centers. The tailstock center support is required only on large work. The lap should be bored or reamed, split lengthwise, and then driven onto the arbor tight enough to hold while it is being turned on the outside. This type of lap does not need a key to prevent it from turning on the arbor, as is the case with lead laps. On round work, lead laps are not to be recommended, as they lose their shape too easily when driven on the arbor or when a sharp corner of the work catches in the lead. A further objection is that they lack the necessary elasticity to hold them securely on the arbor when driven on. Ordinary cast iron will be found suitable for laps, and if made from such material they will hold their shape for a long time. Laps about ¼ inch in diameter will give better results when grooved, but the grooves should not extend to the end. The grooves can be filed in the lap or holes may be spotted as a means of keeping the emery on the surface of the lap. The ends of the lap should be reduced for about ⅛ inch, and the corners rounded to prevent raising a burr when driving or pressing it on the arbor. A piece of copper should be used when driving laps on or off the arbors.

Tolerances as Applied to Gage Making

The tolerances given in Table 4 are for plain gages, and are applied in such a manner that the tolerances permitted on the gage are included in the manufacturing tolerance allowed on the work. This insures that any work passed by the gages will be within the tolerance specified on the drawing. The tolerances given also permit the classification and selection of gages, so that if a gage is not suitable for a master gage it may be classified and used as an inspection gage or working gage, according to the tolerance it is found to have by actual measurement.

Examples of the application of tolerances for master inspection and working gages will be given in connection with the gage diagram Fig. 10 and Table 4. These examples cover all conditions except those for what may be termed special gages. In order to thoroughly understand the system, it will be well to take as an example a simple single-end, double-step snap gage, such as illustrated in Fig. 10, and furnish a complete explanation of the method of applying the tolerances.

Starting with the basic dimension $1.250\ ^{+\ 0.000}_{-\ 0.005}$ and referring to Table 4, the gage tolerance allowed on the gage may be found. The tolerance on the work governs all tolerances on the gages, and since tolerance means the total difference between the maximum and minimum dimensions of the work, the total limit allowed on the work must be used to determine the gage tolerance. In this case the total work allowance is 0.005 inch, (if the allowance read $^{+\ 0.005}_{-\ 0.005}$ inch, the tolerance would be 0.010 inch). Referring to the table, the value 0.005 is found (included in the space 0.004 to 0.006), and directly opposite under "master gages" in the column for "Not Go" male and "Go" female gages, is found the "Not Go" gage tolerance of $^{+\ 0.0000}_{-\ 0.0003}$. In the same manner, the gage tolerance on the inspection and working gage units may be fonnd. The basic maximum dimension is 1.250 inches and the basic minimum dimension is 1.250 minus 0.005 or 1.245 inches. These two values are basic "Go" and "Not Go" dimensions for each gage as will be noted from the diagram in Fig. 10, and the gage tolerances only change in each gage. The inspection and working gages are not made to the basic figures 1.250 and 1.245, but to the basic figures plus or minus the tolerances given. For example, the "Go" end of the inspection gage is 1.2497 (maximum) and 1.2494 (minimum), and these two dimensions are the actual working figures for the toolmaker. The dimensions for the working gage are also computed in like manner, and no confusion should be experienced in applying this system.

TABLE 4. TOTAL MANUFACTURING TOLERANCES ON PLAIN GAGES

Tolerance on Work	Master Gages		Inspection Gages		Working Gages	
	"Go" Male and "Not Go" Female Gages	"Not Go" Male and "Go" Female Gages	"Go" Male and "Not Go" Female Gages	"Not Go" Male and "Go" Female Gagea	"Go" Male and "Not Go" Female Gages	"Not Go" Male and "Go" Female Gagea
0.000 to 0.002	— 0.0000 + 0.0001	+ 0.0000 — 0.0001	+ 0.0001 + 0.0003	— 0.0001 — 0.0003	+ 0.0003 + 0.0005	— 0.0003 — 0.0005
0.002 to 0.004	— 0.0000 + 0.0002	+ 0.0000 — 0.0002	+ 0.0002 + 0.0004	— 0.0002 — 0.0004	+ 0.0004 + 0.0007	— 0.0004 — 0.0007
0.004 to 0.006	— 0.0000 + 0.0003	+ 0.0000 — 0.0003	+ 0.0003 + 0.0006	— 0.0003 — 0.0006	+ 0.0006 + 0.0010	— 0.0006 — 0.0010
0.006 to 0.010	— 0.0000 + 0.0004	+ 0.0000 — 0.0004	+ 0.0004 + 0.0009	— 0.0004 — 0.0009	+ 0.0009 + 0.0015	— 0.0009 — 0.0015
0.010 to 0.020	— 0.0000 + 0.0006	+ 0.0000 — 0.0006	+ 0.0006 + 0.0014	— 0.0006 — 0.0014	+ 0.0014 + 0.0025	— 0.0014 — 0.0025
0.020 to 0.050	— 0.0000 + 0.0008	+ 0.0000 — 0.0008	+ 0.0008 + 0.0020	— 0.0008 — 0.0020	+ 0.0020 + 0.0035	— 0.0020 — 0.0035
0.050 and over	— 0.0000 +0.0010	+ 0.0000 — 0.0010	+ 0.0010 + 0.0025	— 0.0010 — 0.0025	+ 0.0025 + 0.0050	— 0.0025 — 0.0050

Machinery

It is very good practice to give on the gage drawings the actual figures desired and not the basic figure plus or minus the tolerance, as this causes the toolmaker to add or subtract the tolerance as the case may be, in order to find the actual dimensions and the limit allowed on the gage. This offers a chance for a mistake to be made which may not be discovered until the gage reaches the tool inspection department (unless the gage were inspected after each operation). Such possibilities for mistakes could be obviated if the *actual* figures were placed on the drawing in the first place. On the master gages, the above suggestion does not apply, as in this case there is a limit in one direction only, such as $\begin{matrix}+0.0005\\-0.0000\end{matrix}$ or $\begin{matrix}+0.0000\\-0.0005\end{matrix}$ and the toolmaker can readily see what is required.

The application of the tolerance for plain master, inspection, and working gages is such that the tolerance for the gages is included in the tolerance allowed on the work.

Examples of Tolerance Application—Master Gages

The following examples apply directly to master gages, which are of the same design and construction as the working or inspection gages. If it is required to gage a cylinder having an outside diameter $1.250\begin{matrix}-0.005\\+0.000\end{matrix}$ the master gages, whether they be snap, ring or other gages that have inside gaging dimensions, should have the following limits:

"Go" Gage—Dimension of the "Go" or maximum master female gage, $1.250\begin{matrix}+0.0000\\-0.0003\end{matrix}$

"Not Go" Gage—Dimension of the "Not Go" or minimum master female gage, $1.245\begin{matrix}-0.0000\\+0.0003\end{matrix}$

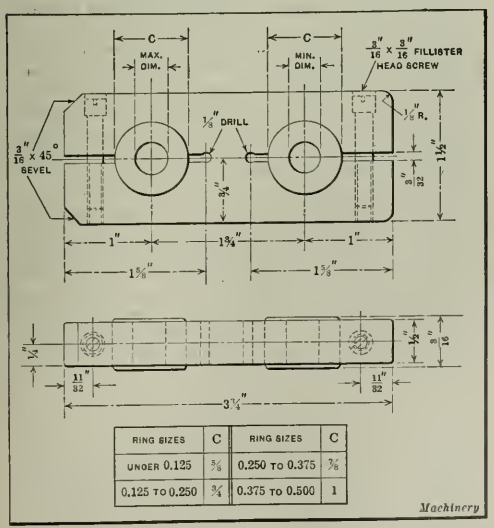
If it is required to gage an internal diameter having a dimension of $1.260\begin{matrix}-0.000\\+0.005\end{matrix}$ the master plug gages and the other gages that have plain outside gaging dimensions should have limits as follows:

"Go" Gage—Dimension of the "Go" or minimum master male gage, $1.260\begin{matrix}-0.0000\\+0.0003\end{matrix}$

"Not Go" Gage—Dimension of the "Not Go" or maximum master male gage, $1.265\begin{matrix}+0.0000\\-0.0003\end{matrix}$

Examples of Tolerance Application—Inspection Gages

New inspection gages will be required to be within the limit of tolerances as shown in Table 4. They are to be discarded when they reach the limit established either by the part drawing or by the master inspection gages which are the physical standards for the limits established by the part drawing.



RING SIZES	C	RING SIZES	C
UNDER 0.125	3/8	0.250 TO 0.375	7/8
0.125 TO 0.250	3/4	0.375 TO 0.500	1

Fig. 9. Standard Plate-holders for Ring Gages

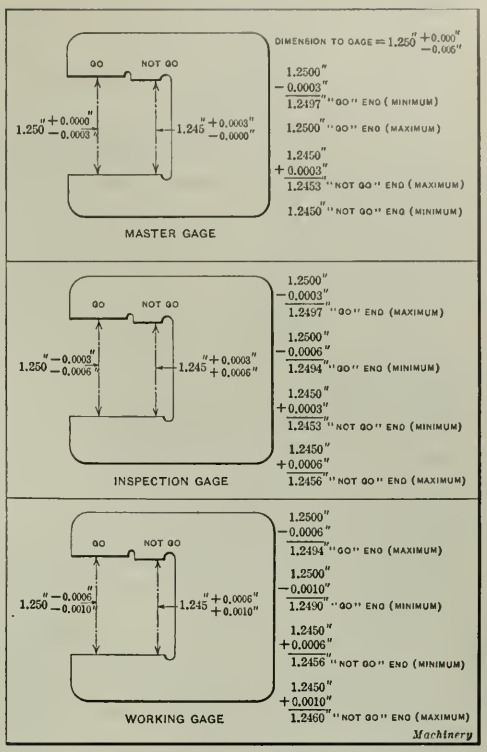


Fig. 10. Master, Inspection, and Working Snap Gages showing Gage Tolerance System

If it is required to gage a cylinder having an outside dimension $1.250\begin{matrix}+0.000\\-0.005\end{matrix}$ the inspection snap, ring or other equivalent gages that have inside gaging dimensions, should have limits as follows:

"Go" Gage—Dimension of the "Go" or maximum inspection female gage, $1.250\begin{matrix}-0.0003\\-0.0006\end{matrix}$

"Not Go" Gage—Dimension of the "Not Go" or minimum inspection female gage, $1.245\begin{matrix}+0.0003\\+0.0006\end{matrix}$

If it is required to gage an internal diameter having a dimension of $1.260\begin{matrix}-0.000\\+0.005\end{matrix}$ the inspection plug gages or other gages that have plain outside gaging dimensions should have the following limits:

"Go" Gage—Dimension of the "Go" or minimum inspection male gage, $1.260\begin{matrix}+0.0003\\+0.0006\end{matrix}$

"Not Go" Gage—Dimension of the "Not Go" or maximum inspection male gage, $1.265\begin{matrix}-0.0003\\-0.0006\end{matrix}$

Examples of Tolerance Application—Working Gages

The application of the tolerances for working gages will be explained by the following examples:

If it is required to gage a cylinder having an outside dimension $1.250\begin{matrix}+0.000\\-0.005\end{matrix}$ the working snap, ring, or other equivalent gages that have inside gaging dimensions, should have limits as follows:

"Go" Gage—Dimension of the "Go" or maximum female working gage, $1.250^{-0.0006}_{-0.0010}$

"Not Go" Gage—Dimension of the "Not Go" or minimum female working gage, $1.245^{+0.0006}_{+0.0010}$

If it is required to gage an internal diameter having a dimension of $1.260^{-0.000}_{+0.005}$, the working plug gages or other gages that have plain outside gaging dimensions should be made to the following limits:

"Go" Gage—Dimension of the "Go" or minimum male working gage, $1.260^{+0.0006}_{+0.0010}$

"Not Go" Gage—Dimension of the "Not Go" or maximum male working gage, $1.265^{-0.0006}_{-0.0010}$

The use of the tolerances suggested for working gages will insure that all parts passing the working gages will pass the inspection gages.

By using this system, female gages are added to the working gage stock when the inspection gages become worn; and when male working gages are reduced by wear so that the inspection gage will not pass the work, these gages are placed in the stock of inspection gages. As inspection male gages become worn below the limit, they should be taken out of the gaging system entirely and either scrapped or inspected for tolerance, and if found correct for master gages, should be used as such. This classification is done in the tool inspection department, where the actual measurement of the gages takes place.

A good general rule to apply for the exact location of the plus or minus tolerances and a rule which applies to the tolerance system in Table 4 and is applicable on special gages, etc., is as follows: A minimum gage has a maximum or plus tolerance, while a maximum gage has a minimum or minus tolerance.

* * *

THE IMPORTANCE OF CAREFUL DETAIL WORK

BY WARFIELD WEBB

Anyone can do ordinary work, but to excel in whatever you undertake is made possible only by recognizing the fact that in connection with your work there is nothing that is not worthy of your consideration. Many fail to achieve the greatest success of which they are capable because they leave to others what they consider to be trivial things, or do not have these small details attended to at all. In engineering, especially, this is a dangerous thing. Many of the greatest achievements in the world of science and engineering have been arrived at by inventors and discoverers who did not overlook trivial details. Had they done so, or had they relegated these details to the care of others, the work that they did would have been left for others to accomplish.

In order to be able to distinguish between details that are of importance and those that are not, judgment is required. This judgment comes largely by the mastery of detail. To one who has become thoroughly familiar with all the details in his line of work, it is easy to distinguish between the important and the non-essential matters, but to attain this judgment and experience takes time; and it is best at all times not to be too sure in overlooking small matters. It is the painstaking care with details and the judgment to distinguish between essentials and non-essentials that most clearly distinguishes the executive from the routine man.

To master details requires concentration and willingness to work. It demands a given amount of energy and a certain amount of labor. Most men are not willing to give this additional amount of labor to their tasks, but are content with their present situation and do not aim to rise higher. They are willing to let the other man move forward. This is one reason why there are so few men who have mastered the difficult details that bring with them a chance for promotion.

ECONOMIC CONDITIONS IN RUSSIA

The Commerce Reports, issued by the Bureau of Foreign and Domestic Commerce, Washington, D. C., recently published a translation from the July 18 number of *Mercator*, a Finnish trade journal, dealing exhaustively with the present economic conditions in Russia. From this article, it appears that most of the industries are being nationalized, so that they are directly controlled by the state, and there is a considerable modification of the power of the labor unions with regard to management. The government has deprived the industrial workers of their right to have any influence on the technical side of work-shop management, and the intention is to prevent any direct influence by the workers in the management of industrial enterprises. Piecework and premium-payment systems have also been introduced in many of the factories that are managed directly by the government. It is apparent from present indications that the tendency in Russia is toward direct state control of all industrial enterprises, the workers having power to influence the management only through their regular voting power as citizens of the state.

With this return to what might be considered more conservative methods of management goes, however, the radical campaign against private property. Several textile mills, until recently independent, have been taken over by the national government and the nationalization is being extended to as many industries as possible. The financial conditions appear to be as yet very unsatisfactory. There is a great deal of paper money in circulation that is almost valueless, and there are so many issues of different kinds of paper money that it is difficult to determine the exact amount of currency in circulation. Some of the large cities are now issuing money. In Odessa, for example, there are three kinds of rubles in circulation issued by the national governments —the Czar, the Duma, and the Kerensky rubles; then there is the currency of the Don Republic, the currency of the municipality of Odessa, and another Odessa currency based on a diamond standard. This indicates the difficulty of doing business with Russia at the present time.

From another source it has been learned that trade carried on between Sweden and Russia takes place entirely on an exchange basis. Swedish merchants will load a ship with necessities required in Russia and will take in exchange in the Russian harbor such goods as have been stored there with a view to exchanging with foreign shippers. No money is handled in the transaction, and no credit is given or asked.

The British Department of Overseas Trade has submitted a proposition for supporting important British trade with Russia. It is the intention, in conjunction with the War Risks Office, to arrange for marine and other war insurance on goods between England and Russia, and to insure British goods from the time they are unloaded until they are sold, and Russian goods from their place of purchase to shipboard in Russian harbor. The great risk on merchandise shipped to and from Russia would thus be covered.

According to a statement published in the Commerce Reports, England considers it necessary to make great efforts to enter the Russian market, because otherwise Germany may dominate in Russia, especially if political developments go in the direction of a coalition of the interests of revolutionary Russia and Germany. Without a merchant fleet and without any connections among the western powers or outside of Europe, there is only one outlet for German energy—over the land boundaries to the eastern markets.

* * *

Speculum metal is the technical name for the alloy of which telescope mirrors or reflectors are made. Its composition is two parts copper and one part tin. The addition of 1 or 2 per cent metallic arsenic gives the metal a greater compactness and a greater luster and hardness, but if such addition is made, the metal is likely to tarnish. The metal is very hard and as brittle as sealing wax.

The Machine Tool Trade

THERE has been no appreciable change in the situation in the machine tool trade during the past month, practically all manufacturers reporting a satisfactory business and many having orders so far ahead that they quote on deliveries well into 1920. Other machine-building industries also seem to be quite active, and this, of course, has a satisfactory effect upon the machine tool trade. The activity on the part of a number of other industries is well indicated by the business of the gear manufacturers who, throughout the country, appear to have their factories well employed. In addition to the well-known activity in the automobile and accessory field, the manufacture of textile machinery appears to be very active; many of the textile mills have built large additions or are contemplating expansion. The machine tool builders who depend largely upon the railways as customers find business quiet, however, except in some special lines; the railways, as is generally known, are not in a position to buy at the present time on account of the policy pursued by the federal railway administration.

There have been local labor disturbances in several places in the machine tool trade, but these appear now to have been settled, the men having gone back to work under the old conditions. The steel strike, of course, has had its influence upon the machine tool trade, and there has been less buying since the beginning of the labor disturbances in the steel field.

In the case of heavy special machinery, there has been a decided reduction in prices since the armistice, and what appears to be ill-advised competition leaves little chance for remunerative business, many plants apparently figuring on prices that will merely keep their organizations together and thereby forcing others to quote equally low. This, however, does not refer to the machine tool line, but to special lines of heavy punching machinery, large shears, hydraulic presses, etc., on which there is comparatively little machining work, and where most of the expense involved is for castings and other material.

In the machine tool field, again, some prices have been increased, because of the continued increase in manufacturing costs. It is not apparent that the machines sold by the Government have appreciably affected the market, although they are now beginning to be sold in increasing quantities. The dealers may feel this competition to some extent, but nearly all the manufacturers quote on deliveries so far ahead that no immediate difficulty is caused by the placing of the government-owned machinery on the market.

Cranes are being sold at prices about 35 per cent below those of a year ago, but as materials are a large item in crane construction, and as there has been a cut of about 25 per cent in materials, this accounts, to some extent, for the reduced prices of cranes. There have been statements made to the effect that prices in this line are likely to be advanced before long.

The shortage of unskilled labor is making itself felt more and more. This is the case especially in foundry work where a considerable proportion of unskilled help is required. It is stated by the American Malleable Castings Association that at the present time fully 200,000 tons of malleable foundry capacity is idle because the necessary labor cannot be secured. Improvement in this direction, it is stated, is not to be expected until there is a flow of immigration sufficient to build up the supply of labor required for foundry work.

Foreign Trade Conditions

Owing to the abnormal conditions of foreign exchange, the export machine tool trade has suffered during the last few months. There is still a considerable amount of foreign trade, however, and advices from France from actual buyers of machine tools indicate that they would still be in the market for American machine tools, at present prices, if the dealers had machines in stock for immediate delivery. The last report of exports of metal-working machinery from the United States, issued by the Department of Commerce, covers the month of August. This report, given in detail in the accompanying table, shows that the value of machine tools exported amounted to slightly over $2,000,000, of which lathes of various kinds represented $775,000. England continues as the biggest customer, having imported metal-working machinery during the month of August to the sum of nearly $1,000,000, of which over $600,000 represented the value of machine tools. The exports to France in metal-working machinery amounted to nearly $800,000, of which about one half represented machine tools. The total exports of machine tools to Japan amounted to about $130,000; to Canada, $115,000; and to Belgium, $110,000; while, in each case, a much larger amount of other metal-working machinery was also exported.

EXPORTS OF METAL-WORKING MACHINERY FROM THE UNITED STATES, AUGUST, 1919

Countries	Lathes	Sharpening and Grinding Machines	Other Machine Tools	All Other Metal Working Machinery
	Dollars	Dollars	Dollars	Dollars
Belgium	45,213	60,802	3,276	132,960
Denmark	468	10,149	26,381	12,754
Finland	1,900	.....	1,592	10,060
France	118,536	65,985	207,829	393,208
Greece	.....	.....	261	.....
Italy	264	.....	40,562	17,405
Netherlands	27,148	1,998	12,820	5,409
Norway	2,288	1,490	8,587	12,228
Portugal	16	4	924	6,993
Russia in Europe	.....	.....	57,000	.....
Spain	19,550	6,107	19,425	56,894
Sweden	13,625	6,867	2,442	22,228
England	327,519	58,252	244,825	341,228
Scotland	.....	6	66,675	5,179
Ireland	.....	82	.....	.....
Canada	27,652	18,282	69,867	271,521
Guatemala	.....	26	162	65
Nicaragua	.....	.....	43	.....
Panama	.....	.....	258	1,263
Mexico	493	6,537	2,834	924
Newfoundland and Labrador	.....	41	.....	551
Jamaica	.....	25	105	480
Other British West Indies	.....	.....	161	25
Cuba	31,845	6,309	34,815	16,225
Haiti	1,320	11	.....	.....
Dominican Republic	590	114	5,421	1,738
Argentina	2,202	2,998	6,533	9,076
Bolivia	.....	.....	.....	169
Brazil	10,000	2,415	7,153	10,765
Chile	4,740	220	1,443	4,388
Colombia	4,958	.....	102	4,030
Ecuador	.....	56	217	488
Dutch Guiana	.....	.....	23	364
Paraguay	.....	315	.....	.....
Peru	3,510	161	1,584	4,286
Uruguay	718	85	1,063	.....
Venezuela	.....	.....	184	.....
China	10,075	481	895	7,016
British India	5,980	3,617	13,252	137,588
Straits Settlements	2,125	12	1,612	.....
Other British East Indies	.....	3,189	.....	.....
Dutch East Indies	21,688	3,395	5,990	5,684
Hongkong	75	55	750	.....
Japan	69,952	19,832	40,594	302,009
Russia in Asia	.....	.....	160	1,400
Siam	.....	.....	600	.....
Turkey in Asia	.....	.....	.....	1,252
Australia	13,237	22,166	9,259	15,078
New Zealand	3,077	693	2,462	803
French Oceania	172	45	.....	.....
Philippine Islands	1,363	802	6,829	16,311
Belgian Congo	.....	.....	.....	1,890
British West Africa	33	.....	.....	.....
British South Africa	3,075	11,265	7,908	11,296
French Africa	.....	63	90	.....
Portuguese Africa	.....	35	288	.....
Egypt	14	.....	203	.....
Total	775,434	314,987	915,469	1,843,253

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This issue of MACHINERY is published and mailed at Cleveland, Ohio, as labor demands have enforced the closing of our printing plant for a month.

Everyone who is familiar with the mechanical work on a periodical of this size will appreciate the difficulty of producing it at such a distance from the publication office; and for any deficiencies caused by these conditions we ask the indulgence of our readers and advertisers.

* * *

CAUSES OF INDUSTRIAL UNREST

The following general causes of the present industrial unrest in Great Britain are given by Sir Robert Horne of the British Ministry of Labor: The long strain of the war; the nervous effect produced by the extreme industrial effort of the nation; the disturbance of normal economic life; the rise in the cost of living; and the absorption into Anglo-Saxon thinking of revolutionary ideas from the European continent.

Generally speaking, the same causes are at the bottom of the industrial unrest in the United States. The disturbance of the normal economic life of the nation by the war naturally had to produce a pronounced effect, and the rise in the cost of living is doubtless the greatest single factor in creating and prolonging the present industrial conditions. It is at least the most obvious and direct of many causes and furnishes the readiest reason for labor disturbances.

The unsettling influences that have come from Europe, and particularly from Russia, should not be overlooked. A large section of old Russia is passing through a political and economic experiment, the failure of which seems imminent. But no matter what the outcome may be in Russia, it is certain that there is no need of any similar experiment in the United States, where every man has (and every woman probably soon will have) through the ballot box, the right and the power to effectively express his political and economic views and wishes, and through his chosen representatives to get them established as part of our institutions—provided only that a majority of his fellow citizens agree with him.

The present economic condition is simply a circle—vicious or otherwise, according to the viewpoint of the observer. The wages of labor are constantly being increased, and as a direct result, the cost of living goes up; then the cost of living having gone up, labor demands greater wages. Apparently, the problem is being attacked entirely from the wrong end. There is but one thing that can reduce the cost of living permanently. That is *increased production.*

* * *

PRACTICAL APPLICATION OF THE TOLERANCE SYSTEM

The old saying that a little knowledge is a dangerous thing could hardly be better exemplified than by the present application of the tolerance system in many shops. Engineers and draftsmen who have worked in the highly organized shops where limits are placed on all drawings, are often eager to introduce the same system in smaller plants where they later may have found employment. But to install a system of limits and tolerances and to place these tolerances upon the drawings properly is by no means an easy task, and the first idea or plan —to put limits on every dimension—will lead to many difficulties and will prove costly in the manufacture of the parts.

The pitfalls into which the designer and draftsman may stumble when applying the limit system and dimensioning drawings in accordance with this system, are pointed out in the article by Earle Buckingham, beginning on page 259 of this number of MACHINERY. At first sight it appears to most mechanical men a simple matter to place limits upon drawings, at least after the proper tolerances have been determined in a general way with reference to the conditions that must be met. But to properly dimension a drawing, even though the important facts relating to the tolerance on the work are known, is by no means an easy task.

The war accelerated the introduction of the system of placing limits on drawings; but the methods by which a great many drawings are now being dimensioned are such that the requirements cannot be met in actual commercial work. When limits are placed on every dimension, it is, in many cases, impossible to keep the work within the tolerance without extreme refinement of the work. Tolerances should be placed upon the vital dimensions only; that is, those dimensions that definitely must be between certain predetermined limits. The other dimensions will then practically take care of themselves. This is a general statement, and to understand its full significance, Mr. Buckingham's article must be studied with considerable care. The subject is not one that is easily understood and mastered, and to comprehend its intricacies fully, the principles involved must be given careful thought.

* * *

AMERICAN ENGINEERING STANDARDS

More than fifty engineers, representing practically every organization interested in the development of standards, attended the first meeting of the American Engineering Standards Committee held at the Engineers' Club in New York City in September. Charles LeMaistre, secretary of the British Engineering Standards Association, was the guest of the American committee. The British association, which was formed in 1901 and during the past eighteen years has done valuable work, at present consists of some three hundred committees, having twelve hundred members, who give a great deal of their time to the work of standardization. This has become thoroughly recognized in Great Britain as an industrial question, and it is felt that each industry should determine its own standards, obtaining when necessary the help of outside engineers and experts in properly defining them for permanent records. The standards adopted by the British Engineering Standards Association are becoming more widely accepted, and that association is now regarded as the central authority for standardization.

In the United States a similar central standards association is necessary; otherwise separate standards may be adopted by a number of different engineering and technical societies. In the electrical industry there are already at least a dozen organizations developing standards in that field. To avoid confusion, it is evident that a central clearing house is necessary for the different standards proposed by different industries or organizations representing them, so that the standards suggested may be adjusted until one that is acceptable to all can be obtained.

Machine Tool Conditions in France, Italy, Switzerland and Holland

By ALEXANDER LUCHARS

Trade Commissioner, Department of Commerce, Bureau of Foreign and Domestic Commerce, Washington, D. C.

WHEN the contract was signed by the American Liquidation Commission to sell for $400,000,000 to the French government about three-quarters of the war material in France belonging to the United States government, a big transaction was completed. The material sold, which cost about $1,300,000,000, included, besides enormous quantities of machinery, supplies and materials, all the machine tools which had been sent to France by the War Department. As is usually the case, there is a wide difference in the estimates of the value and amount of the machine tools, among dealers and others interested, varying from 400,000,000 to 100,000,000 francs.[1] The latter sum I believe to be near the actual value.

Some of these tools are now being sold by the French government to manufacturers in the devastated areas, and some used elsewhere. So far these sales have not materially affected the sales of American tools here, these being in good demand, and many dealers say their volume of sales for 1919 exceeds that of the corresponding period for 1918. It is not thought that many of the machine tools involved in this purchase will come on the market, as the best will probably be retained for adjustments in government plants.

Although an added burden, dealers say the increased duty will not greatly affect the sales of American machine tools. As the duty is based on weight it will have more effect on the sales of heavy tools and machinery, most of which were supplied by England and Germany before the war.

The fear of German sales at prices based on the depreciated mark also overhangs the French market, and a few sales of heavy machines, such as presses, forging machines, boring mills, planers, etc., are said to have been made; but these sales concern the British rather than American manufacturers, as we were unable to sell such machines in Europe for several years before the war, principally on account of transportation costs.

French Machine Tool Manufacturers

The enormous expansion in the use of machine tools during the war has caused a surprisingly small increase in the number of French machine tool builders. Two or three of the older firms for some years have been using modern methods and these have enlarged their plants and improved their equipment. Others appear to have learned nothing since 1914.

There have been few changes among dealers. With the exception of the Associated British Machine Tool Makers, Ltd., there are no important additions to the number of French machine tool dealers since 1914. Most say that business is good, especially in the Northern and North Eastern parts of France; but even in those sections which suffered most from the German invasion some French manufacturers are buying German tools rather than American on account of the difference in price. The exchange rate with France, as with the other Allies, is very favorable to the Germans *in selling*, 45 francs equalling 100 marks. With the Swiss franc there is even more difference, 100 Swiss francs being worth 141 French francs. The purchases referred to are, however, confined to heavy machines. The large number of tools used in France during the war, most of which were creditable examples of American products, have been a great help in educating French manufacturers still further in the use of tools of the best quality.

[1] The French franc, now selling at about 12.5 American cents, is normally worth about 19 cents.

Labor

In spite of sporadic strikes, the French labor situation is settling down, and the thrifty habits of the French working people are reasserting themselves. The legal working day is eight hours, forty-eight hours a week; time is made up for Saturday half holiday; but in small factories the employes often voluntarily work nine and ten hours a day at a proportionate increase in pay. The smaller the shop the less attention is paid to the eight-hour day.

The prevailing wages in and around Paris, and in other manufacturing centers where labor is in good demand are as below. Less is paid in small centers, where living is cheaper.

	1914 Francs Per Hr.	1919 Francs Per Hr.
Lathe hands	0.95 to 1.25	3.75
Assemblers	0.95 to 1.90	3.80
Toolsmiths	1.25 to 1.90	4.00 to 5.00
Helpers	0.80 to 1.05	2.00
Molders	.....	3.00

Automobile Manufacturers

The principal demand for machine tools comes from automobile manufacturers who are busily preparing for 1920. The duty of 70 per cent on American cars will almost close this market to them, especially as the Italian product is admitted at 15 per cent. All the high-priced French automobiles include special features that appeal to the French buyers, and which in the American product are sacrificed for increased output. The French are really *makers*—not manufacturers. There is, of course, no such market for automobiles here as exists in America, but some makers are trying for the low-priced field. One well-known manufacturer, formerly in the gear business, who is credited with having made a fortune in munitions, has changed over his plant to produce a low-priced car in quantities. He originally planned to produce one hundred cars a day, to sell at 8000 francs. He has reached an output of twelve cars a day, but is selling them at 10,000 francs.

As the Future Now Looks

From an agricultural, textile and luxury-producing country, France doubtless will be pushed into the manufacture of metal articles by her acquisition of iron ore fields; but this development will be gradual, for it takes time to change the habits, ideas and industries of a people. The Germans say that their toy industry represents the growth of more than a hundred years and cannot be taken from them by the British with an experience of less than five. It is probable that after the present demand for machine tools in France is satisfied, there will follow a quiet period, which in turn will be followed by a gradual and healthy increase in demand, as the manufacture of metal articles develops.

Industrial Outlook in Italy

The industrial outlook in Italy is uncertain. In the best hotels food is scarce—a sure indication, even to the hurrying traveler, that the needs of the working people are urgent. The lack of coal and other natural resources is a heavy handicap to any nation that seeks to thrive from manufacturing, although in Italy this lack is partly made up by the develop-

ment of water power, the sources of which abound in Northern Italy. The Italians fully appreciate the gravity of this situation and are making strenuous efforts to utilize their water power wherever practicable. Near Bellagio, in the Como district, where coal is selling at $70 a ton, five thousand men have been working for months developing a hydraulic plant to generate about 4000 horsepower for the railways.

The agents of American machine tool manufacturers are not of one mind as to the future for our tools in Italy, but are looking forward hopefully, now that the import restrictions have been removed. On certain lines of tools, especially heavy machines and the cheaper grades of machine tools, there is great fear of German competition, and we shall have difficulty in approaching their prices unless German manufacturers are further handicapped by labor and material costs. On heavy presses and forging machines, large radials and milling machines, planers and special tools for metal products, we shall be unable to compete with German prices on machines delivered in Italy. And the cheaper grades of standard machine tools, of which there are so many German makers, will appeal to many Italian manufacturers who are not educated to paying the difference between the best American tools and German products at 25 per cent to 33 per cent less. While a market will continue to exist in Italy for the best-known American tools, the exchange situation there, as elsewhere in Europe, is a heavy tax on our sales. The demand for high-priced labor-saving tools will come from such concerns as Ansaldo and Fiat, but it is much to be feared that the small manufacturers will be content with the cheaper and inferior tools. Ansaldo[1] continues their pre-war policy of general expansion, having no less than twenty-seven different establishments and six associated concerns employing 50,000 workers, men and women. The Fiat Works[2] made a considerable number of machine tools for their own use during the war and will continue to make lathes for the market.

Italian Machine Tool Makers

According to Ing. Michele Ferrero, president of the Association of Machine Tool and Small Tool Importers and Merchants, there were in Italy during the war, about a dozen factories producing machine tools exclusively, employing a total of 1500 workers, varying in size from 500 to 50 employes. There were also about thirty factories, producing machine tools as a side line. Of these forty-two factories only three or four of the smallest specialized on a single type of machine, the others building varied lines in the old-fashioned way. Now there are about a dozen employing some two thousand workers who are producing (some very good) lathes, shapers, small milling machines, drilling machines and a variety of special tools for metal sundries. The value of machine tools produced before the war was about thirty million lire[3] annually (at present prices) which rose during the war to ninety millions and is now, it is estimated, less than ten millions. Although there are a few Italian machine tool makers who produce machines of excellent quality, it does not appear from this showing, and from the conditions in other machine tool producing countries, that Italy will soon become an important factor in the production of machine tools.

Italian industrial conditions are subject to so many influences that it is difficult to forecast their future. Many factories that have been producing munitions and other war material have not yet returned to their pre-war product. A large part of the equipment in these factories consists of American machine tools, and many of these are coming on the market as the change-over to another product is being made.

Machine Tool Building in Switzerland

Before the war there were only two machine tool building concerns of any importance in Switzerland—the Oerlikon Works at Oerlikon near Zurich, and Fritz Wunderli at Uster. During the war a number of machine builders produced radials, boring mills, tool grinders, screw machines, small plain milling machines, small lathes and other light tools. Oerlikon, which is the oldest machine tool concern in Switzerland, with a reputation for good work, builds engine lathes, horizontal and vertical milling machines, No. 3 horizontal boring machines (floor and table types), radial drills, and have under construction a No. 2 milling machine, a type popular in both Switzerland and France; also a high-speed, geared-head lathe with hardened and ground gears made by Maag of Zurich and said to be quite a departure in that line. Oerlikon has also placed on the market a bevel gear planer, the general operating principle of which is similar to the Gleason machine. This machine is regularly manufactured in two sizes for cutting gears having maximum modules of 12 (2.117 diametral pitch) and 15 (1.694 diametral pitch), respectively. Three larger sizes have also been designed, the largest of which will cut gears having a maximum module of 35 (0.725 diametral pitch). Fritz Wunderli produces small universal grinders, two sizes, wet tool grinders, and surface grinders somewhat resembling Brown & Sharpe No. 2, which compare favorably with American machines. The Wunderli factory is small, but run on efficient American lines and has a reputation for good workmanship. During the war Wunderli built many small plain milling machines for England. Besides these firms there are a number of smaller makers.

The Swiss machine tool market is small; but there will continue to be a demand for American tools of high reputation, because Swiss mechanics appreciate tools of quality. The Swiss franc, as stated previously, is worth more than the French franc, so that German tools sell for correspondingly less, often less than half, and buyers institute comparisons between the American and German prices that are sometimes difficult to meet. It is evident that only the high reputation and sterling qualities of American machines will enable foreign dealers to sell them in the face of such price competition.

Conditions in Holland

Holland was an agricultural and a trading, rather than a manufacturing country when I was last there; and since then the increase in manufacturing is distinctly noticeable. Holland presents every appearance of prosperity. The cities are crowded with well-fed, contented-looking people; the towns are well kept and the fields full of fat cattle; but the world-wide causes for discontent exist there as elsewhere. Food is plentiful and looks high to the Dutch compared with pre-war prices; but only a few items are higher than in the United States. There are few automobile or motor trucks; fat Dutch horses pull the wagons through the streets.

When the blockade became effective, Dutch manufacturers and dealers were entirely cut off from American supplies. Only lately (July) have orders been coming through. One large shipbuilding company then began receiving deliveries on a steel order placed in 1916. Shipbuilding, which is one of the most important Dutch industries, was almost suspended for lack of material. German material manufacturers refused to sell the Dutch unless the latter executed an agreement that the ships built therewith should not be used by any of the Entente Allies for a period of five years; and similar restrictions were insisted on by British material manufacturers against the Central powers.

A good many Dutch machine tool dealers, being unable to get American tools turned to German makers, not only to keep their business going, but because—especially during the last six months of the war—German tools were offered at bargain prices; consequently, the Dutch market is glutted with them. It is estimated that these stocks can be worked off by 1920-1921, if shipbuilding and the other industries requiring them continue to be prosperous.

The German tools I saw in Holland, built during the last months of the war and since, were mostly of inferior quality and finish compared with those now produced by the best German makers; and if those in the warehouses are no better, there will be great difficulty in disposing of them even at bargain prices. They do not compare at all with the best American tools. Swiss tools cost about the same as American in Holland.

[1] Societa Anonima Italiana Gio Ansaldo & Co., Headquarters, Genoa.
[2] Fabbrica Italiana Automobili Torino, Headquarters, Turin.
[3] A lira is now worth between 9 and 10 American cents. Normal value, 19.3 cents.

German Machine Tool and Related Industries

By ALEXANDER LUCHARS, Publisher of MACHINERY

Having finished his work for the Department of Commerce on October 1, and resigned as Trade Commissioner on that date, Mr. Luchars reviews in the following article German industrial conditions and gives his personal opinions thereon. Mr. Luchars takes this occasion to express his appreciation of the uniform courtesy and consideration shown him by Secretary Redfield and other officials in the Department of Commerce.

THE outlook for the coming winter in Germany is most uncertain, and conditions as they exist in the spring will have much to do with her stability and future progress. The German coal which must be given up to France, leaves about 40 per cent of what was used last winter, when there was much suffering among the poor for lack of fuel. This shortage probably will be further increased by the prevailing strikes, and through loafing and slacking. In one Westphalia mine which formerly employed 6100 workers, and now employs 6700, the output is only about 50 per cent of what it was in 1914. The coal shortage will of course affect factories, so that many may close down or run on reduced time. It is expected that wages will be paid in such cases, partly by the government and partly by the employers, adding to the taxes which are already crushing all who have anything to tax.

These taxes often work severe hardships. A maker of small tools who had been in business for fifty years sold out for a million marks. The new law took M. 800,000, and as the income of the remainder was not enough to live on, he went to work again at the bench in his former shop. Besides the taxes on income and profits, those on principal or business capital range from 15 per cent to 65 per cent; but the payment of the latter may be made in thirty annual installments at 6 per cent interest. Many people, especially among the business classes, are very despondent, and even faithful workmen (there are many) seem to have lost heart in their work, saying that there is no incentive to labor, for they can save nothing, and the product of their toil goes only for taxes and indemnities.

Labor Conditions

Employers are harassed by labor's demands and restrictions, by the difficulty of obtaining material, of disposing of their product when it is ready, by the depreciated currency which forms the basis of trade, by the enormous taxes, and all the minor troubles which follow in the train of these greater ones. But the future is not all gloomy. There are some who say that if the workmen will only *work* for whatever wages can be agreed upon, the other evils can be taken care of in time. Some believe labor is beginning to see that the demoralization in fundamental conditions affects working people more than any other class, and that some reasonable working basis must be reached on which the employer and employe can stand.

The strike at the great Siemens' works, employing 32,000 hands, is typical of German industrial conditions. This strike was caused by the tearing down of a notice posted by the management that on July 21, the international "strike day," all the Siemens' plants would be open to those who cared to work. In every works there is a shop committee which, with the management, passes on certain questions that concern the employes (too intricate an arrangement to explain here), and all notices relating to such questions are to be signed by both the management and the shop committee. The notice in the Siemens' works was not signed by the committee, the management claiming that it was not included in the provisions referred to. When the notice was torn down the forty-one members of the shop committee were discharged, whereupon 10,000 workmen began "passive resistance" (loafing around the shop during the working hours and doing no work). These men were told that they must work or be discharged, and, refusing, they were discharged. Then the remaining 22,000 workers struck. Finally, when the shop committee acknowledged that they had exceeded their rights in tearing down the notice, they were taken back and the remaining 32,000 came back.

A law has been introduced in the National Assembly giving a representation in the management of each business to the workers, but many manufacturers do not think that such a representation would mean interference. Partial strikes in departments of vital importance to the works are a favorite resort; for in such cases the workers in the departments not on strike come to the shop and play at working, but produce almost nothing for lack of material, causing great loss to the management who must pay their wages. In the case of total strikes no wages are paid.

Clerks and sales people here are all organized, having committees and rules similar to shop workers. Employers who have to deal with both classes say that the former are, if anything, more difficult to handle than the latter.

One serious obstacle to stability and progress is the lack of a recognized national executive. The President is a figurehead, and the ministers, with the exception of Noske, have no real power. Noske, the Minister of National Defense, derives his power from the willingness of the soldiers to execute his orders; but except for its officers, the army is made up mostly of men who remain in it, not from motives of patriotism, but for the pay and food, and when a better place offers many leave. Its reliability is said to be increasing, and is the saving factor in a precarious situation.

No one in Germany seems to believe that the country will ever regain her former position. Conservative business men say that the return to normal economical conditions is not a question of month but of years; one whose opinion is considered of great value, puts the time at from five to ten years. Such men point to the complete change in the morale of the working classes, and the prevalence of thieving in communities where it was unknown before the war. Food now controls the situation, and unless it becomes more abundant and cheaper during the coming winter, many expect another revolution which will leave the country worse off, as each change under present conditions will lower the standard of those in authority. The supply of certain kinds of food is fortunately increasing. Contrasting conditions with those of some time ago, one German machine tool dealer described the present food as "splendid." Meat and bread cards are still required. The former entitles the holder to two portions of meat and the latter to five slices of black bread daily. Fairly good bread is obtainable at the high-priced Berlin hotels, but the bread eaten by most people is made of potatoes, flour and straw.

Cost of Living and Wages

Prices of all kinds of labor, of metals and materials, and especially of machine tools, have naturally increased much more in proportion than in America—and prices have increased here since the armistice, although the supply of labor should be greater. The cost of living, therefore, is high.

A general comparison of wages paid to machinists and machine shop workers in 1914 and 1919 is given below.

COMPARISON OF WAGES IN THE GERMAN MACHINE INDUSTRIES, 1914 AND 1919

	Wages Per Hour, Marks 1914	1919
Lathe hand	0.60 to 0.75	3.25 to 4.00
Milling machine hand	0.56 to 0.60	2.55 to 3.50
Planer hand	0.60 to 0.72	2.90 to 3.75
Assembler and fitter	0.56 to 0.70	2.70 to 3.60
Drilling hand	0.48 to 0.56	3.00 to 3.50
Blacksmith	0.95 to 1.15	3.50 to 4.00

On piece-work, the man must be guaranteed a minimum wage of about 25 per cent more than for day work. There are no large wages earned at piece-work, for the men will not produce more than an average amount of work under any conditions.

The above figures, however, do not afford an accurate comparison of labor costs on account of time lost loafing, talking and "slacking." In the machinery industry the average hourly product under the eight-hour day is about 50 per cent of what it was in 1913-1914. In the Ludwig Loewe works it was said that the product per man per hour for the first six months of 1919 was 52 per cent of what it was in 1913-1914. In some works it is much less.

Besides the increased wages and diminished output, manufacturers must reckon with extra bonuses or contributions in cash, up to M. 800 for each person or member of the organization such as foremen, draftsmen and superintendents, to enable them to pay their debts. The upper class employes have been giving more trouble lately than the workers.

Hours of Work

All over Germany the eight-hour day prevails, but the division of the day varies in different localities. In most Berlin machine shops the workers start at 7, work till 12.10, take twenty minutes for lunch, and quit at 3. On Saturday the quitting hour is 1, making 44½ hours a week. In the Spandau arsenal when the armistice was signed there were about 40,000 workers employed. The government dared not throw them out of work, so they continued to come during hours, but produced nothing, because whatever they produced would have represented only spoiled material. After some months of this it became evident that M. 25,000,000 a month could be used to better advantage in other ways, so the force was cut down.

Cost of Materials

The following figures give an idea of the increases in the prices of materials from 1914 to 1919. The heavy increases in prices are due not to profiteering, but to greatly increased manufacturing, transportation and other costs. Foundry pig iron, which was quoted at M. 74.50 in the second quarter of 1914, was quoted at M. 215 in the first quarter of 1919, and M. 356.50 in the second quarter of this year. Prices have now been lowered by M. 52 to M. 90 per ton, but the Pig-iron Union states that the blast furnaces are working at a heavy loss.

The materials used in making pig iron have, of course, increased accordingly, coal briquettes having advanced from M. 13.75 to M. 66.10, and blast furnace coke from M. 17.00 to M. 88.85 per ton.

The advances of prices for raw and half-finished products are given in the following table. The prices given are marks per ton.

	Ingots M.	Billets M.	Sheet Billets M.	Sections M.
May 1914	82.50	95.00	97.50	110.00
January 1, 1919	285.00	300.00	305.00	320.00
March 1, 1919	385.00	400.00	405.00	420.00
May 1, 1919	405.00	475.00	480.00	520.00

Copper is selling at M. 5.25 a kilogram (official price). High-speed steel sells for M. 27.50 per kilogram.

There is no room in this article for an extended comparison of prices; but a few typical examples may be of interest: A freight locomotive, which cost, before the war, about M. 80,000 and in 1918 about M. 225,000 cannot be bought now for less than M. 400,000. Gasoline costs about M. 18 a gallon; automobile tires, 32 by 4½, M. 1400; bicycles, M. 1500. A Ford automobile, three years old, without tires, sold recently for M. 10,000. Second-hand American typewriters sell for M. 1200; typewriters of German make, M. 1200. These are, of course, transient prices; when supplies come in, they will fall sharply.

Machine Tool Output During the War

The following table, compiled by Professor Schlesinger, an authority on the subject, gives the output of German machine tools during the past six years, and a comparison of prices as well:

GERMAN MACHINE TOOL PRODUCTION—1913-1918

	Production in Million Marks	Selling Price, Mark per Kilogram	Production in Tons
1913	1060	1.00	1,060,000
1914	1045	1.10	950,000
1915	695	1.30	530,000
1916	660	2.00	330,000
1917	1720	2.50	680,000
1918	780	3.00	260,000

Many and varying estimates have been made of the value of machine tools now in stock in Germany, but conservative authorities place the amount at between M. 200,000,000 and M. 300,000,000, which is a normal figure. This does not include tools owned by the government, but those are not expected to come on the market. The tools in private stocks are said to be second or third rate products; and this statement is supported by the fact that nearly all first-class German machine tool makers are behind in their deliveries—some claim from six to nine months.

Machine Tool Prices

All German prices must be considered in relation to the impaired value of the mark, which in the latter part of October, 1919, was quoted at about 27 to a dollar, as compared with 4¼ in 1914, and similar, although not so great, differences are noticeable in comparison with all Allied and neutral money values. Its effect on imports into Germany is evident, and establishes prohibitive prices for American machine tools there. The price of German machine tools was advanced three times by the government during the war—43½ per cent in 1917, and in 1918, 66 per cent over the 1917 prices. No further government advance was made, but manufacturers advanced prices from 20 per cent to 40 per cent at the end of 1918; and many prices have further advanced (except on war material tools) during 1919. Special machines for peace work use advanced up to 200 per cent, and some small machine tools as much as 500 per cent over 1914 prices. But German tools of the best makes still sell for considerably less than similar American tools can be sold for, according to the following figures furnished by two well-known German dealers:

1919 PRICES FOR BEST MAKES OF GERMAN MACHINE TOOLS

	Marks
Gap lathes, 12-inch, 3½ feet between centers	3400
Gap lathes, 16-inch, 3½ feet between centers	4800
Gap lathes, 16-inch, 5 feet between centers	5100
Gap lathes, 18-inch, 3½ feet between centers	4500
Gap lathes, 20-inch, 5 feet between centers	7400
Gap lathes, 20-inch, 7 feet between centers	7750
Gap lathes, 26-inch, 7 feet between centers	10300
Engine lathes, with gap, lead-screw and feed-rod, 16-inch, 5 feet between centers	7000
Engine lathes, with gap, lead-screw and feed-rod, 18-inch, 3½ feet between centers	8000
Engine lathes, with gap, lead-screw and feed-rod, 18-inch, 5 feet between centers	8500
Plain milling machines (according to size)	4000 to 9000
Universal milling machines (according to size)	7500 to 8500
Vertical milling machines	7200
Crank shapers, 14-inch	4200
Crank shapers, 18-inch	5000
Crank shapers, 22-inch	7000
Drilling machines, 20-inch	1300
Drilling machines, 22-inch, power feed	2700
Four-spindle automatics, 1¾- and 2⅛-inch	26,000 to 27,500

My personal opinion is that the above prices are lower than those for which first-class machines can be bought.

COMPARISON OF PRICES OF GERMAN MACHINE TOOLS—1914-1919

	Marks 1914	Marks 1919
High-speed engine lathe, geared-head, 18-inch, 3½ feet between centers	2800	9000
Tool-room lathe, 14-inch, 3½ feet between centers	2400	8600
Milling machines, hand	230–280	950
Plain (three different sizes)	800	2700
	2600	8100
	4400	13,000 to 14,000
Universal, including head	3500	10,000 to 12,000
Radial drilling machines, 3½ feet	2400	8000 to 10,000
5 feet	4800	16,000 to 18,000

All prices stated are subject to change from day to day, and many manufacturers refuse to quote prices until the tools are ready for delivery.

No American machine tools have come into Germany, except through Holland and Sweden, for about three years, and no reliable comparisons can be made between the selling prices of our tools here in 1914 and the prices that would have to be put on them now. The high ocean freight rates, which will undoubtedly fall in the near future, and the low value of the mark, make any comparison of little value; but judging by what former agents or American manufacturers say, the figures would range from four to seven times what they were in 1913-1914, and from 50 to 75 per cent more than similar German tools sell for. One dealer estimated that an American 14-inch lathe, which he sold for M. 2000 in 1914, he would now have to sell for M. 11,000 to M. 12,000, while a German tool of the same size and of a good make would sell for M. 6000 to M. 7000. A Gleason bevel gear planer, sold here in 1914 for about M. 9000, would now have to be sold for M. 60,000. A Baker Bros. type keyseater, 13-inch stroke, weight 2250 pounds, made by A. H. Schutte, is offered at M. 5500. A four-spindle automatic by the same maker is sold for M. 27,500; 10- to 12-inch lathes made by Pittler, one of the best manufacturers, sell for M. 1000 to M. 1200. On account of their greater accuracy, American tools of the best makes will sell for better prices than German tools of the same type and size; but to say just how much more would be pure guesswork.

The German manufacturers are turning out far better tools than they did in 1913-1914. The designs of many well-known American tools are followed, some are faithfully copied and others adapted by the leading German makers. The German designers have made few changes in machine tools, and few new machines have been brought out. On account of the tendency to copy American machines, or, if not in their entirety, to use their new points, our manufacturers are cautioned about accepting first orders for such machines.

Verein Deutscher Werkzeug-Maschinen-Fabriken

The German Machine Tool Makers Association numbered 72 before the war. It has now 320 members, and they apparently work together for much the same objects that our own association does, except that they are free to regulate prices to any extent they choose. Neither the Germans nor the English are so far advanced as we are in governmental regulation of business. So they have some things to be thankful for. The members of the association employed about 70,000 men and a large number of women in 1917; 60,000 men and fewer women in 1918-1919. A complete list of the members of the association and their products would require too much space, so it will be sufficient to mention the number of makers of different classes of machine tools at the present time:

Engine lathes	90
Vertical boring mills	13
Cutting-off machines	20
Horizontal boring machines	27
Gear-cutting machines	19
Turret lathes, screw machines and automatics	37
Milling machines, all types	83
Drilling machines, all types	43
Planers, slotters and shapers	44
Grinding machines, all types	40

There are said to be some sixty automobile factories in Germany, but not more than a dozen are active, and only a few of those have been able to get material to turn out a normal product. Before the war, few of these manufacturers produced cars as we do in the United States. It is said there were 190 different kinds of cars made. The financial outlook in Germany does not warrant large investments in the manufacture of either pleasure or business cars.

The Tariff and Patents

No definite policy has yet been decided on about the tariff, although it is said that a high protective duty will be placed on imports. The National Assembly being only a provisional body, it is likely that this question will be left to its successor, but there is a marked tendency among those having authority, to arbitrarily shut out all American machine tools, except those types which are not made here.

There has been no important change in the German patent law since 1909; and American manufacturers are advised to patent any improvements that are patentable—not only for their protection in Germany, but in other continental countries where German tools may be sold. According to the German patent laws in effect at the beginning of the war, a patent could be revoked after a period of three years from the date on which a notification of the granting of the patent had been published in the German official gazette, if the patentee had failed to work the patent adequately within Germany or if he had not taken measures to insure the working of the patent. The patent could also be revoked if it was beneficial to the public that others should be allowed to make use of the invention, and the patentee refused to issue licenses for this purpose when offered reasonable compensation and security.

These provisions were changed somewhat by a law which has been in existence since June 16, 1911, and which relates to the compulsory working of patents. According to this law the former provisions do not apply to citizens of any country with which Germany signs a special treaty of patent reciprocity. Such a treaty was concluded between Germany and the United States on February 23, 1909, and, therefore, the above provisions no longer apply to citizens of the United States. According to this treaty, the working of a patent or registered trademark in either country concerned in the treaty, was considered equivalent to the working of the same in the other country. In other words, a citizen of the United States was not obliged to work a patent in Germany if he could show that the requirements of the United States were fulfilled and that the patent was being worked in the latter country. This treaty was, of course, suspended by the declaration of war and no decision has been rendered as to whether the treaty will be permanently revoked or be reinstated.

In Article 307 of the Versailles peace treaty of 1919, it was agreed that patents which were in existence on August 1, 1914, cannot be cancelled on account of not being worked, until the end of a period of two years from the date of the ratification of the treaty. Compulsory licenses can be granted during this two-year period and afterward.

The Central European Nations

In what remains of Austria, the machine tool industry is on an uncertain footing, due to unsettled conditions and a debased currency. In Hungary, the new government is too young for anyone to venture an opinion about the future, except that any government must be an improvement over what Hungary has had lately. In Prague business is said to be encouraging, and the Czecho-Slovak government apparently is growing in strength. Machinery dealers in Berlin also say they are doing a good business with Finland.

Everyone whom I saw in Germany was friendly, and there is no animosity against Americans as individuals; but there is a strong feeling against us as a nation. The Germans say that if we had not come in they would have won the war, and they are not of the readily forgiving kind. This feeling will affect the sale of American machine tools and other products in the future, although those who must have certain types of tools, made only in America, will buy them.

U. S. GOVERNMENT SALES AND BELGIAN MACHINE TOOL CONDITIONS[1]

By ALEXANDER LUCHARS, Publisher of MACHINERY

A MATTER of great importance to American machine tool manufacturers is the amount and effect of the sales of tools by the United States War Department in Belgium. As our manufacturers already know, these are being sold at 1914 prices plus 55 per cent C.I.F. Antwerp; the 55 per cent being figured not only on the 1914 cost of the tools, but on the freight and other costs. Three years' time is given the buyers by the Belgian government, and this item in the terms is perhaps more attractive to the buyers than the low price. A further discount of 10 per cent is given for each year a tool has been in use, unless it has been used so little that its value has not been affected.

Under the arrangement made, the U. S. War Department sells these tools to the Belgian government, which markets them through *La Construction Metallique*, a co-operative society organized to do business without profit, and composed of Belgian manufacturers in the machinery and metal manufacturing industries, any one of whom may become a member by paying a small fee. Any member of *La Construction Metallique* may buy any number of these machines on the above terms, without regard to whether or not they are to replace machines stolen by the Germans. *La Construction Metallique* includes eighteen subsidiary groups of manufacturers, among them makers of automobiles, locomotives, machine tools, motors, engines, etc. The original arrangement for financing these sales was based on a credit of $22,000,000 granted to the Belgian government by ours; $3,000,000 worth of machine tools were sold, and it was then found that the $22,000,000 credit had been used by the Belgian authorities without reserving any of it to pay for the tools. After some delay a second arrangement was made which is now in force, under which the tools are to be paid for from the $50,000,000 Belgian credit recently negotiated with American banking institutions.

It was stated by an officer in authority that it was expected to sell in all about 4,000 machines. The selling of small tools is now being considered. The sales are made in dollars by the U. S. War Department; and the prices at which the machines are bought by Belgian manufacturers are presumably subject to the fluctuations of exchange, unless a heavy loss is to be made up somewhere.

One of the officials in charge of these sales advanced the following reasons in support of them: (1) That the tools had to be sold *somewhere*, and that they would probably do more good in Belgium than elsewhere and would also keep the Germans from selling a considerable part of the amount. (2) That the Belgians need tools badly to re-equip their factories, and have not the money to buy them on ordinary terms of payment. (3) That many Belgian manufacturers are buying American tools who never had one in their shops before, and this sale should make a future market for them which will be worth some transient loss.

The Belgian machine tool dealers are not considering the proposition from any philanthropic standpoint. They say that the prospective enormous Belgian demand has almost disappeared, because manufacturers are waiting to see how much of their equipment they can get from Uncle Sam. One dealer told me that for this reason an order amounting to 300,000 francs, with prospects of a further increase to a million, was cancelled. Another dealer says that machines sold by the United States Government are being bought only by those who have had considerable experience in the past with American tools and know them well. The medium sized and small plants that have been the largest buyers of German machines heretofore have not so far bought any American tools and appear to be waiting until they can again buy in Germany. In spite of this heavy load on the market, a fair business is being done in American tools at current prices, showing that except for this sale a splendid business would be going on.

After investigation there seems to be no doubt that receipts were in most cases given by the Germans for the machine tools and other machinery stolen from Belgian works, and that the tools were also tagged or otherwise marked to facilitate identification. It is also true that an effort is being made by the German authorities to collect and return these machines. Mr. Rother, one of the staff of Schuchardt & Schutte in Berlin, is in charge of the return of these machine tools. But restitution is not easy. It is stated on good authority that only about one-fifth of the machine tools taken away have been returned. The Cockwill Works, from which some 3500 were taken, have had about 300 returned. The Minerva Works, which lost a large number, have gotten back almost none. Many manufacturers are not trying to get their machines back, apparently expecting to buy new ones through *La Construction Metallique* or some other source. There is no special fund to reimburse these manufacturers for money spent for reparations. They will have to wait the distribution of the indemnity, probably a process of years.

All the important Belgian works are said to have placed large orders for machine tools—some in the United States and some in Scandinavia. I heard of none being placed in Germany, but some people say that if the difference in price continues it is only a question of time before it will be done.

The cheap labor which made Belgium a formidable competitor in European and foreign markets is as much ancient history as the 34 shillings a week of the Yorkshire machinists. Belgian labor has gone up since the war and may keep on going up, although some people here think that the apex has been reached. It is reasonably certain to work up to an equality with that of other European countries.

Employers seem to recognize the changed conditions and have not only increased wages, but have arranged a gradual reduction of the hours of work, which were 10 before the war, are now 9, will soon be reduced to 8½, and in 1920 to 8. Some plants have an eight-hour day now. Machinists' wages have increased from 225 per cent to 295 per cent (the present rate being from 19 to 34 U. S. cents an hour) according to the locality and class of work.

Those who are particularly interested in the development of Belgian industries of all kinds should send to the Department of Commerce for the reports of Trade Commissioner H. T. Collings, who has been in Belgium for about a year, and during that time has compiled a mass of valuable information regarding the industries he has been investigating.

There have been quite a number of changes among Belgian dealers during the war. The A. H. Schutte warehouse was leased by the Allied Machinery Company, and recently bought by Alfred Herbert, Ltd., who will occupy it as soon as the Allied lease expires. Isbecque & Company have given up their Antwerp place, and their main office and wareroom are now located at 36 Rue Otlet, Brussels, where they have very convenient accommodations. Henri Benedictus has also closed his Antwerp place and has taken the Steinhaus quarters at 133 Rue due Progress, which are well adapted to his business. R. S. Stokvis & Fils are at the same place, but find it too small for their requirements. Fenwick Freres still have their Belgian headquarters at Liege, but have decided to move to Brussels in about three months, and the tendency among Belgian machine tool dealers is to concentrate in that city.

For many years previous to 1914, Belgium was a hive of industry, and I believe she will recover more quickly from the effects of the war and enjoy a greater proportionate degree of prosperity than any other European nation. And I think Belgium's prosperity and expansion will work out largely in the manufacture of metal products. Higher wages having come to stay, Belgium will be a very large buyer of machine tools, especially labor-saving machines, and the great part of these machines will be bought by hundreds of small shops that we never have heard of, which will start up, grow and expand with Belgium's growth and expansion. Whether or not most of these tools will be bought in the United States depends upon a number of factors—the principal one now is exchange. France and Belgium will buy in future where they can get the most for their money.

[1] Abstract of a letter which is the concluding one of a series on conditions in the machine tool and kindred industries in Europe.

Turret Lathe Practice

Second of a Series of Articles Dealing with Tooling Equipment and Order of Operations for Turret Lathe Work, Based Upon the Experience and Practice of the Gisholt Machine Co., Madison, Wis.

By ERIK OBERG

IN the first article of this series, the machining of flywheels and auto truck wheels was dealt with. In the present article, tractor axle housings, wheel hubs, and motor frames will be described.

Machining an Axle Housing

Fig. 1 shows an axle housing for a tractor, the surfaces finished on the turret lathe being shown by heavy lines. The machining of this part on the turret lathe brings out the application of so-called "chuck bonnets" or fixtures used for holding parts having elongated irregular shapes. Such a chuck bonnet is used for the first operation on this axle housing, while a so-called chuck-plate fixture is used for holding the work in the second operation. The material of the housing is cast iron, and the tooling equipment is applied to a 24-inch Gisholt turret lathe.

Fig. 3 shows the lay-out of the tooling equipment for the first operation, which consists in machining the front end of the housing and boring and reaming the hole. The order of the steps in the first operation is as follows: (1) The housing is held in a special fixture or cradle having an arm which encloses it and steadies it near the outer end. Fig. 3 shows the arrangement in diagrammatical form, while Figs. 7 and 8 show the fixture more clearly. Fig. 5 shows the complete tooling equipment as applied to the turret lathe. (2) Surfaces *A* and *B*, Fig. 3, are rough-turned and faced with tool *H* in the toolpost. (3) Hole *C* is rough-bored with a cutter held in the boring-bar mounted in Side 1 of the turret. Fig. 7 shows the boring-bar just starting this cut. (4) Hole *C* is finish-bored with a cutter held in the boring-bar mounted in Side 4 of the turret. During both the rough-boring and the finish-boring operations, the bar is guided by a pilot entering into a bushing in the chuck, as indicated in Fig. 3. (5) Hole *C* is reamed with the reamer mounted in Side 5 of the turret. (6) Surfaces *B* are finished with cutters held in the head mounted in Side 2 of the turret. During this operation, the head is steadied by a bushing on the end of a pilot which enters into bore *C* and which also insures concentricity of the finishing cut at *B*. This operation is shown in Fig. 8. (7) Shoulder *A* is finished with tool *I* held in the toolpost. The total time for the first operation is 8 minutes.

The lay-out of the tooling equipment for the second operation on this axle housing, which consists in machining the surfaces *E* and *F*, chamfering at *G*, and tapping the hole at *D*, is shown in Fig. 4. A halftone illustration of the tooling equipment is shown in Fig. 6, while Fig. 9 illustrates more clearly the method by which the work is held in this operation. A special chuck plate is used which is attached to the regular faceplate of the machine. The step-by-step operations are as follows: (1) The housing is mounted on the chuck plate and held with clamps. (2) Surface *F* is rough-faced with tool *K* in the toolpost. (3) Hole *E* is bored, and a chamfer is cut at *G* with cutters held in the head mounted in Side 1 of the turret. During this operation, the head is guided by a pilot entering a bushing *L* in the chuck plate. (4) Surface *F* is finish-faced with tool *M* held in the toolpost. (5) The hole at *D* is tapped with a tap held in Side 4 of the turret. The total time for the second operation is 6 minutes.

Tooling Equipment for Finishing a Wheel Hub

Fig. 2 shows a wheel hub which is finished on a 21-inch Gisholt turret lathe in two operations. The hub is finished on all the surfaces indicated by heavy lines in the illustration. Fig. 10 shows the lay-out of the tooling equipment for the first operation, and Fig. 11 shows the equipment in use on the machine. This is an example of the application of the turret lathe for the finishing of small parts and fill-in jobs. The wheel hub illustrated was the main job for which the turret lathe was installed in this instance, but as the machine could not be kept entirely busy on this work, it was also used for finishing another hub part shown in Figs. 14 and 16, as well as the part shown in Figs. 15 and 17.

Referring to the first operation on the wheel hub, as illustrated in Figs. 10 and 11, the step-by-step operations are as follows: (1) The hub is held by special hard chuck jaws as illustrated in Fig. 11. These jaws are grooved at the outer end to fit the rim of the flange of the hub. (2) Surfaces *B*, *C*, and *D* are rough-machined with tool *H* in the

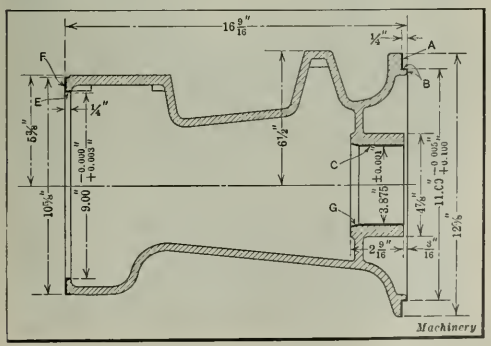


Fig. 1. Axle Housing for Tractor

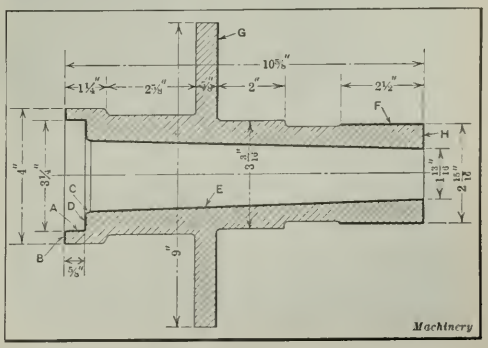


Fig. 2. Drawing of Wheel Hub

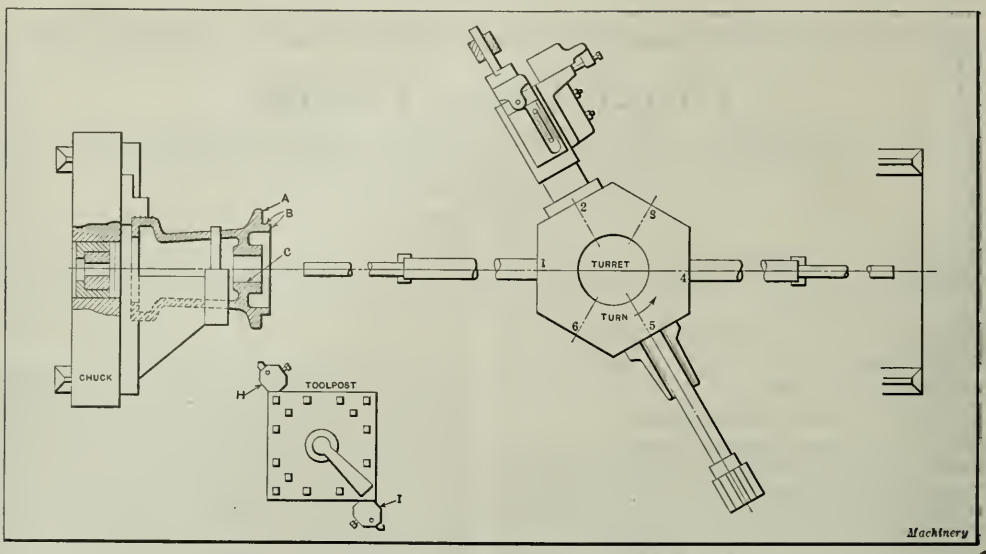


Fig. 3. Tooling Equipment for First Operation on Axle Housing shown in Fig. 1

toolpost. (3) A second roughing cut is taken on surfaces *C* and *D* and a first roughing cut in holes *A* and *E* by the multiple cutters held in the boring-bar mounted in Side 1 of the turret. Fig. 11 shows the boring-bar just entering the work. (4) A second roughing cut is taken in holes *A* and *E* with the taper reamer and cutter mounted in Side 3 of the turret. (5) A finishing cut is taken in holes *A* and *E* with the reamer and cutter mounted in Side 5 of the turret. The total time required for the first operation is 6 minutes.

Fig. 13 shows the tooling equipment for the second operation on the hub. In this case, the hub is held on a taper arbor with a lathe dog used as a driver in the ordinary way. Fig. 12 illustrates clearly the method of holding and driving the work, and also shows one of the heads mounted in the turret in operation. After having placed the work on the arbor, surfaces *F*, *G*, and *H* are rough-turned and faced with tool *I* held in the toolpost, after which surfaces *F* and *H* are finish-turned and faced with cutters held in the head mounted in Side 1 of the turret. (See Fig. 13). Finally, the outside of end *F* of the housing is threaded with a die mounted in Side 4 of the turret. The time required for the second operation is 9 minutes.

Figs. 14 and 16 show how the turret lathe is applied for the finishing of another hub part as a fill-in job. In this case only the hole *A* and the end *B* are finished. The work is held by special chuck jaws in much the same way as the hub in Fig. 11. The surface *B* is faced with a tool held in the toolpost, while the hole *A* is bored with a cutter in the boring-bar mounted in the turret. This is all the work performed on this hub part, and the time required for the operation is 1 minute.

Another hub part in the form of a bushing is machined by the equipment shown in Figs. 15 and 17. The material is malleable iron, the part being known as a hub-point band. This part is held by special hard chuck jaws, as indicated, after which the end *B* is faced with a tool held in the toolpost. Hole *A* is then bored with a cutter held in the boring-bar mounted in Side 5 of the turret, this bar having a pilot which enters a guiding bushing in the chuck. This operation is illustrated in Fig. 17. Finally, the hole is tapped with a tap mounted in Side 4 of the turret. The total time required for performing these operations on the hub-point band is 2½ minutes.

It should be thoroughly understood that the makers of the machine and tooling equipment emphasize that it would not be economical to buy the machine to perform the operations

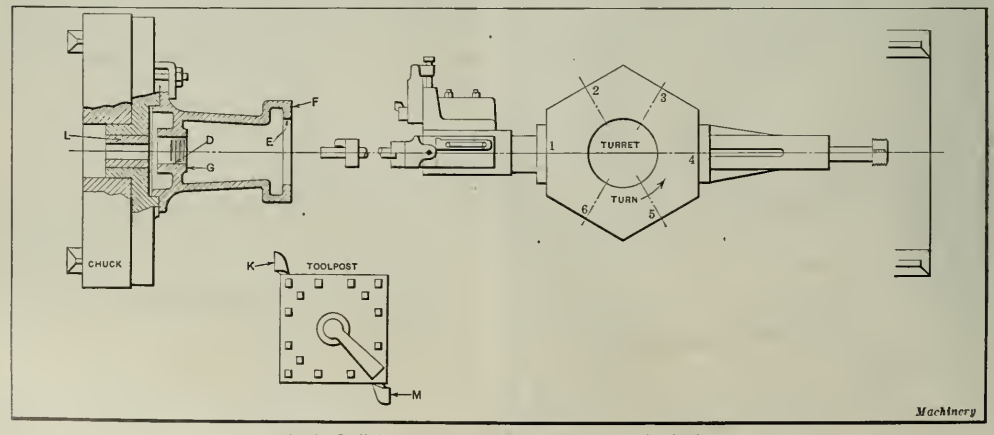


Fig. 4. Tooling Equipment for Second Operation on Axle Housing

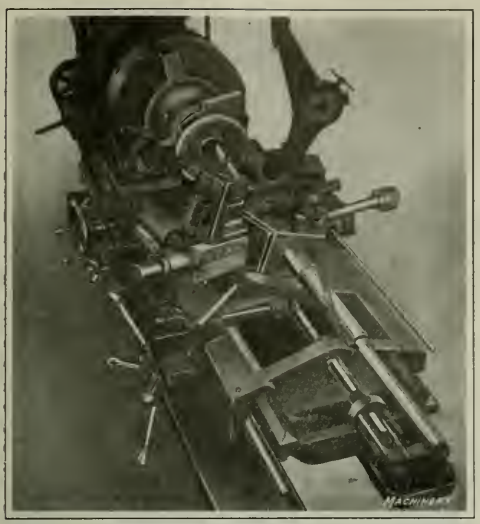


Fig. 5. Machine set up for performing First Operation on Axle Housing

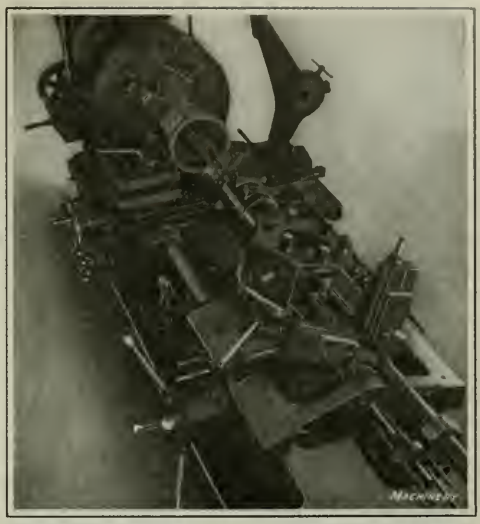


Fig. 6. Machine set up for performing Second Operation on Axle Housing

on the two small hub parts shown in Figs. 14 and 15, if there were no other turret lathe work available, but when the machine is procured for performing work of the type shown in Fig. 2, it may be the most economical method to perform the operations on the other hub parts in the same machine, especially when it is not kept busy on the work for which it is better suited. There is no question but that when the machine is available the work on the smaller hub parts can be performed more quickly on the turret lathe than by any other method, and the examples shown are intended to bring out the fact that the turret lathe often can be used to advantage for performing operations as fill-in jobs for which it would not be bought if there were no other work for which it had been especially obtained.

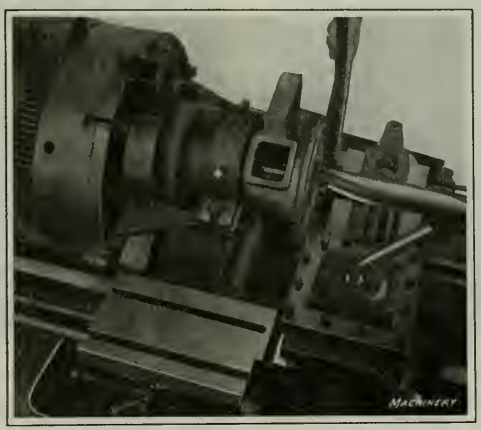


Fig. 7. Boring Hole in First Operation

Equipment Required for Machining a Motor Frame

Fig. 18 shows a motor frame machined on the surfaces indicated by heavy lines. The tooling equipment required for machining this piece in two operations brings into use the auxiliary toolpost or wing-rest in addition to the toolpost tools and the turret tools. The work is performed on a 24-inch Gisholt turret lathe. The material of the motor frame is cast steel.

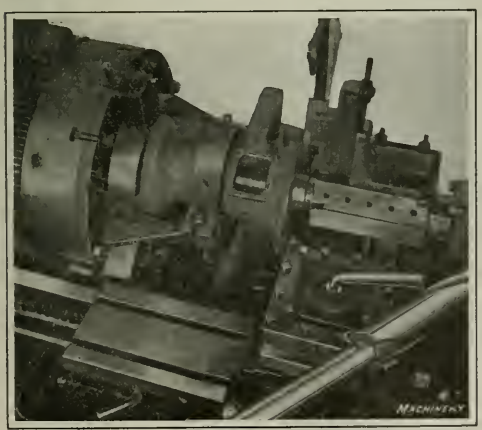


Fig. 8. Facing Head brought up to Work



Fig. 9. Method of holding Work in Second Operation

Fig. 19 shows the layout of the tooling equipment for the first operation, and Fig. 20, the equipment for the second operation; the illustration Fig. 21 indicates how the motor frame is held for the first operation, and Fig. 22 shows the method of holding for the second operation.

In the first operation, the work is carried out step by step as follows: (1) the work is held by special hard chuck jaws having clamping screws as indicated in Figs. 19 and 21. (2) Surfaces *B* and *C* are rough-bored by tool *O* in the toolpost. (3) Surfaces *D*, *E*, and *F* are rough-turned and faced by tool *P* in the toolpost. (4) The outside of the housing at *G* is rough-turned with tool *R* held in the wing-rest. (5) The outside *G* is finish-turned with tool *S* held in the wing-rest. (6) The hole *A* is rough- and finish-bored with cutters held in the boring-bar mounted in Side 1 of the turret. The end of this bar is piloted in the bushing shown in Fig. 19 in the chuck. (7) A second roughing cut is taken on surfaces *B*, *C*, *D*, and *E* with cutters held in the head mounted in Side 2 of the turret. (8) Surfaces *B*, *C*, *D*, *E*, and *F* are finish-turned with cutters held in the head mounted in Side 5 of the turret. It will be noted that both the head mounted in Side 2 and that mounted in Side 5 of the turret are provided with a pilot which enters the bushing in the chuck and also with a collar or bushing which fits the bore *A*. This arrangement insures concentricity of all the finished surfaces. The total time required for the first operation is 35 minutes.

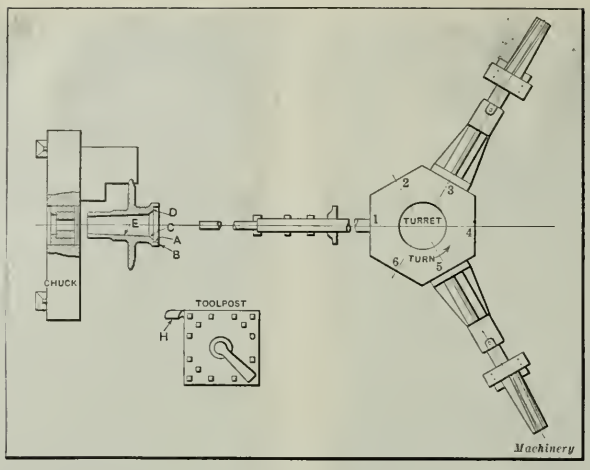


Fig. 10. Tooling Equipment for First Operation on Wheel Hub

For the second operation, the work is held on a special chuck plate as indicated in Figs. 20 and 22, clamps holding it tightly to the plate. The step-by-step operations are as follows: (1) The motor frame is centered on the chuck plate and the clamps are tightened. (2) Surfaces *I*, *J*, and *K* are rough-machined with tool *T* in the toolpost. (3) The outside surface *H* of the motor frame is turned with tool *U* in the wing-rest. (4) The bore *L* is started with tool *V* held

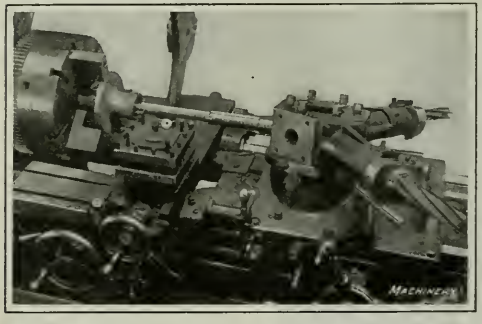


Fig. 11. Machine set up for performing First Operation on Wheel Hub

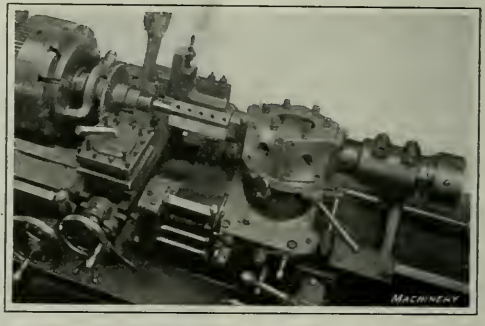


Fig. 12. Machine set up for performing Second Operation on Wheel Hub

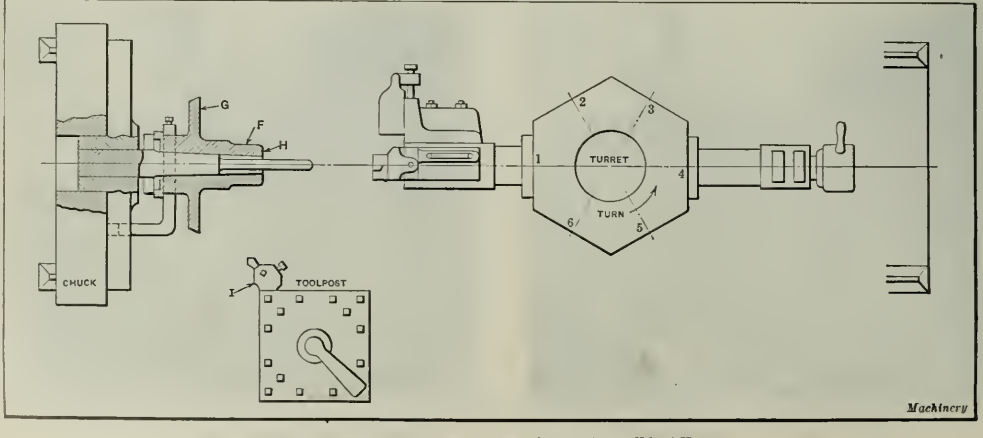


Fig. 13. Tooling Equipment for Second Operation on Wheel Hub

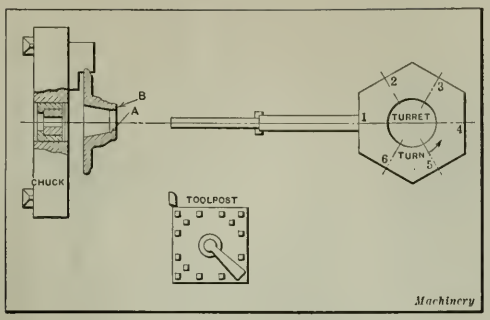


Fig. 14. Tooling Equipment for Another Hub Part

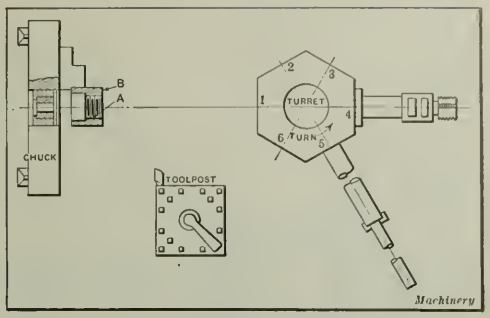


Fig. 15. Tooling Equipment for Hub-point Band

in the toolpost. (5) The hole *L* is rough-bored with cutters held in a boring head mounted in Side 1 of the turret. (6) Hole *L* is finish-bored with cutters held in the boring head mounted in Side 4 of the turret. Both heads referred to are guided by a pilot entering a bushing mounted in the chuck

(9) The shoulders *M* and *N* are finished with tool *W* held in the toolpost. (10) The outside surface *H* of the motor frame is finish-turned with tool *X* held in the wing-rest. The total time required for the various steps in the second operation is 45 minutes.

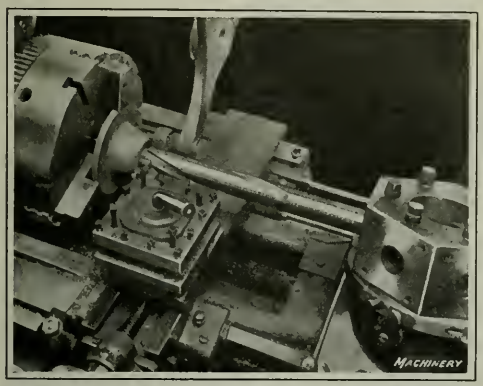


Fig. 16. Machine set up for performing Operation on Part shown in Fig. 14

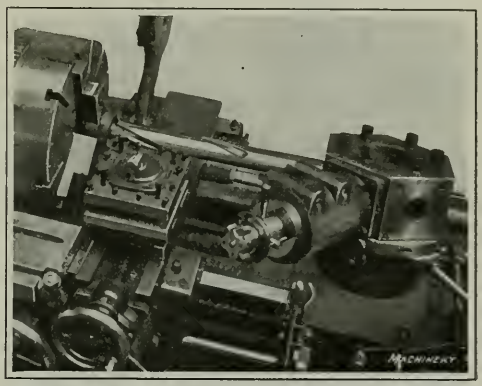


Fig. 17. Machine set up for performing Operation on Part shown in Fig. 15

plate as indicated in Fig. 20. (7) Surfaces *I*, *J*, and *K* are rough-turned with cutters held in the head mounted in Side 2 of the turret. (8) The same surfaces are finished with cutters held in the head mounted in Side 5 of the turret.

A motor frame of somewhat different construction is shown in Fig. 24, where the tooling lay-out for the first operation on a 24-inch Gisholt turret lathe is also illustrated. The tool lay-out for the second operation on this motor housing

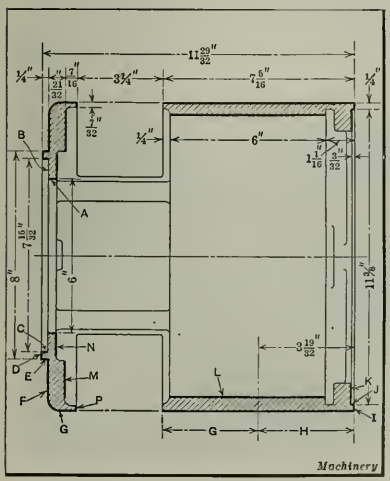


Fig. 18. Motor Frame machined on Turret Lathe

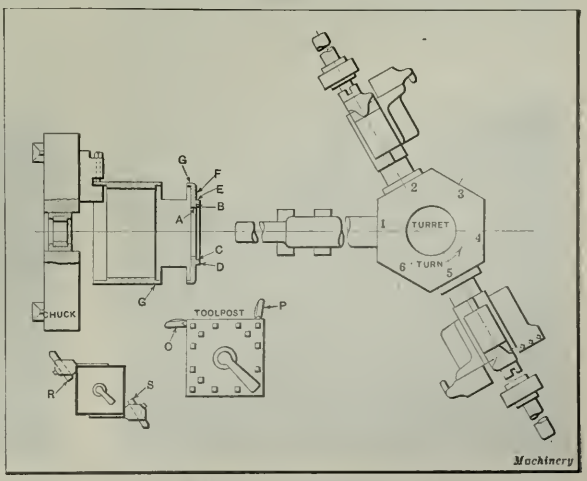


Fig. 19. Tooling Equipment for First Operation on Motor Frame

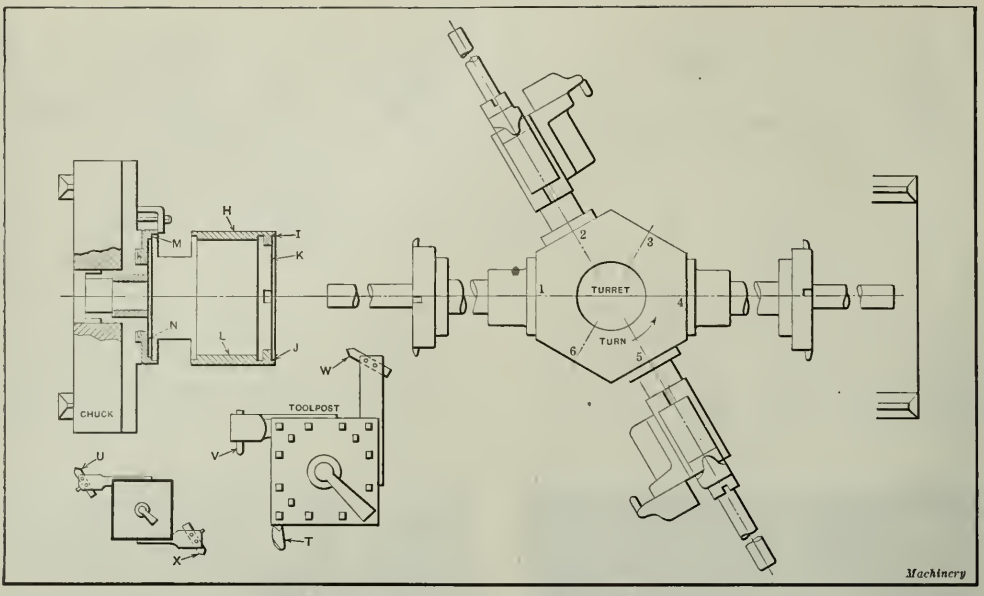


Fig. 20. Tooling Equipment for Second Operation on Motor Frame

is shown in Fig. 27, while Figs. 25 and 26 show the method of holding the work for the first and second operations, respectively. The housing is of cast steel the same as in the previous case, and the method of machining is similar, the various steps for the first operation being, briefly, as follows: (1) The work is held with special hard jaws and clamping screws. (2) Surfaces *B*, *C*, *E*, and *F*, Fig. 24, are rough-machined with tool *K* held in the toolpost. (3) The outside of the motor frame is rough-turned up to the chuck jaws, as indicated at *D* and as shown in Fig. 25, by tool *L* held in the wing-rest. (4) The hole *A* is finish-bored by cutters held in the boring-bar mounted in Side 1 of the turret. This bar is provided with a pilot entering the bushing in the chuck. (5) Surfaces *B* and *C* are rough-faced with cutters held in the head mounted in Side 2 of the turret. The pilot on the end of this tool enters the bushing in the chuck, and a bushing on the pilot also enters the bore *A* so as to insure concentricity of the machined surfaces. (6) Surface *F* is faced with tool *M* in the toolpost. (7) Surfaces *B*, *C*, and *E* are finished with cutters held in the head mounted in Side 5 of the turret. This head is guided with a pilot and a bushing in the same manner as the head mounted in Side 2 of the turret. (8) The outside surface *D* is finished with tool *N* in the wing-rest. The first operation takes 55 minutes.

In the second operation, the work is held by means of a special chuck plate and clamps, most clearly shown in Fig. 26, the detailed operations being as follows: (1) The motor frame is centered on the chuck plate and the clamps are tightened. (2) Surface *B*, Fig. 27, is rough-faced with tool *O* in the toolpost. (3) The outside of the motor frame is rough-turned at *C* with tool *R* in the wing-rest. (4) Holes *A* and *D* are rough-bored with cutters held in the boring heads mounted in Side 1 of the turret. (5) The same holes are finish-bored with cutters held in the boring heads mounted in Side 4 of the turret. In both of these cases, pilots are provided on the ends of the boring-bars entering bushing *S* in the chuck plate. (6) Surface *B* is finish-faced with tool *T* in the toolpost. (7) The outside of the motor housing at *C* is finish-turned with tool *U* in the wing-rest. The total time required for the steps in the second operation is 55 minutes.

Machining a Frail Part in the Turret Lathe

Fig. 23 shows an example of a frail part that is machined in the turret lathe. This part is an armature mounting

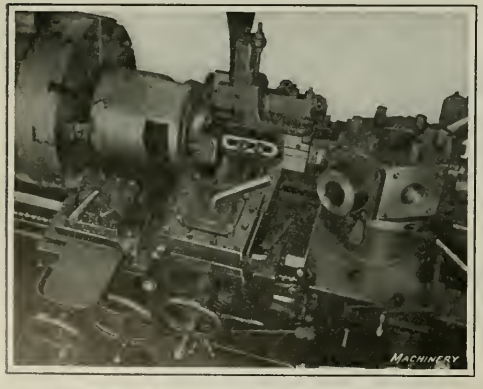


Fig. 21. Detail View showing how Motor Frame is held for the First Operation

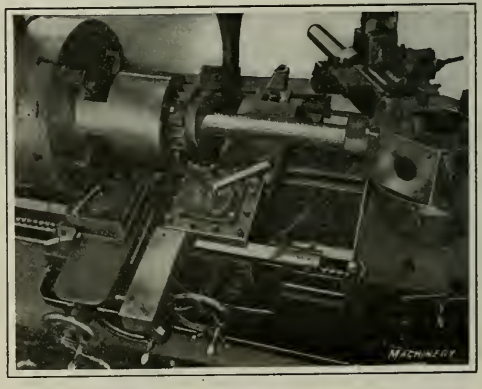


Fig. 22. Detail View showing how Motor Frame is held for Second Operation

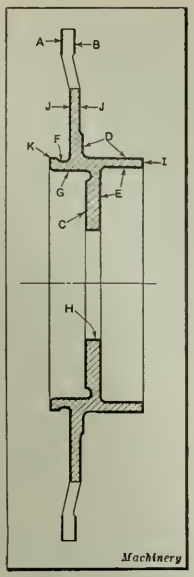


Fig. 23. Armature Part

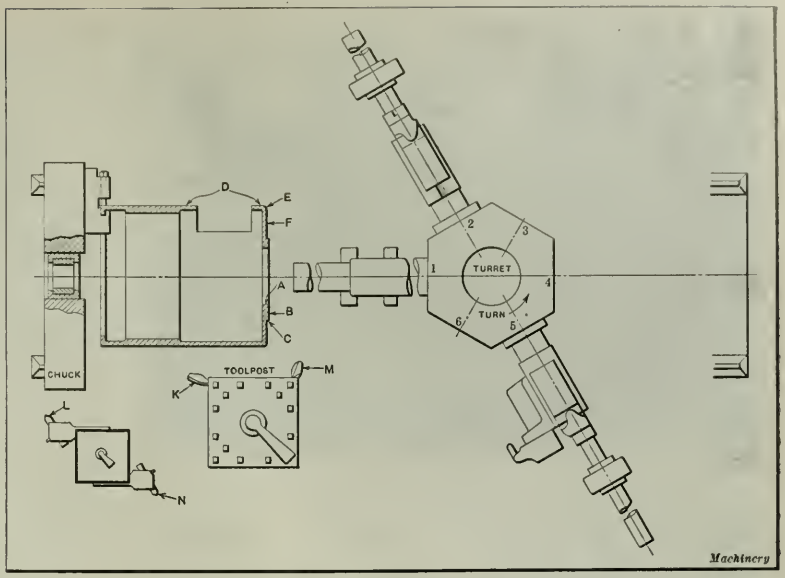


Fig. 24. Tooling Equipment for First Operation on Motor Frame of the Type shown

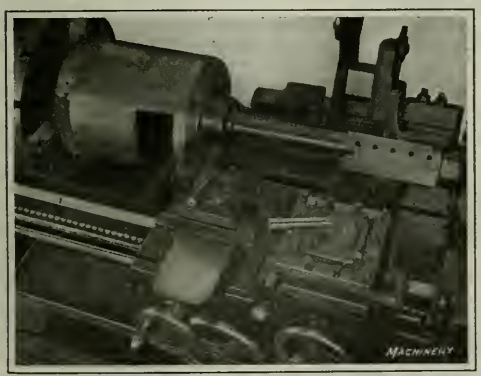


Fig. 25. Method of holding Motor Frame (Fig. 24) for First Operation

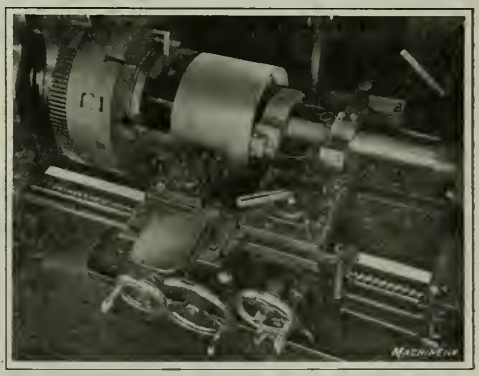


Fig. 26. Method of holding Frame for Second Operation

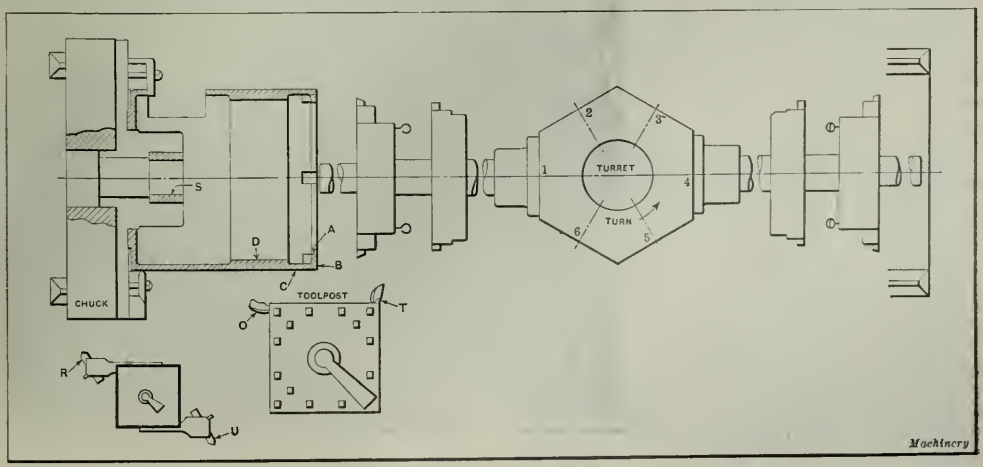


Fig. 27. Tooling Equipment for Second Operation on Motor Frame shown in Fig. 24

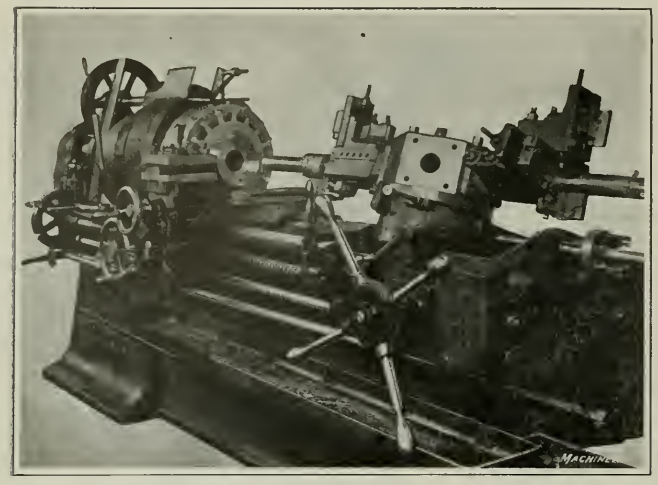


Fig. 28. View showing Method of holding a Frail Part for machining on Turret Lathe

machined on a 21-inch Gisholt turret lathe in two operations. Fig. 28 shows the method by which the work is held in the turret lathe, a special chuck being provided with pin or stud supports for each of the projecting prongs of the armature mounting. Chuck jaws on the inside grip the part, these jaws being more clearly shown in Fig. 30, where the piece is removed from the chuck and where the supporting studs or pins may also be seen. The greatest interest in this operation is attached to the method of holding and supporting the frail part, the actual operations performed upon the part being similar to those already described and consisting of the usual turning, boring, and facing operations for which both the toolpost tools and the heads in the turret are used, and which therefore requires no further explanation.

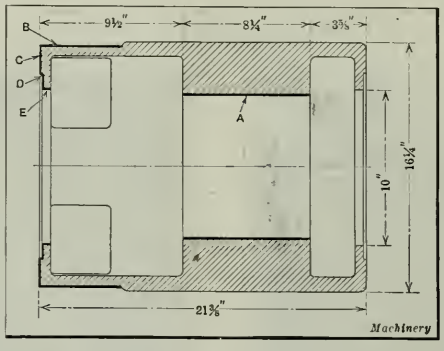


Fig. 29. Heavy Piece machined on Turret Lathe

Machining Very Heavy Work

Fig. 29 shows a very large piece weighing over 600 pounds, made from cast steel, that is machined on a 28-inch Gisholt turret lathe, and which shows the possibilities for handling heavy work on this class of machine, and also illustrates the possibilities for using multiple tools or combination sets of tools for boring different sizes of holes in the work. Fig. 33 shows the tool lay-out for the first operation. As indicated in this illustration, and as also shown in Fig. 31, a special fixture is used for supporting the casting. This is of the so-called "bonnet" type, which gives a support to the casting a considerable distance from its end. Figs. 31 and 32 also show the type of multiple tool-heads employed for boring the three different diameter holes in the casting. The work is carried out step by step as follows: (1) The end *C*, Fig. 33, is faced with a tool held in the toolpost. (2) The holes *A* and *E* are rough-bored and the counterbore *D* is rough-machined with the multiple tool-heads held in the turret. The bar on which these heads are held is guided by the bushing in the chuck. At the same time as the casting is rough-bored, the outside *B* of the casting is rough-turned with the tool held in the toolpost. (3) The outside *B* of the casting is finish-turned with a tool held in the toolpost. (4) The holes *A* and *E* and the counterbore *D* are finished with the multiple cutter-heads mounted in the turret.

In the second operation, the casting is held on a chuck plate provided with clamps, as is clearly shown in Fig. 34. The work, when located on the chuck plate and clamped in position, is shown in Fig. 35. The second operation consists in facing the end of the casting with a tool held in the toolpost, and boring and counterboring the work at the end by means of a two-head boring-bar as shown in Fig. 35. The total time required for finishing this casting, including both the first and second operations, is 70 minutes.

The article in the December number of MACHINERY will deal in the same detailed manner as the first two articles with the tooling equipment and the order of operation for the machining of cylinders, piston rings, clutch cones, and a number of miscellaneous parts. In connection with the machining of these miscellaneous parts, it will be pointed out how turret lathes that sometimes cannot be kept fully busy on the work for which they have been procured, can be used to advantage for other work for which the machine might not have been purchased if there had been no other work to do on the machine, but which, when the machine is available, can be performed on the turret lathe more rapidly, and therefore more cheaply, than on other machine tools.

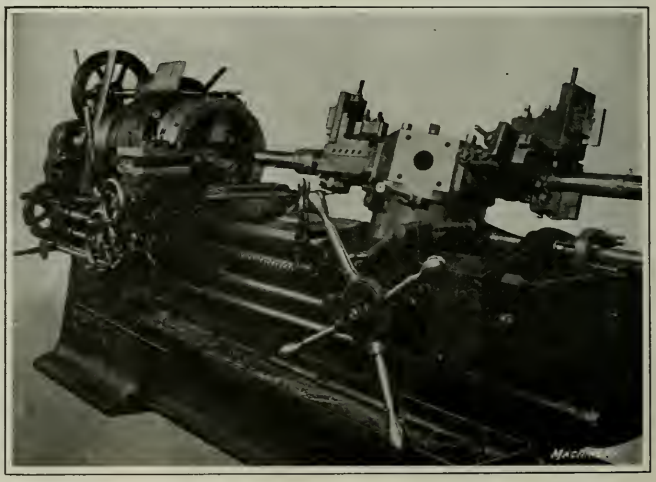


Fig. 30. Machine illustrated in Fig. 28 with Work removed to show Method of holding

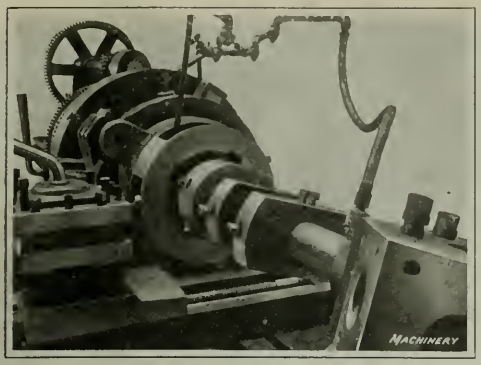


Fig. 31. Special Fixture of the Bonnet Type for holding Heavy Work shown in Fig. 29

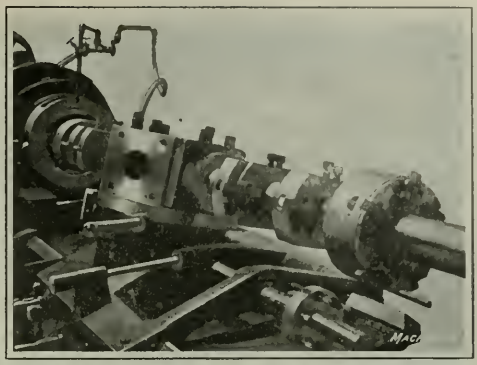


Fig. 32. Fixture and Multiple Tool-head used in machining Work shown in Fig. 29

IMPORTANCE OF THE DEVELOPMENT OF CHEMICAL INDUSTRIES IN THE UNITED STATES

Germany had the leadership in chemistry and we have got to take it away from that country, and we can only do that by developing along lines that have been developed only in Germany on a large scale. We must have something like the German relationship between the universities and the industries, and chemistry in particular is a subject where it is not enough to be a trained and experienced applier of science. The country, if it is to be safe industrially and if it is to have the leadership intellectually in chemistry, has got to have a great number of men who are primarily scientific chemists—not primarily engineers, but men who are able to apply all the great principles of science directly to the problem of the moment, as has been done by many during the war. Every university in America is capable of producing men of that kind, but there are very few that have anything more than a machine standard in their college. You have got to produce a man who is scientifically and intellectually an individualist, who has independent judgment and power. Such a man can be the product only of an institution or of a group of men who can give him something more than most colleges give, unless he is big enough to make himself.—*Professor L. J. Henderson, Harvard University.*

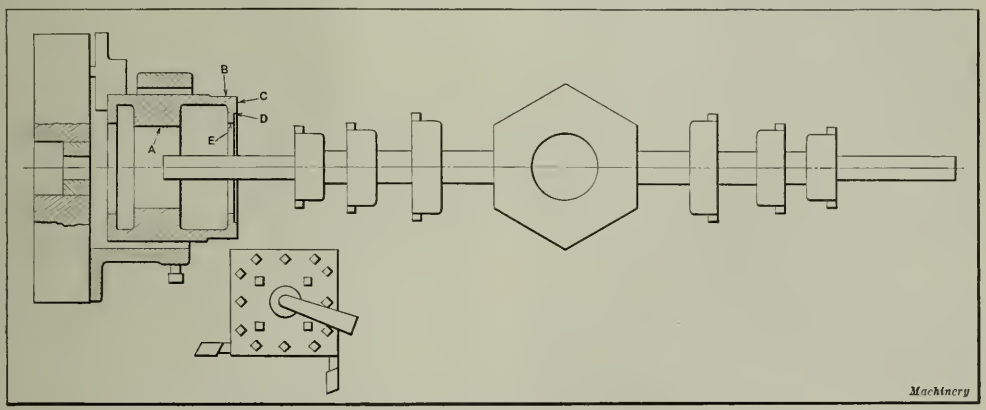


Fig. 33. Tooling Equipment for First Operation on Heavy Casting shown in Fig. 29

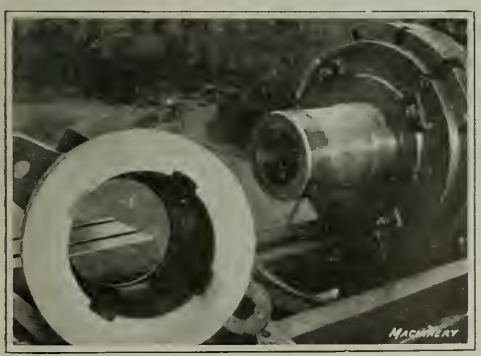
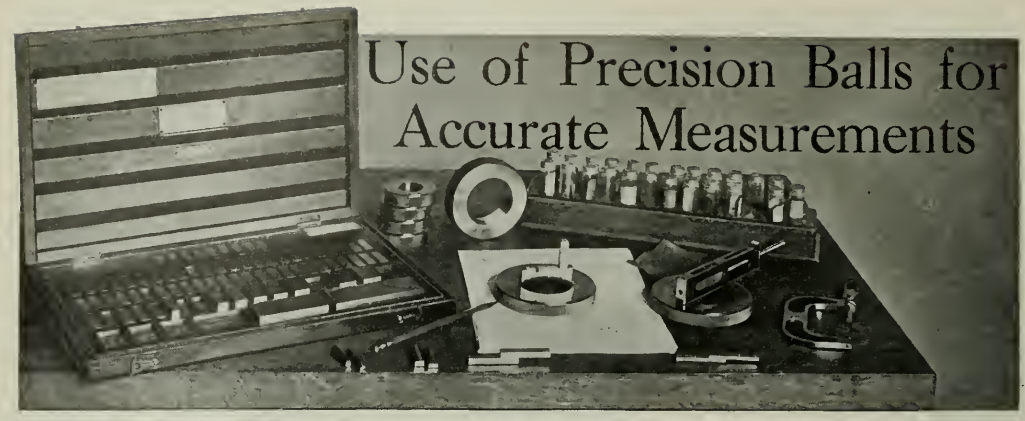


Fig. 34. Method of holding Heavy Casting for Second Operation



Fig. 35. View showing Casting clamped in Position on Chuck Plate



Use of Precision Balls for Accurate Measurements

A Detailed Explanation of the Application of Steel Balls for Precision Measurements in Shop Work

By R. L. RANKIN, Assistant Physicist, Bureau of Standards, Washington, D. C.

PRECISION balls are used in the Gage Section of the Bureau of Standards as attachments for machines and for taking direct measurements in the inspection of gages. While their application to work of this nature is not so general as that of some other accessories, yet they are indispensable, in certain cases, for obtaining accurate measurements. Fig. 1 shows a case of precision balls ranging from 1/16 inch to 4 inches in diameter, these balls being considerably more accurate than ordinary commercial steel balls. Prior to their use, the balls were carefully measured and cards showing the *rated* diameter of each ball, together with the *actual* measurement, were placed in the case. These measurements showed that the rated diameters were accurate to within a few hundred-thousandths inch.

Application of Balls on Measuring Machines

Fig. 2 shows three brass thimbles, in each of which a ball has been mounted, for use as contacts on measuring machines in order to obtain more accurate measurements of flat-end standards or measuring rods, gages and other exact work. These balls are so mounted that they extend, both inside and outside, beyond the wall of the thimble, thus allowing them to make contact with both the part being measured and the spindle of the measuring machine when the thimbles are being used as illustrated in Fig. 3. The sum of the diameters of the two balls is subtracted from the reading which is obtained, in order to calculate the actual length measurement. The balls may be mounted either concentrically or eccentrically in the thimbles. Two thimbles having the balls located concentrically are used for measuring the length of a gage, and thimbles having the balls located eccentrically are used when further data are desired, such as the parallelism of the faces of a gage. In two of the thimbles shown in Fig. 2, the balls are located eccentrically, and in the other thimble the ball is placed in the center.

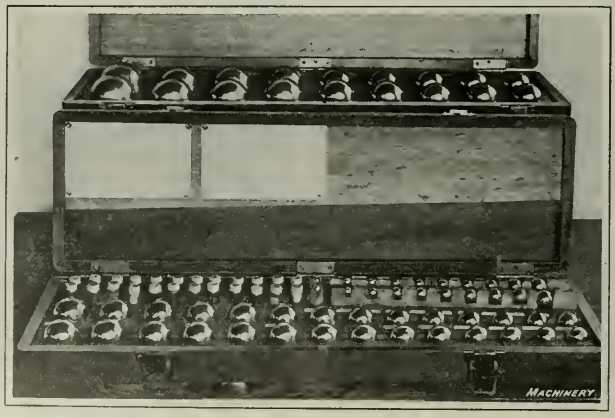


Fig. 1. Case of Precision Balls ranging from 1/16 Inch to 4 Inches in Diameter

Two balls mounted in thimbles, in use on a Pratt & Whitney machine for measuring the length of a flat-end standard, are shown in Fig. 3. The object in using a pair of concentrically mounted ball contacts in determining the length of a flat-end standard is to reduce errors due to poor alignment of the standard when placed in a measuring machine. While flat-end standards up to 6 inches in length can be brought into good contact with both the anvil and the spindle of a machine, it is difficult to secure good alignment of standards of greater length. Consequently, readings frequently are recorded which are 0.001 inch greater than the actual length of the standard, and it is almost impossible to be sure when the minimum or true reading has been obtained. However, errors are largely eliminated by the use of ball contacts. For example; if a true 12-inch end-standard having flat faces $\frac{3}{8}$ inch in diameter is out of alignment enough to give a reading on the measuring machine of 12.00094 inches when no ball contacts are used, the reading with the standard in the same position will be 12.00005 inches when $\frac{1}{8}$-inch diameter ball contacts are used, thus reducing the observed error from 0.00094 to 0.00005 inch.

While concentrically mounted balls are sufficient in most cases for taking length measurements such as just described, it is sometimes convenient to use eccentrically mounted balls when the lathe center holes have not been removed, or when the gaging surfaces of some other type of gage are not in line with each other—that is, offset relative to the axis of the machine. Eccentrically mounted balls are also useful when it is desired to determine just how the gage is aligned so that the small errors observed even when concentric ball contacts are used can be still further reduced. They are also used to determine whether the faces of a flat-end standard are parallel and if they are perpendicular to the axis.

Method of Using Eccentrically Mounted Balls

A gage which is out of alignment after having been placed on a

machine is illustrated by the diagrammatic sketch *A*, Fig. 4. It is not possible except in exaggerated cases, to tell by means of the eye that a gage is out of alignment. In order to determine this fact, the left-hand ball in the illustration is turned around into different positions until the minimum reading is obtained on the machine; it is retained in this position while the right-hand ball is turned around until the maximum reading is obtained. It is found that in such cases the two balls will be opposite each other; that is, both balls will be either at the top of the gage, at the same side, or at the bottom, if the variation in the readings is due to poor alignment of the gage. If the gage is revolved 180 degrees so that the portion of the gage which was formerly at the top is at the bottom, the minimum reading is still obtained at the top on the left-hand end, and the maximum reading at the top on the right-hand end, provided the alignment of the gage is not disturbed when revolving it. By adjusting the position of the gage, it is possible to reduce the difference between the maximum and the minimum readings that are found when each ball is revolved, until the gage is finally in good alignment.

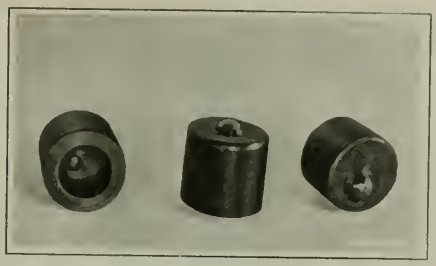


Fig. 2. Balls mounted in Thimbles for Use on Measuring Machine

The faces of the gage illustrated at *B* in Fig. 4, are not perpendicular to the axis of the gage. After the ball at one end is placed in such a position that the minimum reading is obtained and the other ball is placed so that the maximum reading is obtained, results similar to those produced in the preceding case when the gage was out of alignment may be observed, but with this difference: when the faces of a gage are not perpendicular to its axis, the maximum and the minimum readings on both ends revolve with the gage. Thus, if the gage which is illustrated is turned around 180 degrees the minimum and maximum readings will then be at the bottom of the gage, at the same ends, respectively, as they were before the gage was turned.

The most important application of eccentrically mounted ball contacts is in the determination of the parallelism of the contact faces of a gage. If a true flat-end standard is in perfect alignment, the observed length of the gage is the same for every position of each ball, and in the two previous cases the balls were opposite each other when the minimum reading was obtained at one end and the maximum reading at the other. However, when the faces of a gage are not parallel, the balls will not be opposite each other when they are placed in positions which will give the minimum and maximum readings on opposite ends of the gage. They may even be in line when each ball is adjusted for a minimum reading, as shown at *C* in Fig. 4. This occurs when the lack of parallelism is due to the gage being bent or warped. In any case, if the balls are not opposite each other when they are adjusted to give the maximum and the minimum readings, respectively, the faces of the gage are not parallel. The same thing is true if the readings change when one ball, but not the other, is revolved. Because the faces of a gage are not both perpendicular to the axis when they are not parallel, the maximum and minimum readings, at one end at least, revolve with the gage when it is turned around.

Comparator Used for Testing Long End-Standards

A seven-foot comparator which was made by the Bureau of Standards for its own use is shown in Fig. 5. It consists of a 7-foot piece of railroad rail which was scraped flat on the top, a number of holders for the end-standards, some mounted balls, an indicator mounted at one end of the rail, and a micrometer mounted at the other end. This comparator is used to measure the length of end-standards which are longer than the standards of known length commonly used for direct comparison with standards that are to be measured. In using the comparator, the standard being measured is compared with the combined length of several shorter flat-end standards, these standards of known length being placed in the comparator as shown in the illustration, so that their combined length plus the diameters of the balls which are mounted in the holders, will be about equal to that of the standard to be measured. The micrometer at the left end of the device is set so that the indicator at the other end reads zero, after which the short standards are replaced by the standard to be measured and the indicator reading is again brought to zero. The length of the standard is obtained by adding the lengths of the short end-standards to the diameters of the balls, and then adding to or subtracting from this sum the difference between the two micrometer readings. It is necessary to have the balls between the micrometer spindle and the first standard, and between the faces of the standards, in order to obviate errors due to

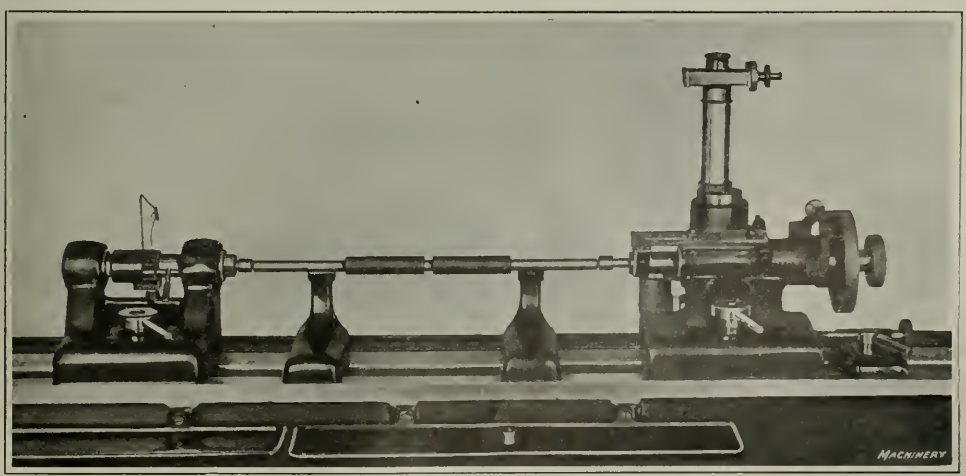


Fig. 3. Pratt & Whitney Measuring Machine in which Ball-contact Thimbles are used

imperfect alignment of the standards. This comparator is simple in construction and operation, and is suitable for use in manufacturing plants.

Use of Balls for Testing Micrometers

A pair of balls, mounted as shown in Fig. 6, is useful for testing the parallelism of the contact faces of ½- and 1-inch micrometers. In doing this, the micrometer is set so that when one of the balls is slid in and out between the spindle and anvil it will barely make contact between the high points. A reading is taken and the micrometer is then adjusted so that the ball will just enter at the low point, after which this micrometer reading is also taken. The difference between these readings is the approximate amount that the faces of the anvil and spindle are out of parallelism.

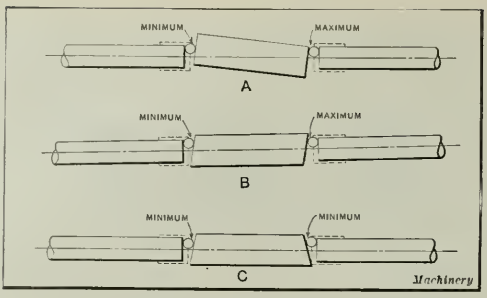


Fig. 4. Diagrammatical Sketches illustrating Use of Eccentrically Mounted Balls

This test is so sensitive that, by supplementing it with two other simple tests, the parallelism of micrometer caliper faces can be determined to within 0.00001 inch, if some means are provided for reading a movement of the micrometer screw of this magnitude. One of these additional tests consists of determining the character of the surfaces of the anvil and the spindle by means of the optical flatness test, which is necessary because the difference in the readings may be due partially to the unevenness of the contact surfaces. The other additional test is a repetition of the first test but with a ball having a different diameter. This test is made because the micrometer faces may be parallel for one position of the spindle and not parallel for other positions, due to the fact that they are not lapped perpendicular to the axis of the screw. For convenience, two balls of different sizes are mounted at opposite ends of the same holder.

Use of Balls in Measuring Gages

The most satisfactory method for measuring the taper of small-diameter ring gages is by balls, as illustrated in Fig. 7. Two balls are selected, one of which will fit near the small end of the hole and the other near the large end. Readings are then taken by means of an indicator or a depth micrometer, to find the distance from the top of the gage to the top of each ball. When care is taken not to force the balls into the hole, very accurate determinations of the taper may be computed from these measurements. The following formula is used to solve the angle of taper:

$$\text{Sin } a = \frac{(R-r)}{(m-M)-(R-r)}$$

in which

a = one-half the included angle of taper;
R = radius of large ball;
r = radius of small ball;
M = measurement taken to top of large ball;
m = measurement taken to top of small ball.

The diameter of the hole at the large and small ends of the gage may be readily determined after the angle of taper is known. The formula for finding the diameter D at the large end is as follows:

$$D = 2 \sec a \, [R + \sin a \, (M + R)]$$

Precision balls are also used in measuring the effective or pitch diameter of threaded ring gages. The method of taking these measurements is analogous to the three-wire method of measuring the effective diameter of threaded plugs, the diameter of the balls being the same as that of the wires used for measuring a plug of the same thread pitch. While the results obtained by this method are somewhat uncertain, due to the great compression of the balls caused by a comparatively light pressure, it can be used in case no check plug accompanies a ring gage.

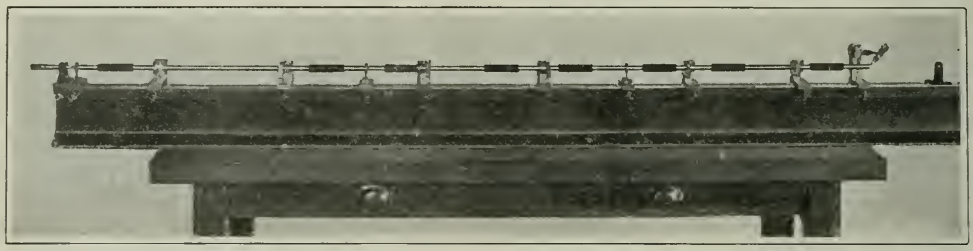


Fig. 5. Comparator built by the Bureau of Standards for measuring Extra Long Flat-end Standards

Other applications of precision balls will suggest themselves to the inspector, but some of the most important are outlined above. Balls of all the sizes shown in Fig. 1 are not usually necessary, but a set of balls ranging by eighths of an inch from ¼ to 1¼ inches in diameter, is very useful.

* * *

The Monthly Labor Review of the Department of Labor shows that during the year 1918 there occurred 3181 strikes and 104 lock-outs in the country. The principal causes for the strikes are summarized as follows: Demands for an increase of wages, 1352; decrease of hours, 79; increase of wages and decrease of hours, 248; recognition of the union, 186; recognition and wages, 95; recognition, wages, and working hours, 66; demand for discharge of foremen, 37; discharge of employes, 203; employment of non-union men, 61; sympathy strikes, 34; jurisdiction strikes, 16; general conditions, 54. The total duration of strikes in 1918 was 28,386 days; in 1917, 24,076 days.

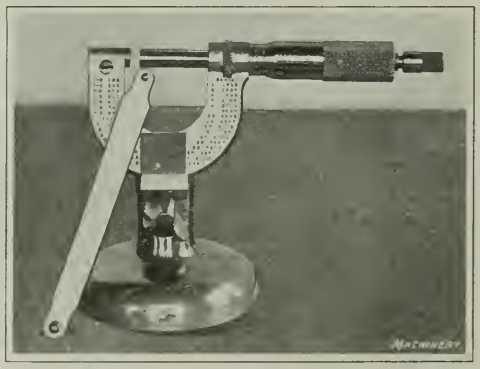


Fig. 6. Mounted Balls for ascertaining the Parallelism of the Faces of Micrometer Spindles and Anvils

INGENIOUS REPAIR JOB

By EDWIN J. BACHMAN

The writer, who is employed in a small repair shop, recently had occasion to repair a concrete mixer which did not operate properly. It was found that the source of trouble would be eliminated if a large sprocket on the engine crankshaft were replaced by a smaller one. The old sprocket had eighteen teeth and was a solid disk casting without spokes. As the new sprocket was to have only twelve teeth, it was decided to make it out of the old one. It was found that the radius of the space between the teeth beneath the pitch circle was 7/16 inch and that the circular pitch was 1½ inches. From these data the new pitch diameter was calculated and the pitch circumference laid out, after which twelve ⅞-inch equally spaced holes were drilled along the pitch circumference. The new sprocket was then turned down to the required outside diameter of the teeth, and a taper was turned on the sides of the teeth to permit them to enter the links of the chain readily. The excess metal between the teeth was then chipped out and filed to the desired shape. The correct contour of the teeth was obtained by the use of a sheet-iron templet. As the teeth had been cast on the original sprocket there was no necessity for great accuracy in machining the new one. A great saving in time was made by the method described, as it would have required more time to make a special milling cutter than is now necessary to do the whole job.

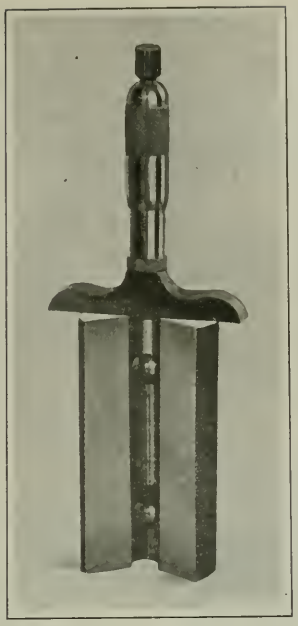


Fig. 7. Measuring the Taper Ring Gages by the Use of Precision Balls

* * *

INTERNAL CHAMFERING TOOL

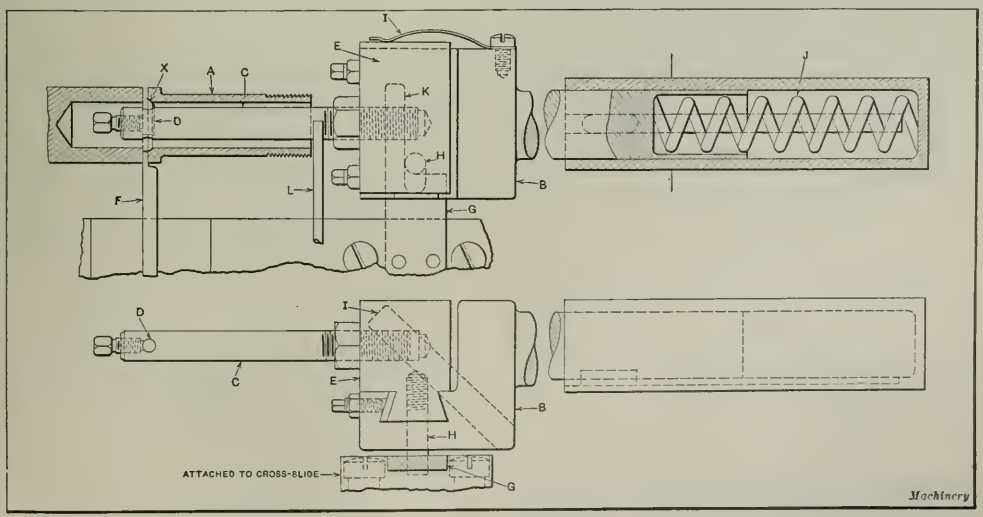
By R. A. MONTE

Nipples of the type shown at *A* in the accompanying illustration are frequently used on gas and oil engines and on other gas, oil, and hydraulic equipment. They are usually made of monel metal, bronze, or steel, and are frequently manufactured in large quantities on turret lathes. In most cases a second operation is required to produce the chamfer shown at *X*, but with the tool here described it is possible to perform this operation simultaneously with the cutting-off operation.

All the operating parts of the tool are carried in the body *B*, the shank of which telescopes into a sleeve which is held in the turret. The holder *C*, in which the chamfering bit *D* is held, is screwed into slide *E* and is prevented from turning by means of a lock-nut. Provision is made for adjusting the dovetailed tongue of the slide by means of a gib and adjusting screws. The cutting-off tool *F* is carried in a block on the cross-slide of the lathe. Pusher *G* is also secured to the cross-slide so that as tool *F* is fed into the work, *G* engages with a pin *H*, screwed into the under side of slide *E*, thus imparting a transverse movement to the slide and engaging the tool *D* with the work. The diameter of the chamfer is governed by the movement allowed the slide by the length of the slot in the body of the tool in which the pin *H* operates. At the same time that the cross-slide is being returned to its former position, after the work has been cut off, the slide *E*, actuated by the flat spring *I*, is returned to its normal position. The purpose of spring *J*, which is contained in the tool shank sleeve, is to absorb any shock that might be caused by sudden contact of the pin *H* with the finger *K* when advancing the tool into the work before starting the operation. The wire *L* is held against the nipple during the cutting-off operation in order to steady the work when it is nearly cut through. A saving in time of 15 per cent has resulted from the use of this device on large quantities of work.

* * *

The U. S. Training Service is devoting special attention to preparing courses in the proper methods of training in various industries so that interested manufacturers may be supplied with adequate material for operating training departments. The Training Service has issued several pamphlets on training, obtainable from the Department of Labor.



Tool used for performing an Internal Chamfering Operation

Stresses in Crankshafts

By VICTOR M. SUMMA, Examining Engineer, American Brake Co., St. Louis, Mo.

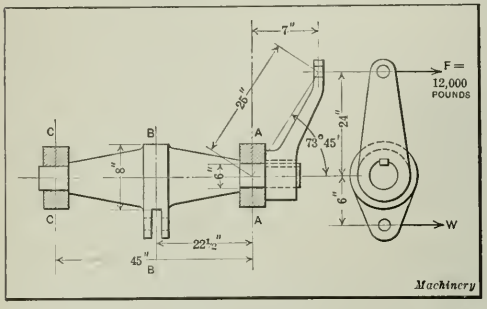


Fig. 1. Example of Crankshaft subjected to Stresses at Section B-B

IN Fig. 1 is shown a crankshaft of the same type as that described in the September number of MACHINERY in connection with stresses at section *A–A*. It is now required to ascertain the intensity of the stresses at the center of the shaft where the cross-sectional diameter is 8 inches. It is evident that the formulas used in determining the stresses at section *A–A* do not apply to section *B–B* nor to any section on the left of the reaction at bearing *A–A*. For determining the stresses at *B–B*, recourse must be had either to Rankine's fundamental equations or to their derivations for the equivalent bending and twisting moments. In the present case, we shall make use of the original formulas:

$$P_1 = 1/2\ (S + \sqrt{S^2 + 4S_s^2}) \text{ and } P_2 = 1/2\ \sqrt{S^2 + 4S_s^2} \quad (1)$$

The solution of the problem will be simplified somewhat if the shaft and the forces acting on it are represented diagrammatically, as shown in Fig. 2. The inclined lines shown as 6 and 24 inches in length represent the toe and the lever arms, respectively, and of course must be imagined as being normal to axis *O–O* of the shaft.

W′ and *W″* are both equal to *W* and act in opposite directions to each other; also forces *F″* and *F‴* are both equal to *F* and act in opposite directions to each other. These two sets of additional forces do not disturb the conditions of equilibrium of the original forces *W* and *F* acting at the ends of their respective arms. For this reason it can be assumed that the shaft is subjected to direct bending stresses due to forces *W′* and *F″* acting at axis *O–O*, and to secondary shearing stresses produced by the torsional moments of couples *WW″* and *FF‴*. *R* and R_1 are, of course, the reactions of *W′* and *F″*, and their magnitudes are found from the following equations:

$$R + R_1 = W' + F''$$
$$R \times 45 - W' \times 22.5 = F' \times 7$$
$$W' \times 6 = F' \times 24$$

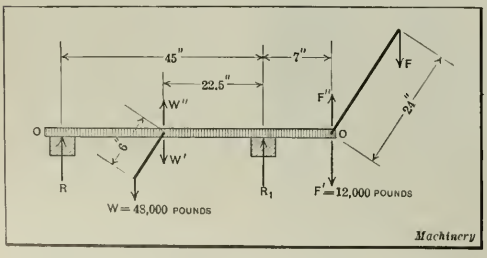


Fig. 2. Diagram indicating Direction and Magnitude of Forces acting on Crankshaft shown in Fig. 1

That is,

$$W' = \frac{12{,}000 \times 24}{6} = 48{,}000 = W$$

$$R = \frac{12{,}000 \times 7 + 48{,}000 \times 22.5}{45} = 22{,}133 \text{ pounds}$$

$$R_1 = 48{,}000 + 12{,}000 - 22{,}133 = 37{,}867 \text{ pounds}$$

Now the tensile or compressive unit stress due to bending alone is

$$S = \frac{22{,}133 \times 22.5 \times 10.2}{8^3} = 9900 \text{ pounds}$$

and the plain unit stress in shear due to the twisting moment is

$$S_s = \frac{48{,}000 \times 6 \times 5.1}{8^3} = 2880$$

Then, substituting these values of *S* and S_s in Formulas (1), we have:

$P_1 = 1/2\ (9900 + \sqrt{9900^2 + 4 \times 2880^2}) = 10{,}680$ pounds per square inch in tension or compression, and

$P_2 = 5730$ pounds per square inch in shear.

Shaft Design for Uniform Strength

Suppose now that we are to design a shaft of uniform strength, as shown in Fig. 3, in which the stresses should

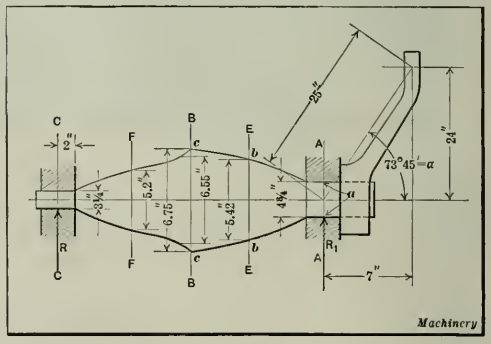


Fig. 3. Shaft designed for Uniform Strength

not exceed 18,000 pounds in tension and compression, and 12,000 pounds in shear. From the following formulas:

$$P_1 = \frac{M\ (1 + \cos \alpha)}{2Z} \text{ and } P_2 = \frac{M}{2Z}$$

we would have for the diameter of the shaft at section *A–A*,

$$d = \sqrt[3]{\frac{12{,}000 \times 25\ (1 + 0.28) \times 5.1}{18{,}000}} = 4\ 3/4 \text{ inches}$$

or

$$d_1 = \sqrt[3]{\frac{12{,}000 \times 25 \times 5.1}{12{,}000}} = 5.03 \text{ inches}$$

The diameter at section *B–B* can be found more easily by making use of the formulas for the equivalent twisting moments for tension and shear; namely,

$$T_s = M + \sqrt{M^2 + T^2} = 18{,}000 \times \frac{d^3}{5.1} \text{ and}$$

$$T_{es} = \sqrt{M^2 + T^2} = 12{,}000 \times \frac{d_1^3}{5.1}$$

And, since $M = 22{,}133 \times 22.5 = 498{,}000$ inch-pounds, and

$T = 48{,}000 \times 6 = 288{,}000$ inch-pounds, we have, solving for d and d_1:

$$d^3 = \frac{5.1\ (M + \sqrt{M^2 + T^2})}{18{,}000} =$$

$$\frac{5.1\ (498{,}000 + \sqrt{498{,}000^2 + 288{,}000^2})}{18{,}000} =$$

301.8 and $d = 6.71$, say 6 3/4 inches

$$d_1^3 = \frac{5.1\ \sqrt{M^2 + T^2}}{12{,}000} = \frac{5.1\ \sqrt{498{,}000^2 + 288{,}000^2}}{12{,}000} =$$

242.2 and $d_1 = 6.23$ inches

At section *E–E*, midway between *A–A* and *B–B*, we have (since $M = 22{,}133 \times 33.75 - 48{,}000 \times 11.25 = 206{,}988$ inch-pounds, and $T = 288{,}000$ inch-pounds):

$$d^3 = \frac{5.1\ (206{,}988 + \sqrt{206{,}988^2 + 288{,}000^2})}{18{,}000} = 159$$

$d = 5.42$

$$d_1^3 = \frac{5.1\ \sqrt{206{,}988^2 + 288{,}000^2}}{12{,}000} = 151 \text{ inches and}$$

$d_1 = 5.32$ inches

As the cubic equations for determining these diameters (d and d_1) give very flat parabolas, these can be easily drawn free-hand through the points *a*, *b*, and *c*.

It is obvious that the portion of the shaft on the left of section *B–B* is free from torsion. Here the shaft is subjected to bending and to a maximum shear only at support *C–C*. Then the diameter at the edge of the frame may be conjectured from an inspection of the solutions of these equations:

$$\frac{22{,}133}{0.7854\ d^3} = 12{,}000 \qquad d = \sqrt{\frac{22{,}133}{0.7854 \times 12{,}000}} =$$

1.55 inch and $\dfrac{22{,}133 \times 2}{d^3 \div 10.2} = 18{,}000$

$$d = \sqrt[3]{\frac{22{,}133 \times 2 \times 10.2}{18{,}000}} = 2.92, \text{ say } 2\ 15/16 \text{ inches.}$$

Also, since the section in question is subjected simultaneously to tension and shear stresses normal to each other, the figure $2\frac{15}{16}$ inches should be increased somewhat, say to 3 1/4 inches, and the value of P_1 should be calculated by Rankine's formula to determine how nearly it approaches the allowable stress of 18,000 pounds. That is,

$$P_1 = 1/2 \left(\frac{22{,}133 \times 2 \times 10.2}{(3.25)^3} + \sqrt{\frac{(22{,}133 \times 2 \times 10.2)^2}{(3.25)^6} + \frac{4 \times (22{,}133)^2}{0.7854^2 \times (3.25)^4}} \right) = 17{,}400 \text{ pounds.}$$

Hence the diameter at section *C–C* may be made 3 1/4 inches.

Again, the diameter of the section immediately at the right of *B–B*, under the influence of the bending moment alone, is

$$d = \sqrt{\frac{22{,}133 \times 22.5 \times 10.2}{18{,}000}} = 6.55 \text{ inches}$$

At cross-section *F–F* midway between *C–C* and *B–B*, we have likewise:

$$d = \sqrt{\frac{22{,}133 \times 11.25 \times 10.2}{18{,}000}} = 5.2 \text{ inches}$$

Having obtained three points, the parabola can readily be drawn in, and, of course, it must be blended into the other one at the center as shown in the diagram. The deflection of such a shaft loaded at the middle with 48,000 pounds could be fairly estimated from the formula:

$$D = \frac{Pl^3}{48EI}.$$

That is,

$$\text{Deflection} = \frac{48{,}000 \times 45^3 \times 64}{48 \times 30{,}000{,}000 \times 3.14 \times 6.75} = 0.029 \text{ inch}$$

or, say, 1/32 inch, if the shaft were of uniform diameter throughout and probably not over 1/16 inch in the present case. The saving of material, which this design would effect over the first one would be approximately 180 pounds per piece.

[In the author's former article in MACHINERY, (see December, 1917, page 307) on compound stresses, the formula

$$P_1 = \tfrac{1}{2}\ (S + \sqrt{S^2 + 4S_s^2})$$

has been credited to Rankine. This formula, however, was first derived by St. Venant, and should, therefore, be credited to him.]

* * *

DRILLING DEEP HOLES OF SMALL DIAMETER

BY WILLIAM S. ROWELL

The drilling of holes less than ⅛ inch in diameter and more than 40 diameters deep represents difficulties varying with the material in which the hole is drilled, the appliances used, and the quantity and kind of lubricant, etc. This fact is well illustrated by an experience of the writer when drilling 3/32 inch diameter holes about 4 inches deep in high-speed steel, using a 14-inch Hendey lathe. The difficulties experienced by the writer in getting oil to, and chips away from, the point of the drill after it had entered the metal to a depth of 8 or 10 diameters, are difficulties commonly experienced. Having no special appliance, the usual method of frequently removing the drill and loading it with oil was followed. It occurred to the writer, however, that the forward motion of the work and the spiral flutes of the drill constituted a pumping action which removed oil from the drill hole before it had a chance to reach the bottom. As the lathe was provided with a crossed belt, a trial was made of reversing the work just as the drill was removed from the hole and allowing it to run backward until the drill, loaded with oil, was again inserted and fed rapidly, *nearly* to the bottom of the hole. At this point the belt was again shifted, driving the spindle in the opposite direction, and the drill was then fed to the work until another withdrawal was due. This cycle of operations was repeated until the hole was finished. The method proved entirely satisfactory.

A trial of the "pumping" effect of the spiral flutes in a revolving hole was afterward made with a piece of 1-inch thick iron which was held in a lathe chuck and drilled through with a ¼-inch drill. The lathe was first run forward a few seconds and then backward a few seconds, and oil was dropped on the drill at the front side of the work while the drill protruded through the piece. The result showed that while the lathe ran forward no oil appeared on the opposite side of the piece, but as soon as the lathe and work were reversed, the oil from the drill ran freely through to the rear side. This idea might be used to considerable advantage on a small drilling machine, which can be more easily reversed than a 14-inch tool lathe.

* * *

The Ordnance Department of the U. S. Army is now engaged on an extensive program covering the redesigning of all types of artillery material, the new designs being intended to meet the requirements which were laid down some months ago by a special board of experts appointed to make a study of artillery material for use in the army. The magnitude of this work is such that the Government has been forced to call upon designers and manufacturers to take contracts for designs to be submitted. Among the designs first asked for are 75-millimeter and 105-millimeter guns and carriages, and manufacturers will also be asked to bid on the manufacture of these guns from the designs submitted. Further information may be obtained by addressing the Artillery Division of the Office of the Chief of Ordnance, U. S. Army, Washington, D. C.

UNFAIR COMPETITION IN TRADEMARKS

By CHESLA C. SHERLOCK

A western manufacturer recently had an experience with the trademark laws which has greatly changed his opinion of this form of governmental protection. His production had been cut down to the minimum during the war through lack of materials, and just as business promised to open up again he found that a certain competitor had adopted a plain imitation of his trademark.

"Why don't you prosecute?" suggested a younger member of the firm.

"Can't," retorted the manufacturer. "We were unfortunate in the selection of our trademark. The courts have said that our trademark was invalid because it contained words descriptive of the quality, characteristics, or ingredients of our product. Hence, we have no trademark at all—at least we are not entitled to governmental protection in it."

The younger member of the firm, however, was not satisfied. He felt that there must be some means of securing protection from this form of piracy, so he saw a legal acquaintance and laid the problem before him. The latter submitted a written opinion as follows:

First, it is sound legal doctrine that words descriptive of the characteristics, quality, or ingredients are not the subject matter of a trademark. A trademark is a form of monopoly granted to the individual by the Government, conferring the exclusive right to use the word, combination, device, or symbol in relation to the goods produced or sold. Since anyone has a right to use words descriptive of the quality, characteristics, or ingredients, it is obvious that such words cannot be the subject matter of a trademark. But, there are two exceptions to this rule, both arising more or less out of statute law.

The first is found in the Trademark Act of 1905. It is to the effect that where a descriptive word has been used *exclusively* for a period of ten years in relation to a certain article, it may be registered and used in a valid trademark, regardless of the general rule. The second is found where unfair competition arises or threatens to arise. One authority has said: "The function of a trademark is to indicate to the public the origin or source of the manufacture of the article which it is used to designate. It is not necessary, however, for the trademark to show these matters on its face, but it is sufficient in this regard, if, by its association with such articles in trade, the mark has acquired with the public a secondary meaning denoting the origin of the article." A manufacturer is entitled to protection from the courts in his trade devices, regardless of whether they have been registered or not, if he is faced with unfair competition. Any effort to appropriate, imitate, or steal the trade devices of another is deemed unfair competition by the courts.

Review of Actual Cases of Trademark Infringements

In Oklahoma, the supreme court said: "All practices between business rivals which tend to engender unfair competition are odious to the law and will be restrained by the courts. No man will be permitted to make use of signs or trademarks which serve to confuse the identity of his business with that of another, so as to mislead the public and divert business from his competitor to himself."

In an English case, the court said: "They have no property in the name, but the principle upon which the cases on this subject proceed is not that there is a property in the word, but that it is a fraud on a person who has established a trade and carries it under a given name that some other person should assume the same name, or the same name with a slight alteration, in such a way as to induce persons to deal with him in the belief that they are dealing with the person who has given a reputation to the name. . . . That is, a fraud on the part of a defendant to set up a business under such a designation as is calculated to lead and does lead other people to suppose that his business is the business of another person."

The United States Supreme Court, in the case of a certain manufacturing company, said: "Undoubtedly, an unfair and fraudulent competition against the business of the plaintiff conducted with the intent, on the part of the defendant to avail itself of the reputation of the plaintiff to palm off its goods as the plaintiff's, would, in a proper case, constitute ground for relief."

In another case, discussing what was necessary to constitute "a proper case," the Supreme Court said: "Much must depend, in every case, upon the appearance and special characteristics of the entire device; but it is safe to declare as a general rule, that exact similitude is not required to constitute an infringement, or to entitle the complaining party to protection. If the form, marks, contents, words, or the special arrangements of the same, or the general appearance of the alleged infringer's device, is such as would be likely to mislead one in the ordinary course of purchasing the goods, and induce him to suppose that he was purchasing the genuine article, then the similitude is such as entitles the injured party to equitable protection, if he takes seasonable measures to assert his rights and to prevent their continued invasion."

Imitations Tending to Deceive Buyer as to Identity of Manufactured Article

In another case, the Supreme Court has said: "There can be no question of the soundness of the plaintiff's proposition that, irrespective of the technical question of trademark, the defendants have no right to dress their goods up in such manner as to deceive an intending purchaser, and induce him to believe that he is buying those of the plaintiff's. Rival manufacturers may lawfully compete for the patronage of the public in the quality and price of their goods, in the beauty and tastefulness of their enclosing packages, in the extent of their advertising, and in the employment of agents; but they have no right, by imitative devices, to beguile the public into buying their wares under the impression that they are buying those of their rivals."

In a case decided by the Federal circuit court, the use of the word "cellonite" was enjoined because of its similarity to the word "celluloid." Said the court: "The defendant's name was of his own choosing and, if an unlawful imitation of the complainant's, is subject to the same rules of law as if it were the name of an unincorporated firm or company. It is not identical with the complainant's name. That would be too gross an invasion of the complainant's right. Similarity, not identity, is the usual recourse when one party seeks to benefit himself by the good name of another. What similarity is sufficient to effect the object has to be determined in each case by its own circumstances."

Use of the same descriptive word in the trade name or in connection with goods does not, in itself, amount to unfair competition. If the rival manufacturer goes a step farther and plainly labels all of his own goods with his own name, even in spite of his alleged similarity of device, it does not amount to unfair competition. In one case, it was shown that even the packages in which the goods were shipped were identical with that of the first manufacturer. The court refused to enjoin this, saying that by applying his own name to the product, in spite of the adoption of other similar characteristics, the alleged unfair competitor had absolved himself from the usual rules of law applicable to such cases.

Briefly stated, manufacturers are entitled to protection, in regard to trade names, in the following instances:

1. When they have a valid trademark, which has been properly registered in the manner prescribed by law.

2. When they have acquired a trade name, or the protection extended to an invalid trade name, as provided by statute.

3. When they have a device, not the proper subject of registration as a trademark, but one in which the courts will protect them from unfair competition, as indicated in the above instances.

Westinghouse Employment Department

Methods Used by the Westinghouse Electric & Mfg. Co., East Pittsburg, Pa., in Hiring Men and in Retaining an Efficient Working Force

By JOHN C. BOWER, Superintendent of Employment Department, Westinghouse Electric & Mfg. Co

In the September and October numbers of MACHINERY, the methods of job analysis used at the Westinghouse Electric & Mfg. Co.'s plant were described, the object of the job analysis being to insure that the right man is obtained for each job in the shop. The present article will deal more specifically with the methods used in the employment department, and the records that are kept. It shows how job analysis is applied to the hiring of men.

LITTLE need be said about the general requirements of an employment department, as this subject has been dealt with both in MACHINERY and in other publications at various times. The present article, therefore, will consist mainly of a review of the actual methods that are used by the Westinghouse Electric & Mfg. Co., in hiring and retaining efficient workers.

It has been found that men recommended by foremen or by other employes are desirable. In the case where a foreman recommends a man, he will feel a certain responsibility toward the new employe, and will assist in training him for his work. He will also try to retain the man, if he feels that he is responsible for his having been hired. Recommendations from other employes that are known to have the right qualities are also desirable, because it is likely that men of the right type would recommend only men whom they are certain would meet the requirements. A form printed on thin white paper and made up into pads is therefore used, on which men can be recommended for employment. It is of advantage to have a standard form so that the recommendation can be filed away for future reference, in case the applicant is employed. Pads with these blanks are distributed to the foremen, and whoever makes the recommendation will hand it to the applicant so that he, in turn, may present it when he applies for work at the employment department. Should the applicant not be hired, the reason is given on the recommendation blank, as indicated in Fig. 1, and the form is returned to the man who made the recommendation. If this is not done, it is likely to create resentment, and future recommendations would be discouraged; but when a just reason is given, there is no ground for complaint.

If in any instance a considerable number of recommendations are received from any one man, it is generally advisable to investigate his motives. Care should be taken that no cliques are formed in the plant, and that neither too many relatives nor too many men of the same nationality—if the men are of foreign birth—are employed in the same department. Most applicants, of course, apply for work without recommendations.

How the Needs for Men in the Shop are Determined

The employment department must, of course, have correct information as to the men needed in the plant at any one time. This information is obtained by having the foremen fill out a blank entitled "Advice of Workman Required." One blank is filled out for each job (not necessarily for each man needed). This form, as shown in Fig. 2, states the number of employes required for the job; gives the name of the occupation as determined by the standard occupation list, which was described in the September number of MACHINERY; gives the job analysis card number, also referred to in the former article; and such other information as is required by the employment department in order to make the proper selection.

It will be seen how much the problem of hiring the right man is simplified by having job analysis cards. All the foreman needs to specify is the card number, and the employment department knows exactly what kind of man is needed In a large shop, like the Westinghouse plant, employing some 20,000 men, this method is, practically speaking, indispensable.

Physical Examination

Before the applicant is definitely hired, he is given an examination in order to determine his physical fitness to fill the position for which he is to be hired. The physician making the examination should have a general knowledge of the work to be performed by the applicant, so that he would not permit the employment of anyone whose health would be endangered by his employment, or who would expose his associates to a contagious disease, or to danger through accidents caused by his own physical defects.

Application Blanks

The application blank used by the Westinghouse company (see Figs. 3 and 4) is a 4- by 6-inch index card on which

WESTINGHOUSE ELECTRIC & MFG. COMPANY
Recommendation to the Employment Department

I DESIRE TO RECOMMEND FOR EMPLOYMENT:—
NAME
ADDRESS
OCCUPATION
SIGNED DATE SEC. CHECK

IT IS UNDERSTOOD THAT THE PARTY RECOMMENDED WILL APPLY IN PERSON OR BY LETTER; E. M. WILL NOT BE SENT FOR BY THE COMPANY. THE EMPLOYMENT DEPARTMENT WILL PLACE THE APPLICANT TO THE BEST ADVANTAGE. THIS FORM CAN BE SENT TO THE EMPLOYMENT DEPARTMENT DIRECT OR BE PRESENTED BY THE APPLICANT

TO BE FILLED IN BY THE EMPLOYMENT DEPARTMENT

ENGAGE AS TO REPORT TO DATE
NOT ENGAGED (GIVE REASON AND RETURN TO PARTY WHO RECOMMENDED) REASON
DATE
EMPLOYMENT DEPARTMENT
FORM 5033-C

Fig. 1. Form used for recommending an Applicant for Employment

Form 1411-F

ADVICE OF WORKMAN REQUIRED

To the Employment Department

Date 191

Help as follows is required in Sec. *Dept.*

Number Required	Name of Occupation	Approximate Rate

INDICATE BY PLACING X IN SQUARE

Occupation Number and Class	Job Analysis Card No.	Day Turn	Night Turn	Premium Work	Piece Work	Task Work	Day Work	Length of Instruction Period

The above must be filled in to agree with Rate Book in Section requesting help.

Foreman Gen'l Foreman

Fig. 2. Form used by Foreman for specifying Help required

spaces are left for the following information: Date; occupation desired; full name; address; special experience; special education; names of concerns by whom last employed; positions held with those concerns; exact date of employment as to the month and year; place of birth; date of birth; nationality; education, whether common school, high school, college, night school, or correspondence school course; whether married, single, or widowed; number of children under sixteen years of age; number of dependents; height; weight; and citizenship. In case of foreign-born applicants, the question as to whether they have their first papers is also included, together with the date of first papers, and the number of years in the United States; and if they are citizens, the date of second papers; and in addition, the following questions: Have you ever worked for the Westinghouse Electric & Mfg. Co.? In what department did you last work? Have you ever worked for any other Westinghouse company? Have you ever served an apprenticeship, and for what trade? How long, and where? Do you keep house, board or live with your parents? Do you own your own home? Do you carry insurance—health, accident, or life? Do you speak or write English?

The questions are selected with the idea in mind of not asking anything which the average applicant would object to answering. An applicant's religion and the organizations to which he belongs are among the items that he may not want to disclose, as they are considered personal affairs and do not affect the employer or the applicant's status as an

FORM 5023-C

APPLICATION FOR POSITION

AS _____ DATE _____

STATE OCCUPATION DESIRED

Full Name

Address No. | Street | City | State

Have you ever worked for this Company | Last Dept. Worked in | Have you ever worked for any other Westinghouse Company?

Have you ever served Apprenticeship and for what trade? | How long and where?

Special Experience

Special Education

PREVIOUS EMPLOYMENT AND REFERENCE

GIVE NAME OF CONCERNS BY WHOM LAST EMPLOYED	POSITION HELD	GIVE EXACT DATE OF EMPLOYMENT AS TO MONTH AND YEAR

Fig. 3. Front of Application Blank

Place of Birth		Country or State		Date of Birth	
Nationality		White	Colored	Male	Female
Education	Common School	High School	College	Night School	Correspondence
Housekeeper?	Board?		Live with Parents?	Own your Home?	
Married?	Single?	Widowed?		Number of Children under 16 years?	
Height	Weight		Number of Dependents		
Do you carry Insurance?	Health	Accident	Life	None	
Speak or Write English?	Speak	Write	Both	Neither	
Citizen?	First Papers?		Date of First Papers		
Date of Second Papers			Years in U. S. A.		
Have you any Physical defects?	If so, What?				

Remarks:

Fig. 4. Back of Application Blank

employe. The other information obtained by means of the application blank, however, is useful in selecting the man and in determining, later, proper policies in dealing with the working force.

What is done after a New Man has been Employed

If the applicant is engaged, advice to this effect (Fig. 5) is sent with him to the foreman requiring his service. This blank gives the following information: The date; the name of the foreman; the name of the applicant; the job for which he has been selected; and his hourly rate, as well as the number of the job analysis card according to which he was selected. The applicant is also provided with a check and a button of identification, which is his pass to the plant. The record of his physical examination is also specified on this form. Should the physical examination indicate that the man is not fit to fill the job for which he has been first selected by the employment department, an effort is made to find some other suitable position, and if there is none available, his application is filed in a folder for future reference. An opportunity is also given the new employe to become a member of the Relief Department, which is usually accepted.

At the Westinghouse plant, it is considered of importance to have the foreman approve of the man tentatively hired by the employment department, because no foreman should be asked to have an employe in his department unless he is satisfied with him. This also applies to the applicant, who ought to be given an opportunity to know his foreman, as few employes would stay long on a job if they were not satisfied with the executives. In some cases, the foreman may want an interview with the applicant before he is considered by the employment department, in which case this request is granted. This arrangement, however, is seldom necessary.

When the applicant has been definitely accepted by the foreman, the latter keeps the form advising him that the man has been engaged until the applicant reports for work at the specified time. Should he fail to report, this is noted on the form by the foreman, and the form is returned to the employment department and will act as a new requisition for a man for the job, making it unnecessary to fill out another "Advice of Workman Required" (Fig. 2). If the applicant does report, however, a card as shown in Fig. 6 is sent to the accounting department, together with the advice of hiring (Fig. 5) that was previously sent by the employment department to the foreman. Form Fig. 5 is returned by the accounting department to the employment department, and Form Fig. 6 is retained as a record of the employe in the accounting department. The return of the form to the employment department is a notification that the applicant has definitely reported for work, and that the requisition for a new man is filled. The form is filed in a folder provided for each employe.

When hired, a booklet is given to the new employe of the various shop rules which must be followed in the Westing-house plant, and other items of information which are of value to him. All other information that the new man may require is also freely given to him by the employment department, and any questions that he may ask are answered.

Employment Department Cooperates in Setting Wage Rates

At the Westinghouse plant, all occupations are classified and standard rates of pay are determined in the manner explained in the previous articles. The employment department assists in this work and is in a position to note errors that may have been made. Attention is called to such errors, and suggestions are made for improvements required in the system to meet changing conditions. Sometimes the wage payment plans may make it difficult for the employment department to obtain the right kind of men. The suggestions offered by the employment department are taken up and discussed with the executives with a view to improving the system. It has been definitely determined by the company's experience that it is better to pay a high day rate with a comparatively low premium rate, than to pay a low day rate and a high premium rate. If the day rate offered to a new applicant is low, he will compare it with the prevailing rate in other plants, and may not be willing to take the chance of making up his day's pay on premium rates.

Taking Care of Complaints of Employes

An effective method has been installed in connection with the employment department for receiving and handling

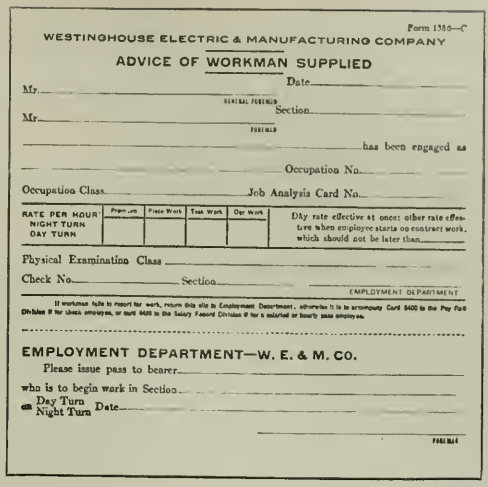
complaints made by employes. While the chronic complainer is not encouraged, it is recognized that all complaints should be investigated and that the employment department must be in a position where it can receive these complaints and properly look into their cause. This is done during the noon hour. The general superintendent is also present at the noon hour at the employment department for interviews with employes in the plant. Frequently grievances which would have grown into difficult problems have been received and adjusted at this time.

Transferring Men from Department to Department

It is often necessary to transfer a man from one department to another, either because the employe requests a transfer to more suitable or desirable work, or because the employe is no longer needed in one department, but may be advantageously employed in another. A special form, Fig. 7, is provided for this purpose also, which is filled in by the foreman to notify the employment department when a man desires a transfer or when his services are no longer required in the department where he works. On the back of the blank the foreman writes down his opinions as to whether the request should be considered or not, and gives his reasons. When the application for transfer has been received by the employment department, an investigation is made and the applicant for transfer is interviewed. In granting transfers, care should be taken never to show any partiality, and to grant transfers only when there is a good reason. Under the system of classification of jobs used by the Westinghouse Electric & Mfg. Co., men must sometimes be transferred to better jobs in order to obtain a higher rate of pay, the transfer being in the form of a promotion. When properly done, transfers to more suitable work prevent much discontent.

Reducing the Working Force

When it becomes necessary to lay off men in any one department, the employment department is notified on the same blank (Fig. 7) in advance of the contemplated lay-off, so that there is an opportunity to place the employe in some other department. This reduces the labor turnover and creates a feeling of appreciation on the part of the employe toward the plant. It is of importance to keep a man who has received special training in the plant, because later it may become necessary to reinstate him in his former position, when his services are required there. This method often obviates training new men. Discharges are also avoided as far as possible, even when a man does not prove satisfactory in a certain department. The foreman realizes that although a man may not prove satisfactory to him, he may fit into another department on a different line of work, and the transfer system aids in reducing the number of discharges.



Form 1356—C

WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY

ADVICE OF WORKMAN SUPPLIED

Date

Mr. _____ GENERAL FOREMAN Section

Mr. _____ FOREMAN has been engaged as

_____ Occupation No.

Occupation Class Job Analysis Card No.

RATE PER HOUR	Premium	Piece Work	Task Work	Day Work	Day rate effective at once; other rate effective when employee starts on contract work, which should not be later than
NIGHT TURN					
DAY TURN					

Physical Examination Class

Check No. Section

EMPLOYMENT DEPARTMENT

If workman fails to report for work, return this slip to Employment Department, otherwise it is to accompany Card 5400 to the Pay Roll Division if for check employes, or card 4400 to the Salary Record Division if for a salaried or hourly pass employe.

EMPLOYMENT DEPARTMENT—W. E. & M. CO.

Please issue pass to bearer

who is to begin work in Section

on Day Turn / Night Turn Date

FOREMAN

Fig. 5. Notice sent to Foreman when Employe is hired

Efficiency Records of Employes

The employment department maintains a record of every employe, which gives the employe's name; the rate of his advancement in the organization; the number of times he has been employed, if he has returned after having once left; the departments he has worked in; and the length of his service, whether intermittent or continuous. Other information of value is also included, and the record is referred to in case an ex-employe returns for employment. This record is also used by the employment department in considering transfers and in dealing with complaints. At the Westinghouse plant, this record is made in the form of a folder so that it can be used for filing within it the application card and other forms relating to the employe.

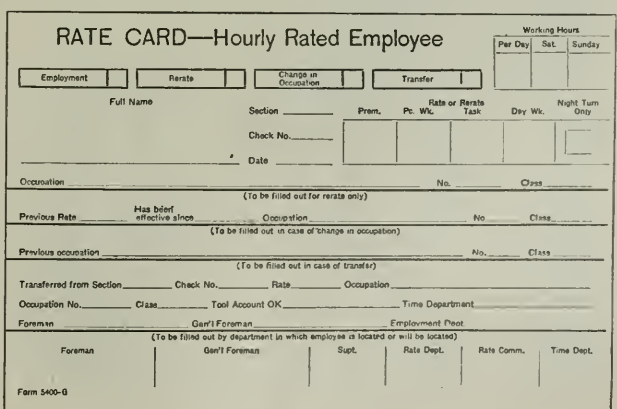
A record of service is also kept on a card, 4 by 6 inches. This record, Fig. 8, gives the most essential information about the employe, and contains an analysis of his characteristics. This form is provided at the time the applicant is employed, and filled in from time to time with the required information. When the employes know that a record is being kept of their efficiency and that this record is the determining factor in selecting them for promotion or increasing their pay, its effect is marked. It is also possible to promote systematically and with fairness. In case an employe complains because he is not promoted, the record furnishes generally an answer to his complaint. If the employe leaves the company and returns for re-employment, this record is also valuable in determining whether or not he ought to be re-employed.

How to Reduce the Labor Turnover

In order to reduce the labor turnover, the employment department should obtain the real causes for men either leaving their employment voluntarily or being dismissed. These causes should be classified into four main heads, as follows: Other positions; dissatisfied; discharged; and unavoidable. These main causes may be further subdivided as follows:

Other Positions—Better position; former position; going into business for himself; higher pay elsewhere; work nearer home; leaving to learn a trade.

Dissatisfied—Earnings too low; general human environment in plant; living conditions; nature of work; objection to foreman; unsafe or unsanitary



RATE CARD—Hourly Rated Employee

Working Hours: Per Day | Sat. | Sunday

Employment | Rerate | Change in Occupation | Transfer

Full Name

Section Prem. Rate or Rerate Pc. Wk. Task Day Wk. Night Turn Only

Check No.

Date

Occupation No. Class

(To be filled out for rerate only)

Previous Rate Has been effective since Occupation No. Class

(To be filled out in case of change in occupation)

Previous occupation No. Class

(To be filled out in case of transfer)

Transferred from Section Check No. Rate Occupation

Occupation No. Class Tool Account OK Time Department

Foreman Gen'l Foreman Employment Dept.

(To be filled out by department in which employee is located or will be located)

Foreman | Gen'l Foreman | Supt. | Rate Dept. | Rate Comm. | Time Dept.

Form 5400-G

Fig. 6. Card sent to Accounting Department as a Permanent Record

conditions; night work; working with colored men; wanting to make a change. Absence for two weeks without giving any reason is also placed in this class.

Discharged — Carelessness; dishonesty; disobedience to shop rules; incompetency; intemperance; irregular attendance.

Unavoidable—Lack of work; death; returning to school; home conditions; pensioned on account of age; sickness.

The labor turnover may be materially decreased if the real reasons for leaving the work in the plant are determined, so that conditions within the plant may be corrected to prevent good men leaving in the future. The employment department interviews every man who gives notice that he expects to leave, and encourages him to remain. The interview, to be effective, must be obtained while the employe is still at work and should be arranged as soon as possible after notice has been given that the man expects to leave. In order to provide for sufficient time to encourage the employe to remain, a notice of three days is required of the men who expect to leave, before they will be able to get their pay. The same blank (Fig. 7) that is used for reporting transfers is also used for giving notice of leaving the employ of the company. This notice is given to the foreman, who, in turn, fills out the blank and sends it to the employment department. When the reasons for quitting indicate that unsatisfactory conditions exist in the department where the man is working, an investigation is made by the employment manager and the facts, if necessary, are reported to the executive who has authority to remedy the conditions.

REPORT ON EMPLOYEE— Form 5931-A

Date_____ 191

Name_____ Sec._____ Chk. No._____

Address No._____ Street_____ City_____ State_____

Occupation_____ Occupation No._____ Class No._____

Hourly Rate | Average Earned Rate Last Three Months | Dept. Rating

THE ABOVE NAMED EMPLOYEE Check a, b, c, d, e, as case may be and fill in date

a ☐ Desires a Transfer

b ☐ Desires to leave the Employ of the Company with Notice on_____ Date 19___

c ☐ Desires to leave the Employ of the Company without notice_____ Date 19___

d ☐ Has not reported for work since_____ Date 19___ and has not been reported to Relief Dept. as being sick or injured.

e ☐ Service not (Required) (Desired) after_____ Date 19___

Member of Relief Dept.?_____ Relief Dept. No._____ Relief Dues_____

_____ Foreman _____ Employee

_____ Gen'l Foreman _____ Pay Roll Division

_____ Ch. Cost Clerk _____ Relief Dept.

(GIVE REASONS ON BACK OF CARBON COPY)

TO BE FILLED IN ONLY BY THE EMPLOYMENT DEPARTMENT

☐ Quit With Notice ☐ Quit Without Notice ☐ Laid off Reduction of Force ☐ Transferred ☐ Discharged

Date_____ 19___

_____ Employment Department

Fig. 7. Form used for reporting on Transfers, Leaving Company's Employ, etc

Method of Discharging Employes

In discharging employes, a notice is sent by the foreman of the plant to the employment department, as mentioned. The employe is entitled to a hearing by the employment manager before being definitely discharged. This method has proved to be satisfactory to all concerned, as it places upon the employment department the responsibility of the discharge and does not prevent this department from placing the employe somewhere else in the plant, should this seem advisable. The foremen like the arrangement because it removes from them the responsibility of discharge, but allows them, at the same time, the privilege of deciding who should remain in their departments. If a foreman is unfair in dealing with an employe, this will generally be disclosed by the investigation made by the employment manager. The employment manager is assisted in this work by an adjustment committee appointed by the management.

When men are dismissed during slack periods, a record of their addresses is kept so that they may be communicated with as soon as a need for men again arises. This makes it possible to rehire many old employes who have been given the proper training for the work for which they are required.

Reports to the Management

A brief monthly report giving the most important items relating to the employment department is sent each month to the executive management of the plant. At the end of each year a general report is made of the work, which also contains suggestions concerning possible improvements in the plant and its systems, with a view to making it easier to hire and hold a desirable class of men.

Kinds of Forms to Use in the Employment Department

A detail that may seem of small importance, but which has been found to require attention, is that of selecting the proper kinds of forms and using the proper kinds of paper for the forms, in order that the records kept may be as useful as possible. When forms are to be filled in with ink, the paper should be such that it will take writing well. All forms to be made out in duplicate should be put up in pad form. White paper is the best for all blanks, as it provides records that are most easily read. When there are a number of questions on the form, the space should be so blocked off that the answers to one question will not be confused with the answers to another. As far as possible, questions should be so asked that a simple check mark is all that is necessary for an answer. If this is not possible, a simple "yes" or "no" is all that should be required. Whenever the same form can be adapted for use for two purposes, it is well to do so, in order to reduce the number of forms. Most forms can be made of the standard 4- by 6-inch index card size.

SERVICE RECORD—WORKS EMPLOYEE Form 6005-C

Name in Full | Address (in Pencil)

Country of Birth | Date of Birth | U. S. Citizen | Dependents | Date Last Employed

Date	Occupation	Number	Class	Section	Check Number	Contract Rate	Day Rate

Grade

Date of Rating | Performance: Accuracy, Carefulness, Knowledge, Skill, Speed, Total | Characteristics: Adaptability, Dependability, Industry, Character, Tact, Total | Intelligence: Analytical, Common Sense, Perception, Resourceful, Teachable, Total | Physical Qualities: Activity, Endurance, Health, Physique, Strength, Total | Leadership: Self Expression, Initiative, Judgment, Self Confidence, Self Control, Total | Grand Total

Fig. 8. Employe's Service Record Card

Production Milling on Automatic Machines

Advanced Practice in the Milling of Duplicate Parts—Third Installment

By EDWARD K. HAMMOND

IN the June number of MACHINERY a description was published of the "Ohio" tilted rotary milling machine which had just been placed on the market at that time by the Oesterlein Machine Co., of Cincinnati, Ohio. Provision has been made in the design of this miller to enable it to be operated on either the continuous rotary or the indexing principle. Continuous rotary milling has already been fully discussed in this series of articles on milling practice, so that further reference to the subject is unnecessary. When used as an indexing machine, two or more work-holding fixtures are mounted at the periphery of the circular table of the "Ohio" miller, and a suitably arranged mechanism provides for alternately indexing the table to bring the next piece of work into the operating position, and then feeding the cutter-head in toward the center of the table, so that the cutters are fed across the work. Such an arrangement enables a high rate of production to be attained, because a number of pieces of work may be mounted around the periphery of the table, and the table may be indexed at high speed to bring the successive castings or forgings into the milling position. The cutter-head is also withdrawn from the work at high speed, the slow-feed movement being utilized only during the actual cutting. The operator of this machine is only required to remove the finished pieces of work from the fixtures and set up fresh blanks, so that there is virtually no idle time of either the machine or its operator.

Milling Yoke Forgings on "Ohio" Indexing Milling Machine

Fig. 1 shows a machine equipped with two work-holding fixtures arranged for operation on the indexing principle. This machine is used at the plant of the Stuebing Truck Co., Cincinnati, Ohio, for straddle-milling the outside faces of cast-steel yokes. The advantage secured by the indexing principle of operation is quite apparent in this case, because if the machine were used as a continuous rotary miller, a great deal of time would be lost in moving the table through practically a complete semicircle between each of the milling cuts. As the cuts are quite short, the percentage of idle time would be very high, especially in view of the fact that a low rate of feed must be used in milling these steel castings. The illustration shows the machine just as it is about to commence the straddle-milling operation. The spindle head carrying the straddle-mills will feed radially toward the center of the table, until the cut is completed, after which a dog will automatically trip the feed movement and engage a rapid return mechanism which will carry the cutters quickly out of engagement with the work. At the same time, the table indexing mechanism will be automatically engaged, causing the table to be quickly moved through a half revolution, ready for milling the next casting which has been set up in the fixture at the opposite side of the table. While this piece is being milled, the operator will remove the finished piece and substitute a fresh blank in its place.

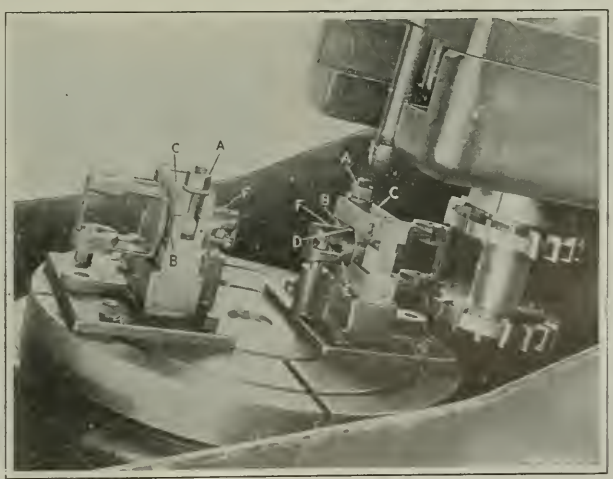


Fig. 1. Straddle-milling Yoke Forgings on "Ohio" Tilted Rotary Milling Machine operated on Indexing Principle

On this job, it is of great importance to provide work-holding fixtures with a quick-acting clamping mechanism, because the time required to take the cut on these forgings is quite short, so that the operator has only a limited period in which to remove the milled yoke, and to set up a rough forging in its place. For this purpose, it is merely necessary for the operator to turn nut *A* through about half a revolution, after which the bolt may be swung on pivot *B* to enable strap *C* to be raised. On the under side, it will be seen that this strap carries a V-block *D* that fits over the top of the forging; and on its under side, the forging is supported by a similar V-block *E*. Endwise location of the work is provided by a pilot *F*, which fits through a hole that has previously been drilled in the inner end of each forging. After the milled piece has been removed from the fixture, the operator sets up a new forging by merely slipping it over pilot *F* and then dropping strap *C* into place on top of the forging. The clamping bolt is next swung up into the slotted end of strap *C*, after which nut *A* is tightened. Very little time is required for unloading and reloading the fixture. On this operation, the time taken in milling one forging is forty seconds; that is to say, the rate of production is ninety forgings per hour.

Operations on Potter & Johnston Indexing Milling Machines

Before entering upon a discussion of the methods of handling those milling operations that can be advantageously done on the indexing type of machine built by the Potter & Johnston Machine Co., Pawtucket, R. I., it will be

well to present a brief description of features of this miller. From Fig. 2 it will be seen that two parallel work-holding tables are provided, which are mounted at a fixed height from the floor on a circular indexing turntable that provides for bringing the two work-holding tables alternately into the operating and loading positions. This arrangement enables the shop using a milling machine of this type to secure the usual benefits of the so-called "continuous-production" machines; namely, that the operator loads the work in the fixtures mounted on one table, while the cutters are working on pieces held in fixtures on the other table, so that both the machine and the operator are kept constantly employed, except for the brief intervals during which the machine is indexing. The finished work is not moved back under the milling cutters, and as a result, there is no danger of marring the finish of the work in making such a return movement of the table. By mounting the spindle on a slide carried by the column, provision is made for obtaining vertical adjustment of the position of the spindle; and the column is carried by a horizontal slide which affords transverse adjustment for the spindle, so that any desired position on the table can easily be reached.

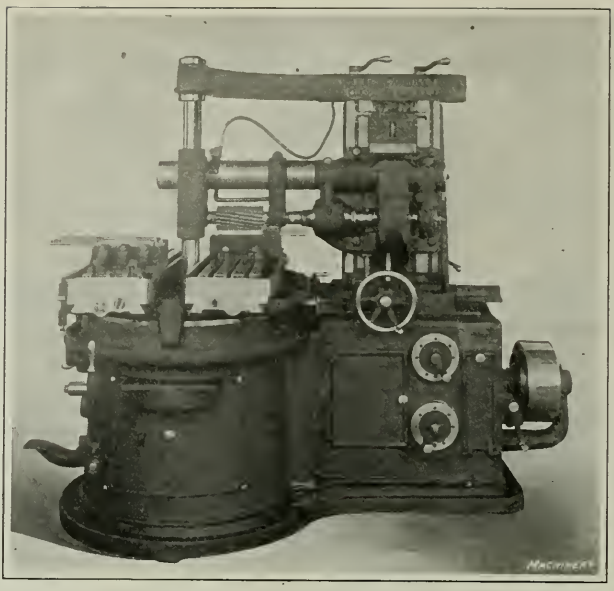


Fig. 2. Automatic Indexing Type of Milling Machine built by the Potter & Johnston Machine Co.

Milling a Turret Revolving Pawl

Fig. 3 shows two views of the finished turret revolving pawl after being milled, and also diagrams indicating the manner in which successive milling operations are performed in making this part. According to the method of procedure used at the plant of the Potter & Johnston Machine Co., there are nine operations required for the production of each of these pawls. The first eight are milling operations, and these will be discussed in detail; but as the final operation consists of drilling and counterboring a hole in the pawl, no consideration will be given to this part of the work. The machine steel from which these pawls are made is delivered to the milling department in blocks measuring 10 3/16 inches long by 2 inches high by 1½ inches thick. Each of these pieces of steel contains sufficient material for making two pawls, a piece 5 inches in length being required for each pawl, while 3/16 inch is allowed for the kerf removed by a parting tool. The reader will obtain the best idea of the way in which the successive operations are performed on these parts by referring to Fig. 3, which shows in diagrammatic form the successive steps that are involved. Operation 1 consists of squaring up the four sides of each steel blank, so that they are at accurate right angles to each other. After this has been done, the second operation is to part the blanks at the center, in order to produce two pieces, each of which is 5 inches in length.

Some of the methods employed in tooling up the Potter & Johnston indexing rotary milling machines for the performance of operations on these pawls are quite unusual, and as they are the means of effecting substantial reductions in production costs on those operations where they are em-

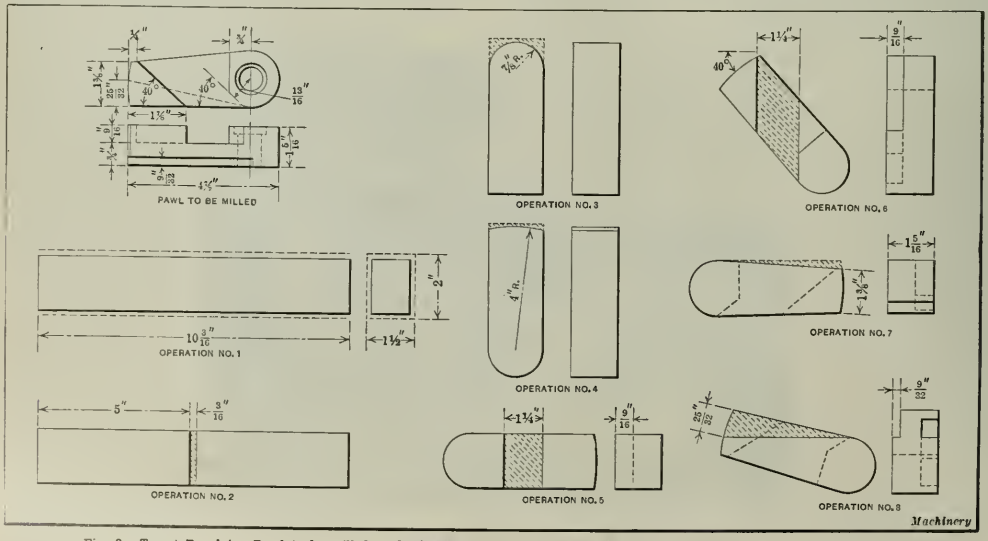


Fig. 3. Turret Revolving Pawl to be milled, and Diagrams showing Successive Milling Operations to be performed on this Part



Fig. 4. Indexing Milling Machine equipped for performing Third and Fourth Operations on Turret Revolving Pawls

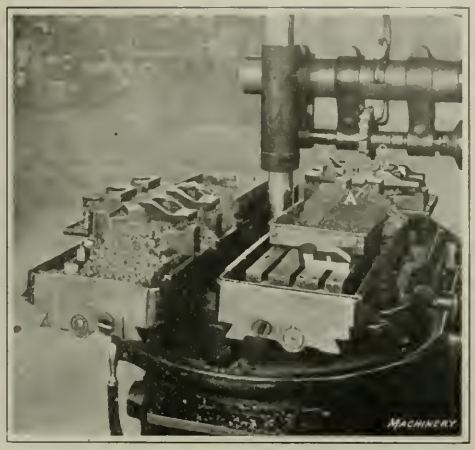


Fig. 5. Indexing Milling Machine equipped for performing Fifth and Sixth Operations on Turret Revolving Pawls

ployed, special emphasis will be laid upon such features in order that the readers of MACHINERY may fully appreciate their importance, and consider the possibility of applying similar methods in handling milling operations in their own shops. A case in point is seen in the provision made for performing Operations 3 and 4, as indicated in the diagrams shown in Fig. 3. The machine used for the performance of both of these operations is illustrated in Fig. 4, where it will be noticed that provision is made on a single machine for simultaneously performing two operations. Two concave or formed milling cutters finish the upper and lower edges of the blanks to a radius of ⅞ inch and 4 inches, respectively.

It will be apparent that the fixture mounted on each of the work-holding tables of this Potter & Johnston milling machine provides for holding two rows of five pieces each, so that at every traverse of the table ten pieces are milled, five on the upper end and five on the lower end. Then the turntable is indexed to bring the fixture carrying these milled pieces around to the loading position. Very little thought will make it apparent that five of these pieces have been milled at both the top and bottom, while the other five have only been milled at the top. As a result, five finished pieces are removed from the fixture, and the other five, which have only been milled at the top, are taken out of that side of the fixture in which they were held for the third operation, turned over end for end, and replaced in the opposite side of the fixture, on the same table, ready for performing the fourth operation. Then five other pieces are set up in the other side of the fixture ready to have the third operation performed on them. After milling operations have been performed on the pieces carried by the fixture mounted on the other work-holding table, the machine will be indexed to provide for milling the pieces that have just been set up. The fixtures for holding the work for milling are of quite simple design. It will be recalled that the blanks have already been faced off on all four sides, and in setting them up for the third and fourth operations, five blanks are secured in each side of the work-holding fixture. By tightening set-screws *A*, these pieces of work are pushed back against blocks *B*, which support the thrust of the milling cutters. Then as an additional means of steadying the work and holding it down in the fixture, five set-screws *C* are provided at each side, and tightened against the work.

As in the case of Operations 3 and 4, a single Potter & Johnston indexing type of milling machine is employed for the performance of Operations 5 and 6. The fifth operation consists of milling a transverse slot 1¼ inches wide by 9/16 inch deep across one side of the work; and after this has been done, a diagonal slot of the same depth and 1¼ inches in width is milled at an angle of 40 degrees to the sides of the blank. The result produced by the combination of these two milling operations is to form one side of the pawl, as

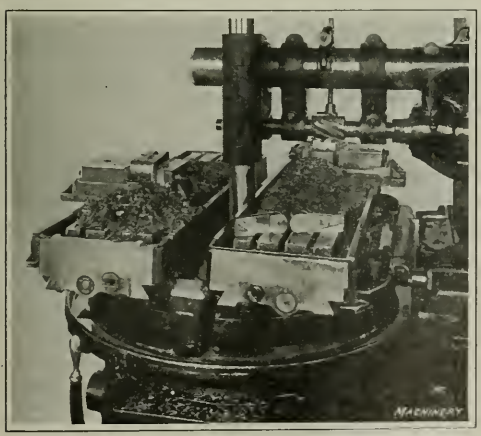


Fig. 6. Indexing Milling Machine equipped for performing Seventh Operation on Turret Revolving Pawls

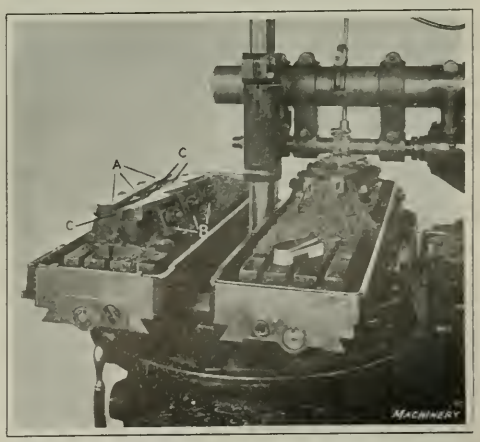


Fig. 7. Indexing Milling Machine equipped for performing Eighth Operation on Turret Revolving Pawls

shown at the upper left-hand corner of Fig. 3. A milling machine equipped for performing Operations 5 and 6 is illustrated in Fig. 5, but the provision made in this case for handling two successive operations on a single machine is somewhat different from that which was shown in the preceding illustration. In the present instance, only one milling cutter is required on the arbor, and the performance of the fifth and sixth milling operations with this cutter is accomplished by setting the work at different angles for handling the two operations. On the work-holding table shown at the right-hand side of the machine in Fig. 5, it will be seen that the fixture provides for holding the pieces at right angles to the direction of travel of this table, so that a straight slot is milled across the work, as indicated diagrammatically for the fifth operation in Fig. 3. At the left-hand side of the machine, a similar form of work-holding fixture is provided, except that this fixture holds the pieces inclined at an angle of 40 degrees to the direction of travel of the table. The pieces milled while held in the fixture mounted on the right-hand table are taken out when this table is indexed to the loading position, and they are then set in the

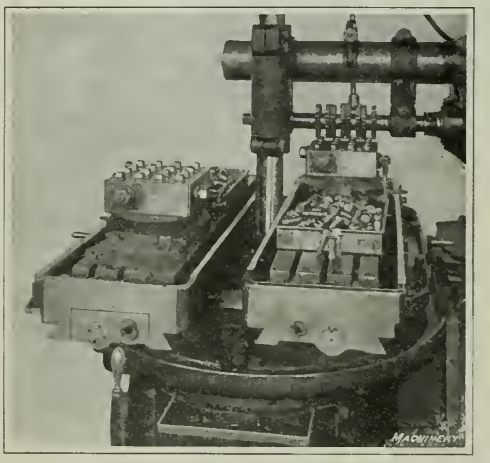


Fig. 8. Indexing Rotary Milling Machine equipped for squaring Heads of Cap-screws

fixture on the other work-holding table, ready for the performance of the sixth operation, as indicated in Fig. 3.

It will be apparent from Fig. 5 that the work-holding fixtures provided at both sides of the machine are of simple design. They have thrust blocks *A*, which serve the double purpose of supporting the work against the pressure of the milling cutter, and also locating the pieces to be milled at the proper angle to the direction in which the table travels. Obviously, the thrust block will be at right angles to the direction of table travel for the fifth operation, and inclined at an angle of 40 degrees for the sixth operation. After the pieces of work have been located against these thrust blocks, they are held down by means of straps *B*, which are made of sufficient width so that each strap holds two pieces of work. Four pieces are held in each fixture, so that the milling operation can be performed on all of them at a single setting of the work.

Operation 7 consists of milling one side of the turret revolving pawl to a slight taper angle, and for the performance of this operation the Potter & Johnston milling machine is equipped as shown in Fig. 6. It will be evident that the fixture carried by the work-holding table at each side of the machine consists of a milling vise of standard design, which holds two pieces of work. The only special feature of each of these vises is that a tapered block is placed between the jaws, and the work to be milled is laid on this block before the jaws are tightened. In this way, provision is made for inclining the sides of the two pieces of work at such an angle, that the regular horizontal movement of the table results in milling off one side of the work to the desired angle of taper.

The eighth and final milling operation performed on these pieces, consists of milling the opposite edge of the pawl in the manner indicated in Fig. 3. Here it will be seen that the cut to be taken is 9/32 inch deep, and that it is taken at an angle to the parallel edge of the work, thus sharpening the wedge-shaped form of the highest portion of this side of the pawl. Fig. 7 shows the equipment of a Potter & Johnston milling machine for the performance of this operation. It will be seen that the work-holding fixture mounted on each of the tables is so designed that provision has been made for mounting six pieces of work in each fixture. The fixtures on both tables are of identical design, and it will be apparent that each has two rows of work *A* mounted in it. Two rows of straps *B* hold these pieces; and the proper location of the work is obtained by means of center blocks *C* against which the work is clamped, to obtain the proper inclination with the direction of travel of the work-holding table.

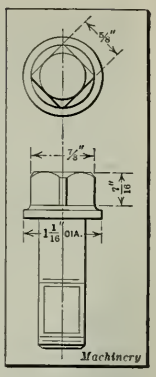


Fig. 9. Cap-screw

It will be seen that two inserted-tooth milling cutters are mounted on the arbor, and these are located in such a way that a single traverse of the table provides for milling the two rows of pieces of work on their inner edges. In order to perform the operation in this way, it will be evident that the work must be set up in the fixture with the ends of the pieces in one row facing in the opposite direction to the ends of the pieces in the other row held by the same fixture. On each fixture there are a block *D* and a pin *E*, which support the pieces of work at the ends of the two rows, so that the thrust of the milling cutters will not have a tendency to cause these pieces to alter their position in the fixture.

For the performance of these eight successive milling operations, individual production times have not been tabulated, but the rate at which fully milled turret revolving pawls are produced is three per hour. The material is machine steel, and in accordance with the usual practice, the cutters and work are supplied with a copious flow of a cutting emulsion made of soluble oil and water. This is an important point in milling steel, because the tendency of the work to become heated will make it impossible to operate under maximum conditions of production, unless such a precaution is taken.

Straddle-milling Bolt Heads on Potter & Johnston Machine

It is for such work as the milling of duplicate parts which are made in large quantities, that the Potter & Johnston automatic indexing milling machine is able to show the greatest saving in production costs. An example of such work is shown in Fig. 8, which illustrates one of these machines set up for straddle-milling bolt heads. It will be apparent from this illustration that each work-holding table is provided with a fixture that carries sixteen bolts in four rows of four bolts each. On the arbor of the milling machine there is mounted a gang of eight cutters with spaces left for traversing the four rows of bolts between them, to mill the flats on opposite sides of the heads. After this has been

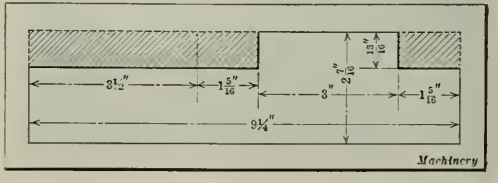


Fig. 10. Turret Revolving Pawl Block on which Milling Operations are performed by Machines shown in Figs. 11 and 12

done, the turntable is indexed to bring the opposite work-holding table and fixture into the milling position. The bolts which have already been fed between the cutters have been milled on two sides of their heads, and to provide for milling the other two sides, each work-holding fixture is mounted on a pivot and provided with an index mechanism, so that it may be swung through an angle of exactly 90 degrees.

When the operation has been completed on the work mounted in a fixture on one side of the turntable, the machine is indexed to bring the opposite fixture into the milling position. By feeding the bolt blanks between the cutters a second time, the remaining two sides of the heads are milled, thus finishing the operation. The possibility of indexing the entire fixture in order to provide for milling the second pair of sides on the bolt heads, instead of having to remove all of the pieces from the fixture and reset them in the required position for the second operation, is naturally the means of effecting a substantial saving in the amount of time required for milling these parts. With the equipment illustrated in Fig. 8, the rate of production attained is 160 milled bolts per hour.

Milling Turret Revolving Pawl Blocks

Fig. 10 shows a piece known as a turret revolving pawl block, which is produced in large quantities at the plant of the Potter & Johnston Machine Co., Pawtucket, R. I. This job is one which may be advantageously handled on an indexing type of milling machine of this company's manufacture. Figs. 11 and 12 show machines equipped for the performance of two successive milling operations on this piece. For the first cut taken on the machine shown in Fig. 11, it will be evident that the work-holding table at each side of the turntable is equipped with a fixture that provides for holding four of the steel blanks from which these turret revolving pawl blocks are made. This first cut consists of removing a section of metal from one end of the blank, which is 3½ inches long by 13/16 inch in depth.

It will be seen that on the machines shown in both Figs. 11 and 12, the work-holding fixtures are of essentially the same design, and that each fixture provides for holding four of the blanks for turret revolving pawl blocks. The fixtures are of simple design, consisting of two walls *A* at right angles to each other, against which the four blanks are located to bring them at exactly right angles to the direction of travel of the table. One of these two walls of the fixture also serves to support the four blanks against the thrust exerted by the milling cutters. It will be seen that at each of the other two sides of the fixture, there are two straps *B* which are tightened to locate the work firmly against the two opposite walls, to which reference has just been made. These straps are placed at an angle, so that they serve the additional purpose of forcing the work firmly down on the bed of the fixture.

Referring to Fig. 11, it will be seen that the arbor of the milling machine carries three inserted-tooth cutters, which are of sufficient width to provide for taking the preliminary cut that is 3½ inches in length by 13/16 inch deep. The position of this cut is indicated by dotted lines in Fig. 10. For the second operation on these parts, the work is set up in the machine shown in Fig. 12, where it will be seen that two pairs of inserted-tooth milling cutters are mounted on the arbor to provide for taking a cut 1 5/16 inches in width by 13/16 inch deep at each end of the high portion that still remains on the blank, thus bringing it to the condition shown in Fig. 10. In setting up these two machines, it will be noticed use is made of two gangs of two milling cutters, in Fig. 12; and of a gang of three cutters, in Fig. 11. The reason for using these gangs of cutters with interlocking teeth, instead of employing a single cutter in each case, is that the spiral angles of the teeth of cutters comprising such a gang can be opposed to each other, thus neutralizing much of the end thrust on the work; and in addition, such a method of setting up cutters on an arbor allows the action of the milling machine to be smoother than would otherwise be the case. It will be seen that this principle of using a gang of cutters in place of one, has been quite generally employed in setting up the Potter & Johnston machines for the performance of those milling operations which have been discussed. For the operations performed on the machines shown in Figs. 11 and 12, the rate of production is fourteen completely milled turret revolving pawl blocks per hour.

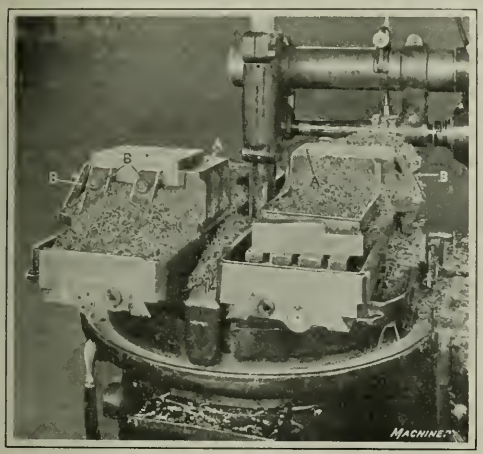


Fig. 11. Indexing Rotary Milling Machine on which the First Operation is performed on the Turret Revolving Pawl Block

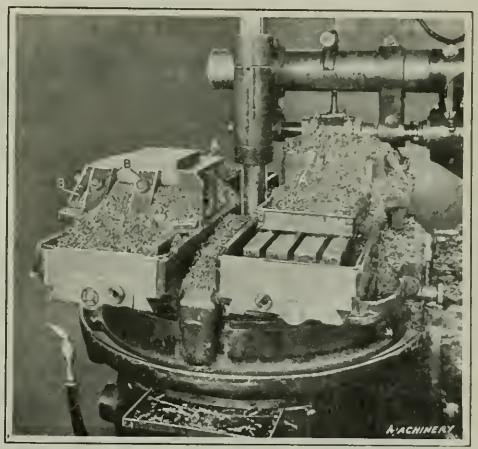


Fig. 12. Indexing Rotary Milling Machine on which the Second Operation is performed on the Turret Revolving Pawl Block

* * *

The United States Railroad Administration, in a circular recently issued, calls attention to the cooperation that manufacturers can give the railroads in order to prevent car shortage during the coming winter. In this circular, it is mentioned that shippers and receivers of freight can assist the railroads, and their own industries as well, by loading all cars to the full possible or carrying capacity, by prompt loading and release of cars, by ordering cars only when actually required, by eliminating the use of railway equipment in transfer service that can be handled equally well by motor truck, by reducing the diversion and reconsignment of cars to a minimum, by promptly unloading cars, by ordering goods in quantities representing the full carrying capacity of cars, by ordering from the nearest available source, and by pooling orders so as to secure full car loads.

Designing Change-Gears

Calculations Involved in Designing Change-gear Mechanisms for Machine Tools so that Speeds will Vary in Geometrical Progression

By W. C. STEUART

PRACTICALLY all machinists and shop men, and the great majority of draftsmen and designers as well, know little of the calculations involved in designing a series of change-gears for a machine tool. Perhaps there has been a reluctance on the part of those who understood the subject to impart their knowledge to others. The writer

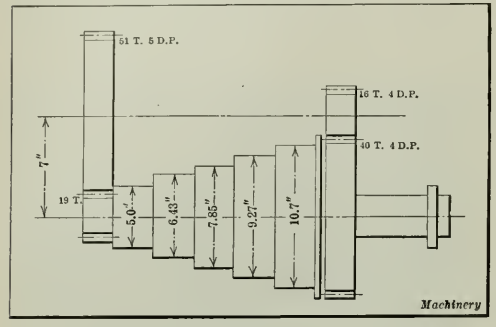


Fig. 1. Designer's Sketch of Cone Pulley and Back-gearing of Lathe Headstock

has seen designers who had this work in hand, and yet who knew so little of the simple mathematical principles that govern the matter that they would figure for days in a haphazard cut-and-try fashion. The result was often a series of irregularly progressing speeds or feeds, frequently overlapping in one or more places. These overlaps or duplications of speeds were regarded as unavoidable.

In most calculations with which the designer has to do, the slide-rule is a great time-saver, but those who do not understand it need not despair, for with a table of geometrical progression ratios at hand, nothing more obtruse than an occasional recourse to square root will be required of them. It is not the intention to deal with any given set of change-gears to be applied to a particular kind or size of machine tool, but merely to explain the methods that may be followed in practically all cases. Indeed a comparison of machines of the same size and for the same purpose as offered by different builders discloses an astonishing variation in the number and range of speeds and feeds afforded by the various designs. A perusal of the catalogues of any of the well-known lathe builders will confirm this. The designer must be guided in each instance by his knowledge of what others are doing along the same line, the latest practice in the most progressive shops, and the recent developments in tool steels. Occasionally, the requirements of some particular customer will have considerable weight in deciding the matter; especially in the case of machines originally designed as special machines and afterward put on the market. The best plan of all in the case of a standard line of machines is to find out what the other fellow is offering and try to improve upon his machine. This does not mean to steal all or a part of his design, but merely to find out how far we have to go to outdo him. Of course it is impossible to work up a line of standard machine tools without adopting features that appear in other machines, for if new machine tools were so made, they would probably be regarded as freaks, and would be unsalable.

Speed Calculations for Lathe Headstock

We will begin with one of the simplest and most familiar of varying speed propositions—the lathe headstock with the stepped cone pulley and simple back-gears, as in Fig. 1. The headstock is to have a five-step cone with back-gears, giving ten speeds in all, and the speeds are to range from 300 down to 10 revolutions per minute.

The first thing to determine is the geometrical progression of ten numbers from 1 to 300. Perhaps it may be well to explain the difference between geometrical and arithmetical progression, as this is a thing one generally forgets immediately after learning it, like algebra, unless one has use for it. Numbers in arithmetical progression progress by adding a constant number: as 2-4-6-8-10-12, etc., while numbers in geometrical progression progress by multiplying a constant ratio: as 2-4-8-16-32-64, etc., the numbers given having a ratio of 1 to 2. It is in this latter manner that the speeds and feeds of machine tools usually progress.

Now returning to the lathe headstock, we proceed to find the speeds either by logarithms, by the use of tables, or by the slide-rule method which was explained in a recent number of MACHINERY. (See "Calculating Geometrical Progression," June, 1919, page 973). We find that to have speeds from 10 to 300 revolutions per minute, ten in number, we must use a ratio of 1.46, which on multiplying gives the results shown in the first column of Table 1. Five of these speeds are obtained from the five-step cone. The function of the back-gear is to double the speeds, making ten in all. We have decided, from observation or experience, that the least practicable diameter for the smallest cone step is 5 inches. This gives a starting point from which all the other

TABLE 1

Speeds Varying in Geometrical Progression	Speeds Actually Obtained
10..... = 10.0	9.7
10 × 1.46 = 14.6	14.5
14.6 × 1.46 = 21.3	21.0
21.3 × 1.46 = 31.0	30.0
31 × 1.46 = 45.3	45.0
45.3 × 1.46 = 66.0	65.0
66 × 1.46 = 96.4	97.0
96.4 × 1.46 = 140.5	140.0
140.5 × 1.46 = 205.0	202.0
205 × 1.46 = 299.3	300.0

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cone steps may be calculated, as their ratios must be to one another as the ratios of their speeds.

The highest speed is obtained, of course, when the belt is driving from the largest step of the countershaft cone to the smallest step of the headstock cone and the back-gear is out of mesh. It is customary to make the countershaft and headstock cones alike; consequently the two middle steps will be of the same diameter, which makes the countershaft speed the same as the middle speed of the cone, without the back-gears, or 140.5 revolutions per minute. The size of the largest step may be obtained by the following formula:

$$\text{Diam. largest step} = \frac{\text{Max. spindle speed} \times \text{Diam. smallest step}}{\text{Speed of countershaft}}$$

Applying this formula we have:

$$\text{Diameter of largest step} = \frac{300 \times 5}{140.5} = 10.7 \text{ inches}$$

The middle step should next be determined. It is the sum of the large and the small diameters divided by 2:

$$5 + 10.7 \div 2 = 7.85 \text{ inches}$$

The second largest step will be the mean between the middle and the largest step:

$$7.85 + 10.7 \div 2 = 9.27 \text{ inches}$$

The second smallest step in like manner will be:

$$5 + 7.85 \div 2 = 6.43 \text{ inches}$$

The back-gears obviously must be of such ratio as to reduce the first five speeds to a second or slower five. The ratio between the slowest of the first five and the slowest of the second five is as 10 to 66 revolutions per minute or 6.6 to 1. As the back-gear consists of two pairs of gears, this ratio is the product of their respective ratios, and we must extract the square root to find what these respective ratios may be. The square root of 6.6 is 2.56. Therefore the ratio of each pair of gears should be 2.56 to 1. We may now proceed to find the number of teeth in the gears. It is customary to make the gears next to the faceplate of heavier pitch, as they are the slowest running and consequently transmit the most power, or to speak more correctly, they have the greatest tooth pressure. Suppose we find by calculation, experience, or comparison with other makers (the last two methods are the best) that the faceplate gears should be 4 diametral pitch and the back-gear shaft admits of using a 15-tooth pinion. Then:

$$15 \times 2.56 = 39 \text{ teeth, approximately}$$
$$15 \div 4 = 3\tfrac{3}{4} \text{ inches pitch diameter}$$
$$39 \div 4 = 9\tfrac{3}{4} \text{ inches pitch diameter}$$

One-half of the sum of the pitch diameters, or $6\frac{3}{4}$ inches, equals the center-to-center distance. . So far the process is simple, but here we strike one of those snags with which every designer is familiar; we wish to make the other pair of gears 5 diametral pitch, but 5 diametral pitch gears will not fit into $6\frac{3}{4}$-inch centers. The solution of the problem is to make the faceplate gears with 16 and 40 teeth, respectively, which will make the centers an even 7 inches, as shown in Fig. 1.

$$16 \div 4 = 4 \text{ inches pitch diameter}$$
$$40 \div 4 = 10 \text{ inches pitch diameter}$$

TABLE 2

Countershaft Speed, R.P.M.	Countercone Diam., Inches	Headstock Cone Diameter, Inches	Back-gears	Spindle Speeds, R.P.M.
140 × 10.7	÷ 5.00		Out	= 300
140 × 9.27	÷ 6.43		Out	= 202
140 × 7.85	÷ 7.85		Out	= 140
140 × 6.43	÷ 9.27		Out	= 97
140 × 5.00	÷ 10.7		Out	= 65
140 × 10.7	÷ 5.00	× (19 × 16 ÷ 51 × 40)		= 45
140 × 9.27	÷ 6.43	× (19 × 16 ÷ 51 × 40)		= 30
140 × 7.85	÷ 7.85	× (19 × 16 ÷ 51 × 40)		= 21
140 × 6.43	÷ 9.27	× (19 × 16 ÷ 51 × 40)		= 14.5
140 × 5.00	÷ 10.7	× (19 × 16 ÷ 51 × 40)		= 9.7

Machinery

$$\text{Therefore the center distance equals } \frac{10 + 4}{2} = 7 \text{ inches.}$$

This alters the ratio slightly, as the ratio of 40 to 16 is 2.5. The difference must be made up in the other pair of gears as follows:

$$6.6 \div 2.5 = 2.64 \text{ ratio for 5 diametral pitch gears.}$$

Twice the center distance or 14 inches is the combined pitch diameters of the gears, and with 5 diametral pitch the combined number of teeth is 70. The desired ratio is 2.64. Add 1 to this ratio and divide it into the total number of teeth. Thus:

$$70 \div 3.64 = 19, \text{ approximately}$$

Therefore we have 19 teeth in the pinion and 70 — 19 = 51 teeth in the gear. The spindle speeds will now be checked as shown in Table 2 to see how close we have come to the desired result. We will make the countershaft speed 140 revolutions per minute even. The results shown in Table 2 are also compared with the ideal speeds in Table 1. It is possible to get even closer results by a little juggling, but such accurate speeds are seldom necessary.

Calculations for Feed Mechanisms

As we have now gained a knowledge of methods, the next problem, while more complicated in some respects, will not require so much explanation. We will continue with the lathe, taking the feed this time. The design of lathe to be considered does not conform to good practice, inasmuch as the lead-screw does the feeding. Very few, if any, lathe builders make lathes of this kind in these days, as it causes too much wear on the lead-screw and renders it inaccurate for screw-chasing; but as screw feeds are often used on other machine tools, and moreover, as the application of the same

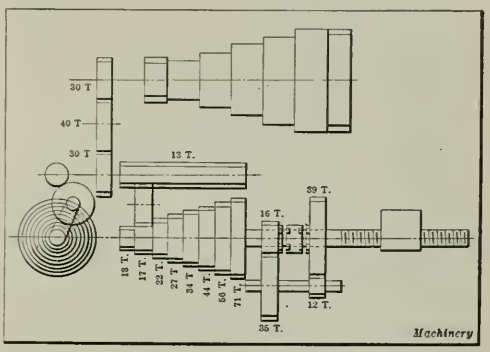


Fig. 2. Sketch of Feed-changing Mechanism of Lathe

gearing to the usual lathe feed will be considered later, we will depart from the established path for the time being. Our example this time is shown in Fig. 2, which illustrates a cone of gears and a swinging idler driven from the main spindle by suitable connecting gears. We shall assume that the lead-screw is to have 4 threads per inch, (a very common pitch for lead-screws) and the feeds are to vary from ¼ to 1/150 inch per revolution of the spindle. Spindle speeds are expressed in terms of revolutions per minute, while feeds are given in terms of feed in fractions of an inch per revolution of the spindle; consequently, if the speed is doubled, we double the feed per minute, but not per revolution of spindle. Sixteen feeds in all are required and these are to be obtained by using eight gears in the cone and a back-gear similar to that on the spindle drive.

As the screw has 4 threads per inch, it is manifest that its fastest speed is one revolution to one revolution of the spindle and its slowest speed, 1/150 × 4 = 1/38 revolution approximately. By using the numbers 4 and 150 the geometrical progression may be determined. By one of the methods already alluded to we find the ratio to be 1.275. The various gear ratios may then be determined by repeatedly multiplying by the ratio of the geometrical progression. These gear ratios are given in the first column of Table 3. The second ratio is given as 1 to 1.28 instead of using the exact value of 1.275. In the next column, these ratios are expressed by numbers representing the numbers of teeth in the gears. When the lead-screw makes one revolution to one revolution of the spindle, which is the case when the drive is from the long pinion having 13 teeth to the gear having 13 teeth, the feed per revolution will be ¼ inch, because there are 4 threads per inch on the lead-screw, so that one revolution of the latter is equivalent to a ¼-inch feeding movement. Consequently, the values in the last column are approximately equal to one-fourth of the gear ratios, or their equivalent values as expressed by the numbers of teeth.

The first eight feeds are obtained through the cone of eight

gears. Between the eighth and ninth feed the back-gear comes into play. The ratio of this back-gear will be the ratio between the first and ninth feeds or 1 to 6.95. We might find the square root of 6.95 and make both pairs of gears alike; but one of the pinions must have a clutch face while the other has not, and therefore it is better practice to accommodate them to this difference. Suppose we find it necessary to make the clutch pinion with 16 teeth and the

TABLE 3

Gear Ratio	Numbers of Teeth in Gears	Feed per Rev. of Spindle, Inch
1 to 1.00	13 ÷ 13	1/4
1 to 1.28	13 ÷ 17	1/5
1 to 1.62	13 ÷ 22	1/6.4
1 to 2.07	13 ÷ 27	1/8
1 to 2.62	13 ÷ 34	1/10
1 to 3.35	13 ÷ 44	1/13
1 to 4.27	13 ÷ 56	1/17
1 to 5.45	13 ÷ 71	1/22
1 to 6.95	13 ÷ 13 × (12 × 16 ÷ 39 × 35)	1/28
1 to 8.85	13 ÷ 17 × (12 × 16 ÷ 39 × 35)	1/35
1 to 11.27	13 ÷ 22 × (12 × 16 ÷ 39 × 35)	1/45
1 to 14.80	13 ÷ 27 × (12 × 16 ÷ 39 × 35)	1/57
1 to 18.30	13 ÷ 34 × (12 × 16 ÷ 39 × 35)	1/71
1 to 23.40	13 ÷ 44 × (12 × 16 ÷ 39 × 35)	1/92
1 to 29.80	13 ÷ 56 × (12 × 16 ÷ 39 × 35)	1/120
1 to 37.80	13 ÷ 71 × (12 × 16 ÷ 39 × 35)	1/156

Machinery

other pinion with 12 teeth. The sizes of the two remaining gears might be determined by algebra, but a little guessing and trial will be as rapid and will be easier for the non-mathematical. Both pairs of gears must have the same center distance. Let us try 34 and 38 teeth.

$$34 \times 38 \div 12 \times 16 = 6.73$$

This ratio is not quite large enough, so another trial will be made using 35 and 39 teeth.

$$35 \times 39 \div 12 \times 16 = 7.10$$

This ratio is a little too much, but is as close as it is practicable to come to the desired result. The reader will understand that the three gears driving from the spindle to the long pinion do not enter into the calculations, as they are gears of the same size, a 30-tooth gear driving a 30-tooth gear, with a 40-tooth idler in between, the size of which has no effect whatever on the speed. (See Fig. 2).

Now suppose we do not want to use a screw for feeding, but wish to follow the approved practice in lathe design and use a splined shaft in combination with a rack and pinion and worm-gear. The splined shaft may either take the place of the screw, or, as in a lathe, may parallel the screw and be driven from it by even gears. If we wish to obtain the same feeds as with the screw, we must have a 1 to 4 ratio in the rack and worm-gear combination to make it equivalent to the lead-screw having 4 threads per inch. To obtain exactly the same feeds, a circular pitch rack is required. A diametral pitch rack would vary somewhat from the even circular pitch desired. Assume that the rack is ½ inch circular pitch and that the pinion has 12 teeth. Then as the circumference of a 12-tooth pinion of ½-inch circular pitch is 6 inches, every turn of the pinion-shaft will give a feed of 6 inches. We must reduce this to ¼ inch as follows:

Circumference of pinion or $6 \times 4 = 24$ teeth in worm-gear

This is correct for a single-thread worm; if the worm has a double thread, the wheel must have 48 teeth, a triple thread, 72 teeth, and so on.

Speed-changing Mechanism of Horizontal Boring Machine

The next problem will be a horizontal boring machine. This is a somewhat more complicated proposition than the preceding, yet having mastered the simple principles of the first three problems, the reader will have no difficulty with this one. We will suppose that the spindle speeds are to range from 10 to 200 revolutions per minute, and the geometrical ratio is 1.31 for a range of twelve speeds obtained from the arrangement of gearing shown in Fig. 3. The speeds are to be as listed in Table 4. As the ratio 1.31 causes the last two speeds to fall slightly short of the speeds desired, namely, 151 and 198 instead of 152 and 200, we will arbitrarily increase them to suit our requirements. As 400 revolutions per minute is a good speed for the driving pulley, we will adopt that as its speed.

Table 4 resolves what may at first sight seem a formidable problem, into a very simple calculation. The ratios of the first three or simple gear changes are the ratios of the first three speeds. Thus:

$$200 \div 152 = 1.31 \qquad 200 \div 115 = 1.72$$

The ratio of the first or lowest back-gear will be the ratio between any speed of the first series of three and any speed of the second series of three of the same relative position.

$$200 \div 88 = 2.26 \quad \text{or} \quad 115 \div 51 = 2.26$$

The ratio of the second back-gear will he the ratio between any of the first series and any corresponding speed of the third series. Thus:

$$200 \div 39 = 5.1 \quad \text{or} \quad 152 \div 29.6 = 5.1$$

For the last and greatest reduction we use the two back-gears combined, which gives the three slowest speeds shown in the table.

The next step is to find just how many teeth the gears must have to give the desired ratios. There are a great many factors that govern the size of gears, such as the size of the shafts, the peripheral speed which affects both the quiet running qualities and the wear, permissible diameter of the largest gear, etc. Usually the conditions are such that the best results are obtained by making the smallest pinion as small as possible, the pinion having, say, thirteen or fourteen teeth, which is the smallest number that will give good wearing qualities. Let us suppose that the shaft diameters permit the use of fourteen teeth in the smallest pinion. Then the first pair of gears for the highest simple ratio will have 14 and 24 teeth. (See Fig. 3). Thus:

$$14 \times 1.72 = 24 \text{ teeth in the large gear}$$

The combined number of teeth in this pair will determine the total number of teeth in the other two pairs. Thus to find the second pair we must consider that $1 + 1.31 = 2.31$ and dividing this into the total number of teeth:

$14 + 24 = 38$ $\quad 38 \div 2.31 =$ say 17 teeth in the pinion

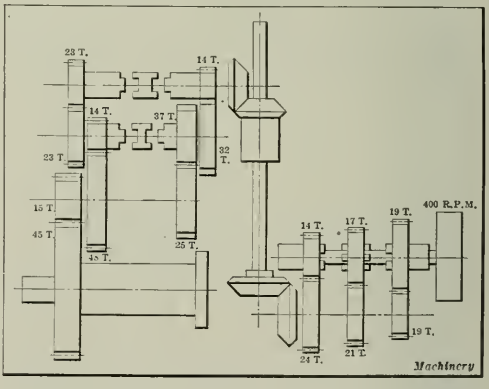


Fig. 3. Gearing for varying Speed of Horizontal Boring Machine Spindle

Now 17 teeth in the pinion subtracted from the total number of teeth equals 21 teeth in the gear. The 1 to 1 gearing will of course be:

$$38 \div 2 = 19 \text{ teeth in both gears}$$

The next consideration is the first or 1 to 2.26 back-gear Again using 14 teeth for the pinion we have:

$$14 \times 2.26 = 32 \text{ teeth in the large gear}$$

The other or even pair of this combination will have 23 teeth each. It is well to call attention here to the fact that the back-gears in this case are single pairs of gears used alternately with a pair of even gears, instead of the double

gear reductions used in the former examples. In some cases where very large reductions are required, it is impossible to obtain the necessary ratio with one pair of gears. Even in the present instance the ratio of the second back-gear of 1 to 5.1 would call for too large a gear to work into some designs; and for purposes of illustration we will suppose that to be the case in the present instance. There is but one way to solve the problem without the use of compound gearing such as we used in the other examples; thus, instead of making the other pair of the set even, make them multiply, that is, make the driven gear run faster than the driver. Too much multiplication is inadvisable, as the friction of the gears becomes too great and consumes too much power. This can be clearly demonstrated by trying to turn a train of clock gears by hand, using the large gears as drivers. A slight multiplication is not objectionable, however. Personally the writer does not believe in multiplying more than 1.5 to 1, but considers that much permissible.

It will be apparent upon a little consideration, that by whatever amount we make the non-reducing gears multiply, by just that amount we may lower the reduction in the reducing pair. Thus if we make the multiplication 1.5 to 1 then the reduction will be as follows:

$$5.1 \div 1.5 = 3.4$$

The reducing pair will be 3.4 to 1 instead of 5.1 to 1. Again taking 14 teeth for the pinion, we will have:

$14 \times 3.4 = 48$ teeth in the large gear, as shown in Fig. 3

To find the multiplying pair, take the total number of teeth in the reducing pair, 62 teeth, and divide by 1.5 + 1 as we did with the other change-gears:

$$62 \div 2.5 = 25 \text{ teeth and } 62 - 25 = 37 \text{ teeth}$$

Then the driver will have 37 teeth and the driven gear 25 teeth as shown in Fig. 3, and the ratio equals 1.5 to 1. These gear calculations should now be checked as shown by Table 5. The figures representing spindle speeds have been given as whole numbers, except in one place, decimals being considered non-essential. The 17 to 21 gear combination is the only one that gives results deviating very much from the ideal speeds. The smaller the aggregate number of teeth in the combinations, the more these variations are likely to occur, but within reasonable limits, they are of no consequence in speed or feed gearing; it is only in screw-cutting or indexing combinations that we must sacrifice every other consideration to obtain the exact ratio. The 15 to 45 combination in the faceplate drive is purely arbitrary; so long as we maintain the 1 to 3 ratio, the number of teeth may be anything desired, the size of these gears being entirely a matter of design.

TABLE 4

Spindle Speeds, R.P.M.	Gear Ratios	Back-gear Ratios	Faceplate
200.0	1 to 1		1 to 3
152.0	1 to 1.31		1 to 3
115.0	1 to 1.72		1 to 3
88.0	1 to 1	1 to 2.26	1 to 3
67.0	1 to 1.31	1 to 2.26	1 to 3
51.0	1 to 1.72	1 to 2.26	1 to 3
39.0	1 to 1	1 to 5.1	1 to 3
29.6	1 to 1.31	1 to 5.1	1 to 3
22.6	1 to 1.72	1 to 5.1	1 to 3
17.2	1 to 1	1 to 5.1 × 1 to 2.26	1 to 3
13.1	1 to 1.31	1 to 5.1 × 1 to 2.26	1 to 3
10.0	1 to 1.72	1 to 5.1 × 1 to 2.26	1 to 3

Machinery

AMERICANIZATION WORK CONDUCTED BY WORCESTER MANUFACTURERS

A few weeks ago, the Norton Co., Worcester, Mass., announced the graduation of its Americanization classes. The Norton Co. is one of several Worcester manufacturers who have adopted systematized methods for Americanizing their foreign-born employes, and there is every evidence that in that city the experiment has been a success. Working directly under the guidance of the Bureau of Immigration, an Americanization committee, with Waldo Lincoln as chairman and Carl F. Dietz as secretary, has achieved some definitely practical results, particularly in the industries where the foreign-born and foreign-speaking employes became an ever-increasing majority of the labor element as more and more Americans entered the war service. It became important to place before these foreign-born workers correct ideas as to America's part in the war as well as to the principles for which America stands, whether in peace or in war. Classes were formed in the night schools as well as in industrial plants for instructing the foreign-born workers along these lines and to point the way to citizenship. The Norton Co. doubtless led the several Worcester industries in this work, Mr. Dietz, the secretary of the Americanization committee, being the general sales manager and vice-president of this company. Aided by the Worcester committee, the Norton Co. established three classes for its non-English-speaking employes, conducted wholly on the principle of giving free instruction on the company's time.

These three classes met for one-hour sessions twice a week, the classes representing, respectively, the illiterate, the intermediate, and the advanced stage, and as fast as the individual progressed, he was promoted to the next higher class. The personal work in the class-room was managed by Anthony A. Lepore, whose knowledge of languages and whose understanding of the foreign-born man's point of view were practical assets in making this work a success. For a period of more than six months, these classes pursued their study of English, practicing conversation, and reading from simple text-books about American ideals and American leaders. Twenty-seven employes have graduated so far, and have been given a diploma in Americanization, issued by the Department of University Extension under the Massachusetts state system of education.

It is of great importance to note that these twenty-seven men were all enthusiastic to become American citizens, and have all taken out their first citizenship papers. Graduation exercises were held in the assembly hall of the company with the entire personnel of the classes and their families and friends present.

The importance of work of this kind cannot be too highly estimated. There would be far less difficulty with foreign-born labor in the United States if employers generally would, either individually or on the cooperative basis, adopt methods for Americanizing foreign-born workers.

TABLE 5

Driving Pulley, R.P.M.	Change-gears	Back-gears	Faceplate Gears	Spindle, R.P.M.
400 ×	19 ÷ 19 ×	(23 ÷ 23) × (37 ÷ 25)	× (15 ÷ 45) =	198
400 ×	17 ÷ 21 ×	(23 ÷ 23) × (37 ÷ 25)	× (15 ÷ 45) =	159
400 ×	14 ÷ 24 ×	(23 ÷ 23) × (37 ÷ 25)	× (15 ÷ 45) =	115
400 ×	19 ÷ 19 ×	(14 ÷ 32) × (37 ÷ 25)	× (15 ÷ 45) =	87
400 ×	17 ÷ 21 ×	(14 ÷ 32) × (37 ÷ 25)	× (15 ÷ 45) =	69
400 ×	14 ÷ 24 ×	(14 ÷ 32) × (37 ÷ 25)	× (15 ÷ 45) =	51
400 ×	19 ÷ 19 ×	(23 ÷ 23) × (48 ÷ 14)	× (15 ÷ 45) =	39
400 ×	17 ÷ 21 ×	(23 ÷ 23) × (48 ÷ 14)	× (15 ÷ 45) =	31
400 ×	14 ÷ 24 ×	(23 ÷ 23) × (48 ÷ 14)	× (15 ÷ 45) =	23
400 ×	19 ÷ 19 ×	(14 ÷ 32) × (48 ÷ 14)	× (15 ÷ 45) =	17
400 ×	17 ÷ 21 ×	(14 ÷ 32) × (48 ÷ 14)	× (15 ÷ 45) =	13.6
400 ×	14 ÷ 24 ×	(14 ÷ 32) × (48 ÷ 14)	× (15 ÷ 45) =	10

Machinery



Representative Government in a Manufacturing Plant

A Plant Where the Principles of the American Forms of Government are Applied Because the Employers Believe that this System Fosters a Spirit of Cooperation and Mutual Interest Which Strengthens the Organization and Increases its Efficiency

An Interview with J. J. CALLAHAN, Assistant to the President, Passaic Metal Ware Co., Passaic, N. J.

THE representative system of factory government, which has been called "industrial democracy," is founded on the principle that *cooperation* between all the members of an industrial organization is always better than *competition*, and that every employe should work *with* the company rather than *for* it. No arguments are needed in support of the fact that cooperation in any organization, whatever its object, fosters a spirit of contentment among its members and develops in them a greater capacity for effective work. There are many theories and schemes designed to allay industrial strife. Some are based entirely upon the system of wage payment. Perhaps the employe is rewarded if his daily output exceeds a certain fixed task or quantity, or possibly he receives a certain percentage of the profits, as provided for by whatever plan has been adopted. Let the system of wage payment be what it may, if the employes believe that the scheme of the management is to get from them the maximum and give to them the minimum, their natural impulse is to reverse this order and give the least in labor for the highest wage obtainable.

The Representative Government Plan of Management

Both the employer and the employe may believe in dealing justly with each other, but this will not come about as long as there is a feeling of distrust between them. Since this distrustful spirit is in so many instances due entirely to misunderstanding, any plan of organization which brings the employer and the employe closer together is worth at least a fair trial. The particular plan which is to be considered, has been developed and applied to factory administration by John Leitch, who defines it as "getting on a man-to-man basis." It is presented here in the belief that the readers of MACHINERY are interested in any system of shop and factory administration which has been so highly regarded as to be applied in nearly fifty large manufacturing and industrial plants throughout the United States. While any readjustment of industrial conditions which gives the workers a direct voice in the management naturally meets with opposition from many employers, the fact remains that the effort to place the industries upon a more democratic basis is advancing steadily, and employers are becoming very enthusiastic over the improvements resulting from a representative system of administration.

Representative Management Applied to a Sheet Metal Plant

The Passaic Metal Ware Co., of Passaic, N. J., is one of the plants where industrial democracy, or the representative system of administration, is in successful operation. This system of management is modeled after the government of the United States. There is an executive body, or "Cabinet," a "Senate," and a "House of Representatives." The Cabinet is composed of the officials of the company, and its membership is not controlled in any way by the employes. The cabinet has the power to veto any "bill" that may have been passed by the other governing bodies, but it is a notable fact that the use of this power has never been necessary, either at the plant of the Passaic Metal Ware Co., or, so far as is known, in any of the other plants where this system of administration has been adopted. This shows that the workers do not try to institute radical changes that would not be mutually beneficial. The president of the company is the President of the Cabinet.

The Senate is composed of the foremen, heads of departments, or supervisors. Whenever a department foreman enters the employ of the company, he automatically becomes a member of the Senate, and the selection of foremen rests with the company officials. The Senate elects a president, and also whatever committees are needed. The employes throughout the plant elect the members of the House, and there are representatives from all departments, so that the interests of each class of workers may be properly looked after. The number of representatives depends upon the number of employes in a department, the idea being to have a representative for each group of approximately twenty people. The House elects a speaker, or chairman, and it also works through selected committees, the same as the Senate.

Sessions of Senate and House

The sessions of both the Senate and House are held during working hours. At the Passaic Metal Ware Co.'s plant the Senate meets every Friday afternoon at 1:30, and the House at 3:15. The illustration on page 257 shows the Senate in session, while the heading illustration shows a meeting of the House. In this plant there are about four hundred fifty employes. The Senate has eighteen members, and the House twenty-one members. The discussions during the meetings of these legislative bodies center largely upon improving the

means of production, which is partly due to the fact that this system of management shows clearly the relation between profits and the means of making them possible. Perhaps one department is not receiving material of the right kind or the required quantity from another department, and as everyone responsible is a member of the Senate, the difficulty is located and steps are taken to remedy it; or possibly a machine or some tools are not working satisfactorily —the Senate is then concerned with the reason why. During these discussions as to the best ways and means, facts are often brought to light and improvements are finally made which would not be possible in a plant where this interchange of ideas was not encouraged, or was entirely lacking. When manufacturing methods or other technical details are considered from every angle and from the viewpoint of every department, which is what occurs at these Senate meetings, a more efficient plant is the result; at least, that has been the experience of the Passaic Metal Ware Co.

The improvement of manufacturing methods is not confined by any means to the ideas which originate at the meetings of the governing bodies. It is recognized that any employe may possibly, as a result of his experience and observation or by reason of natural ability, be able to suggest changes and improvements of commercial value; and to encourage the suggestion idea, prizes are awarded. These suggestions are placed in a box (unsigned, to avoid charges of favoritism), and the rather delicate task of deciding which ones are practicable and worth a prize is in charge of a suggestion committee. Incidentally, in one plant where this plan has been adopted, a certain suggestion from an employe was estimated to be worth $100,000.

Occasionally mass meetings of all the employes are held, but these are not often required because anyone in the plant can have his or her representative bring before the Senate or House any matter which is considered important.

What Happens to Wages?

Any mention of the labor problem naturally suggests the question of wages. When employes are asked to assume in part the burden and responsibility of management, what happens to wages? At the plant of the Passaic Metal Ware Co., wages were comparatively high before the introduction of the representative form of government, but they have been increased for the reason that production has also increased. The plan is to share equally with the employes the savings that may result from better teamwork under the new plan of management. The relative saving on the unit cost of production is the basis on which the savings are computed. When the general trend of wages and prices of raw materials is upward, if the cost of production has not risen proportionately, the net gain represents what has been saved. These savings are paid every two weeks, and are distributed as dividends on each employe's wage. The wage-percentage plan is considered more just than an equal distribution, because it is assumed that an experienced worker, upon whose vigilance and skill may depend the value of expensive products, should receive more of the savings than, for example, an inexperienced boy, for the reason that the skilled worker receives more wages, which he does because he is more valuable, holds a more responsible position, and renders a greater service. It will be noted that 50 per cent of the savings goes to the employes. This is considered fair by the employes who recognize that production costs are reduced by the chief executives as well as by the men under them, although the very active part taken by the workers in the improvement of manufacturing methods shows what can be accomplished when a man believes that his opinion is respected and feels that he is working *with* the company and not simply *for* it.

It is not in accordance with the business principles upon which this form of shop management is based to disregard existing wage scales when industrial democracy is introduced, and invite the men to adjust the wage question to suit themselves. That would obviously be an unsound policy, and would result in undermining the financial foundation beneath the business structure, so that everyone would lose eventually. However, regulation of wages, as well as changes in working hours, may be advocated by the Senate and House of Representatives; and according to the experiences in dif-



The Senate of the Passaic Metal Ware Co. in Session—The Senate is composed of the Foremen, the Heads of Departments, and Supervisors

ferent plants, the tendency has been to deal fairly with these matters. Wages have been increased when it has been the only just course, and in a number of instances they have been decreased voluntarily. The fact that the members of the Senate and the House view expenditures of the company's money in much the same way as though the transaction were of a personal nature, shows that the men feel a sense of responsibility and realize that the existence of the business depends upon reasonable production costs.

Advantages Claimed for the Representative System of Management

The principal advantages claimed for industrial democracy are: (1) an increase in the quality as well as in the quantity of the product; (2) the elimination of waste, both as to effort and material; (3) a lower production cost; (4) the elimination of strikes; and (5) a decided decrease in labor turnover.

The tendency is to improve the quality of the manufactured product, since rejected parts diminish the dividends; and the making of goods of quality is good business. The quantity is increased because there is an incentive for everyone to work—an incentive that is more potent than money alone. The production costs are certain to diminish when the experience of practically the entire organization is centered on the various details which determine whether a plant works smoothly or not, and frequently no one is better qualified to smooth out the wrinkles than the man who is closest to the particular work which is not quite up to the standard. Industrial democracy puts "the whole man on the job."

Now as to strikes: Can it be possible that there are no serious labor troubles? That has been the experience wherever the industrial democracy plan has been adopted. This plan is not antagonistic to labor unions; in fact, men are encouraged to join unions if they care to, and urged to take the constructive parts of industrial democracy and apply them to the union idea. Strikes, however, are not likely to occur when the workers are contented and know that they are getting a square deal. When the employer and employe are competitors and each tries to drive the hardest bargain possible, it is easy for the professional labor agitator to start trouble; but when there is a feeling of cooperation and partnership and a complete understanding, there can be no misunderstanding, and misunderstanding is the basis of all strikes. A well run union dovetails into industrial democracy as a glove fits the hand, but the professional agitator of Bolshevik principles has nothing to offer which is superior or even equal to what is obtained as a result of the plan of administration where justice, cooperation, energy, economy, and service are the principles which govern the activities of the whole organization.

The meaning of the term "labor turnover" has been almost forgotten at the Passaic Metal Ware Co.'s plant; in fact, this plant has the reputation of being a most desirable place in which to work; because the plan which grants to each man the right of self-expression makes him feel that he has a proprietary interest in the business. When these facts become known, others desire to join the organization.

It is understood, of course, that under this plan of management, the foremen have full authority to give orders, and these are obeyed without argument. If a workman believes that the foreman has been unjust, his grievance is investigated at the proper time, and full justice is given him; but arguments are not tolerated, and discipline, which is essential in any well-managed organization, is voluntarily maintained.

The General Principle upon which this System is Based

The remarkable success which has resulted from the application of democratic principles to factory administration is not possible unless an honest effort is made both by employers and employes to deal fairly with one another; and the company must prove its sincerity by giving the "big 50" and giving it first. In every such instance the men have shown themselves willing to readily cooperate and to do their share, but the "50-50" basis is one of the fundamentals of industrial democracy. A visitor entering the plant of the Passaic Metal Ware Co. will notice two American flags and the graphic representation of industrial democracy beneath them, which has for its cornerstones Justice, Cooperation, Economy, and Energy, with Service as a capstone. These basic principles have been adopted both by the executives and the employes as the only certain foundation upon which to build a business structure that is to endure and serve the best interests of all, and all have promised to uphold them.

General Conclusions

The experience of employers has been that granting the employe means of self-expression and a measure of self-government does not, in practice, weaken authority, or disrupt the organization, but strengthens it. "Authority," in its commonly accepted sense, gives way, in part at least, to cooperation. As explained in Mr. Leitch's book, "Man-to-man," industrial democracy represents "*a change in spirit* and not a change in the relative rights of ownership." Evidently, there has been some misunderstanding in regard to this point, as indicated by the following quotation from an editorial in an industrial journal:

"The theory of industrial democracy appears to be that by turning over a business to be directed in part, at least, by the workers, and by paying them a substantial bonus as profit-sharing or dividends, you will inspire a greater enthusiasm which will help the business. You start with a false premise if you accept this idea of the best method of creating an industrial democracy and you ignore the positive and absolute facts. You recognize not industrial democracy but industrial socialism, and you are simply taking one step in the direction of complete socialism. Socialism preaches the division and distribution of all property, and when you set up a condition where the owner of property is deprived of the right to manage it, you are merely one step away from the distribution idea which will follow later."

An investigation of this system of management as it is actually applied will show that it does not deprive the property owner of the right of management, but places the management upon a more secure footing. It assures teamwork by all; it banishes misunderstandings and grouches; it puts the whole man on the job and he works with head, heart, and hand. The owner, either directly or through executives representing him, and the employes cooperate and give the full benefit of their combined experience to the organization, because real cooperation is known to be good business policy. The owners or executives become friends of their men, and the men, friends of the executives. Industrial democracy is a satisfactory working agreement, and those who have first-hand knowledge of it consider it a practical solution of the problem of a fair and equitable basis of harmonious understanding between the employer and the employe.

* * *

SAFETY IN THE STEEL INDUSTRY

The steel industry has emerged from the extremely hazardous class of occupations; at least this is the conclusion that may be drawn from the fact that the largest and most conservative insurance companies in the country have announced a radical downward revision of the extra premium rates charged for insurance on the lives of workmen in the steel industry because of the supposedly hazardous nature of their occupations. In the past, blast furnace, Bessemer plant, open-hearth plant, crucible steel plant, and rolling mill employes have been paying a considerable extra rate in addition to the regular life insurance rate. At present, these extra rates are entirely abolished in two instances and reduced to from one-third to one-fifth of the rates of 1908 in all other cases. This is one of the most interesting indications of the remarkable effect that the safety-first movement has had in the steel industries.

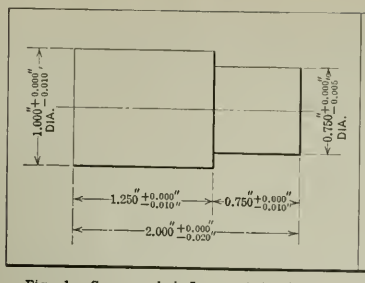


Fig. 1. Common but Incorrect Method of Dimensioning

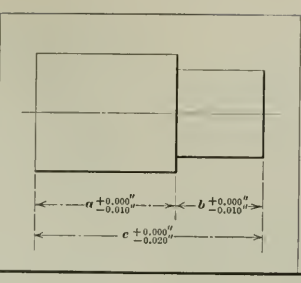


Fig. 2. One Interpretation of Dimensioning in Fig. 1

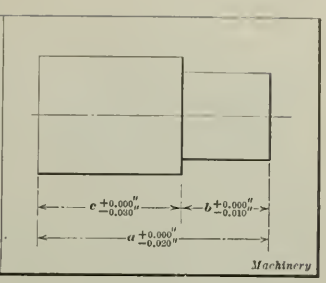


Fig. 3. Another Interpretation of Dimensioning in Fig. 1

Component Drawings for Interchangeable Manufacture

First of Two Articles on Methods of Dimensioning Drawings and Indicating Tolerances

By EARLE BUCKINGHAM, Engineer, Pratt & Whitney Co., Hartford, Conn.

THE art of expressing mechanical information by means of drawings is still in the process of evolution. Many details have become conventionalized, yet these comprise little more than the alphabet of the language of drawings and relate principally to conventional meanings of the lines, figures, and relative locations of the several projections which go to complete the drawings. Such, for example, are the full lines which represent the visible outlines of the part; the dotted lines which represent the hidden outlines; the light dot-and-dash lines which indicate center lines; the light dimension lines—and all the other conventional lines and characters which are employed. The third-angle projection is also fairly well established in mechanical drawing. This branch of drawing is fully covered in text-books, so no further mention of it will be made here. The subject of dimensioning, however, is so incompletely covered that this article will be devoted to a detailed discussion of this subject. The addition of tolerances on component drawings has created new problems which have not, as yet, been fully solved, and which, therefore, require considerable and thoughtful study.

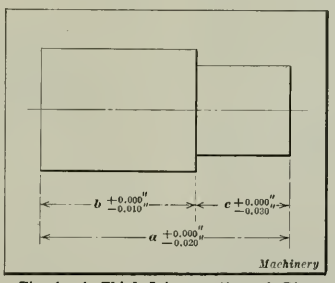


Fig. 4. A Third Interpretation of Dimensioning in Fig. 1

The matter of dimensioning, as given in books and taught in various schools, receives only minor attention. Little more than the a b c of the subject is taught. In actual practice—particularly where tolerances are involved—so many different conditions are to be met, so many different shades of meaning must be clearly expressed, and so many different types of workmen must be informed by these drawings that this alphabet must be fully understood and carefully used to enable it to serve its purpose. It is necessary, in order to consider intelligently this subject of dimensioning with tolerances to discard all school training in the application of dimension lines, etc.

The main purpose of a mechanical drawing is to express or record information. This information is of many kinds and is used for many purposes. The drawing, to be correct, must clearly and consistently express the particular information required to serve its specific purpose. For example, a type of drawing that may be correct for the use of a toolmaker in building a jig, may be incorrect for the use of a machine operator in the manufacturing department engaged in quantity production. Inasmuch as the drawings are the written or pictured expression of the design, they may be roughly classified into functional drawings and manufacturing or component drawings.

Functional Drawings

The functional drawing, like the functional design, primarily expresses the functional conditions to be maintained. The detailed information relating to many of the manufacturing problems that are involved which does not appear on these drawings is supplied by the mechanic who uses them. Thus, in those cases where only a few special mechanisms, or jigs, fixtures, tools, etc., are to be made in a general machine shop or toolroom, where the type of workman is such that this detailed information is unnecessary, functional drawings only are required. Such drawings need not express tolerances, clearances, and other minor details so essential on the manufacturing drawings. For example, a notation such as "drive fit" or "sliding fit" is sufficient to indicate and obtain the desired results. Yet, even here, if the drawings are to serve their purpose

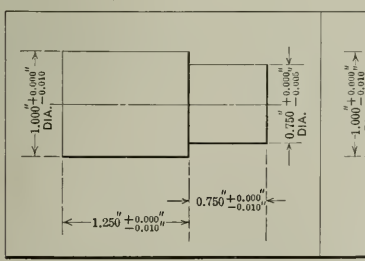


Fig. 5. Correct Dimensioning if Length of Body and Length of Stem are most important

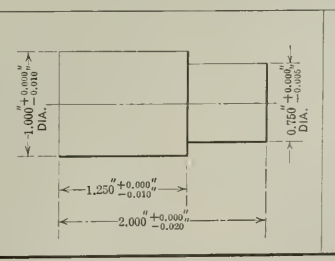


Fig. 6. Correct Dimensioning if Length of Body and Over-all Length are most important

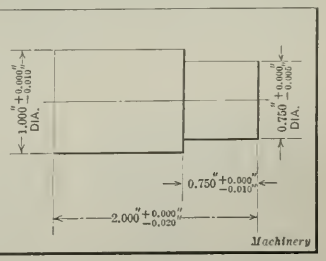


Fig. 7. Correct Dimensioning if Over-all Length and Length of Stem are most important

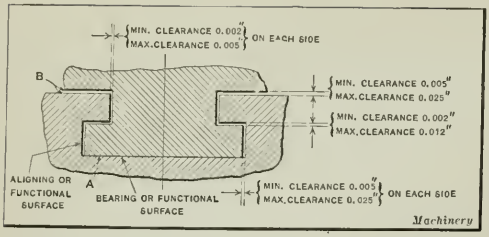


Fig. 8. Sketch showing Functional Requirements of Slide

efficiently, the information given must be so expressed that it may be used directly. In order to attain this end, every line drawn and every dimension expressed must be made with a full understanding of the final results required and of the means to be employed to obtain them.

Manufacturing Drawings

The manufacturing drawings, to be complete, must express all suitable information that is available. For the purposes of the present discussion, we will confine ourselves to component drawings of an interchangeable product. As stated in a preceding article, the proper dimensioning of component drawings with tolerances is a mathematical problem. Five laws are given, which, if carefully observed, will simplify many of the equipment and production problems.

Laws of Dimensioning

1. In interchangeable manufacturing there is only one dimension (or group of dimensions) in the same straight line which can be controlled within fixed tolerances. This is the distance between the cutting surface of the tool and the locating or registering surface of the part being machined. Therefore, it is incorrect to locate any point or surface with tolerances from more than one point in the same straight line.

2. Dimensions should be given between those points which it is essential to hold in a specific relation to each other. The majority of dimensions, however, are relatively unimportant in this respect. It is good practice to establish common location points in each plane and to give, as far as possible, all such dimensions from these points.

3. The basic dimensions given on component drawings for interchangeable parts should be, except for force fits and other unusual conditions, the maximum metal sizes. The direct comparison of the basic sizes should check the danger zone, which is the minimum clearance condition in the majority of cases. It is evident that these sizes are the most important ones, as they control the interchangeability, and they should be the first determined. Once established, they should remain fixed if the mechanism functions properly and the design is unchanged. The direction of the tolerances, then, would be such as to recede from the danger zone. In the majority of cases, this means that the direction of the tolerances is such as will increase the clearance. For force fits, such as taper keys, etc., the basic dimensions determine the minimum interference, while the tolerances limit the maximum interference.

4. Dimensions must not be duplicated between the same points. The duplication of dimensions causes much needless

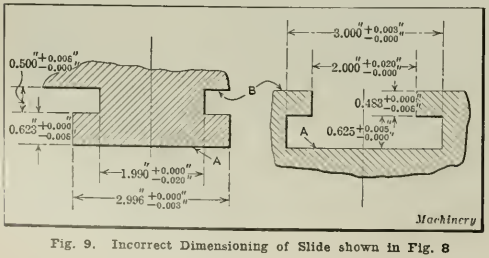


Fig. 9. Incorrect Dimensioning of Slide shown in Fig. 8

trouble, due to changes being made in one place and not in the others. It causes less trouble to search a drawing to find a dimension than it does to have them duplicated and more readily found but inconsistent.

5. As far as possible, the dimensions on companion parts should be given from the same relative locations. Such a procedure assists in detecting interferences and other improper conditions.

When attempting to work in accordance with general laws or principles, one other elementary rule should always be kept in mind. Special cases require special consideration. This may be another method of saying that the exception proves the rule. The following detailed examples are given to illustrate the application of these five laws and to indicate results of their violation.

Violation of First Two Laws

For the first example, we will take the stud shown in Fig. 1. This shows a very common method of dimensioning such a part, but one that is extremely bad practice. It violates the first and second laws given above. As the dimensions given for the diameters are correct, they are eliminated from the discussion. The dimensions given for the various lengths are wrong: first, because they give no indication as to the essential lengths; second, because of several possible sequences of operations, some of which would not maintain the specified conditions. Composite surface conditions are created, whereas they should be kept elementary.

Fig. 2 shows one possible sequence of operations indicated alphabetically. If we first finish the dimension *a* and then finish *b*, the dimension *c* will be within the specified limits. In

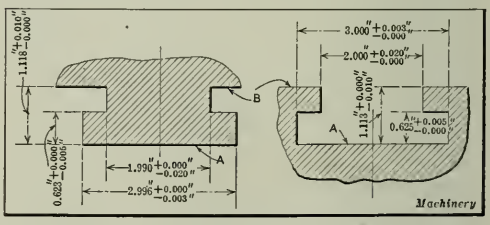


Fig. 10. Proper Dimensioning of Slide shown in Fig. 8

this case, however, the dimension *c* is superfluous. Fig. 3 gives another possible sequence of operations. If we first establish *a*, and then *b*, the dimension *c* may vary 0.030 instead of 0.010 inch as is specified in Fig. 1. Fig. 4 gives a third possible sequence of operations. If we first finish the over-all length *a*, and then the length of the body *b*, the stem *c* may vary 0.030 inch instead of 0.010 inch as specified in Fig. 1.

If three different plants were manufacturing this part, each one using a different sequence of operations, it is evident from the foregoing that a different product would be received from each plant. The example given is the simplest one possible. As the parts become more complex, and the number of dimensions increase, the number of different combinations possible and the extent of the variations in size that will develop also increase.

Fig. 5 shows the correct way to dimension this part if the length of the body and the length of the stem are the essential dimensions. Fig. 6 is the correct way if the length of the body and the length over-all are the most important. Fig. 7 is correct if the length of the stem and the length over-all are the most important.

If the part is dimensioned in accordance with either Fig. 5, Fig. 6, or Fig. 7, the product from any number of factories should be alike. There is now no excuse for them to misinterpret the meaning of the drawing. The point may be raised that the manufacturer should study the drawing to determine what his sequence of operations should be in order to maintain all dimensions and tolerances given. On such a simple part as was given for the first example, this would not be difficult. On a more complicated piece, however, it would be almost

impossible. Such conditions occur when the draftsman makes little or no effort to reduce as many surfaces as possible to elementary ones. Furthermore, when the manufacturer or workman sees such dimensions on a component drawing, he is justified in assuming that the designer or draftsman who made them had little or no idea as to the essential conditions to be maintained. In such cases, the sequence of operations and the register points for machining will be established to facilitate production, or to suit the ideas of individuals as to the most essential conditions. Often, this will result in some of the operations on a component being arranged to suit one idea, while the remainder are completed in accordance with an almost diametrically opposed conception. It cannot be too strongly impressed upon the draftsman that when a drawing leaves his hands it must not be open to more than one interpretation. This, in turn, demands that a uniform method of interpretation be adopted and published by each plant for the guidance of all concerned. It is self-evident that a universal method of interpretation of drawings with tolerances would be of great benefit to all manufacturing plants. This is a field where the various engineering societies, working in close cooperation, could render valuable service.

Violation of the Second Law

Let us take as the second example the slide shown in the sub-assembly, Fig. 8. This sketch gives the functional conditions which must be maintained. It is well to note that it is a

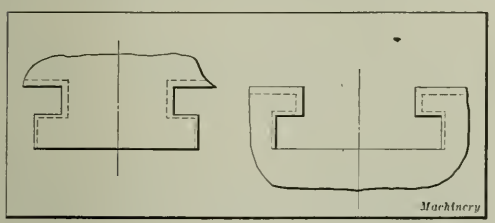


Fig. 11. Graphical Illustration of Application of Tolerance

very desirable practice to add to a set of component drawings a series of sub-assemblies of this kind. These would show graphically the functional requirements of the most important operating members of the mechanism, when the detail drawings are insufficient, in themselves, to express them clearly. Such a practice will prove of great assistance in limiting the interpretation of the component drawings.

Fig. 9 illustrates a common method of dimensioning such details. This is wrong, as it violates the second law previously stated. These parts are dimensioned in Fig. 10 in accordance with the foregoing laws. It will be noted that all dimensions for height are given from the bearing surface *A*, which is the most important in this case. If the slide should be designed to bear at *B* instead of at *A*, surface *B* would become the most important, and the various dimensions of height would be given from there instead of from *A*. The same functional conditions (see Fig. 8) are maintained in Figs. 9 and 10. Attention is called to the fact that in Fig. 10 it is possible to allow a tolerance of 0.010 inch on the dimension to the top surface *B*, whereas in Fig. 9 only 0.005 inch can be allowed as a manufacturing tolerance when making this cut.

Thus, the improper and careless dimensioning of component drawings results directly in reducing the manufacturing tolerances, in addition to creating uncertainty by not indicating the essential surfaces. Furthermore, the possibility of draftsman's errors is greatly increased by dimensioning as shown in Fig. 9 because the draftsman, in this case, must make several additions and subtractions of basic figures and tolerances in order to check the maximum and minimum clearances. In Fig. 10, on the other hand, the direct comparison of the basic dimensions checks the minimum clearance. The maximum clearance is readily checked by adding the sum of the tolerances to this minimum clearance. In general, the direct comparison of the

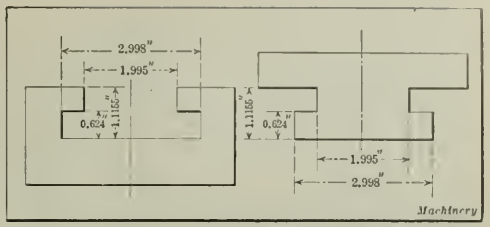


Fig. 12. Dimensions for Functional Gages for Part shown in Fig. 10

basic dimensions should establish the minimum clearances between elementary surfaces on companion parts.

No mention has been made of the dimensions of width in the previous example. Strictly speaking, dimensions so given are central with the center line. Half of the tolerances for width may be utilized on either side of the center line. This does not mean that the surfaces must be absolutely central; one side can be made to the maximum dimension and the other side to the minimum. In general, the tolerances should be understood to establish a parallel zone of acceptable work, all parts falling within this zone being acceptable. Fig. 11 illustrates how the dimensions and tolerances in Fig. 10 establish such a zone. The full lines show the basic or maximum metal conditions, while the dotted lines show the minimum metal conditions.

In the previous example, each surface has been considered as an independent elementary surface, and the meaning of the drawing interpreted accordingly. But there is also a certain condition of alignment which these various surfaces must maintain in relation to each other. When considering this phase of the subject, the surfaces become composite. Whenever composite surfaces are involved, the functional requirements of these surfaces must be taken into consideration. The only satisfactory method of solving such problems is in terms of the inspection gage requirements. If the succeeding solutions are accepted, the accompanying interpretations, expressed in terms of functional gages, must also be accepted.

To a certain extent, the amount of tolerance required to machine a given surface depends on the methods employed to check the results obtained. For example, the maximum thickness of the tongue of the slide shown in Fig. 10 is 0.623 inch. If this thickness is checked with an ordinary snap gage, practically the entire tolerance is available for variations in thickness. If, however, the width of this snap gage were equal to or greater than the length of the tongue, any deviations in the surfaces checked from true parallel planes would tend to prevent the part from entering the gage. In this case, part of the tolerance would be consumed by the errors in alignment of the two surfaces, leaving the remainder for variations in the distance between them.

One of the principal reasons for providing clearances in the design is to discount this condition of misalignment. Therefore, in developing functional gages to check these conditions, we are justified in utilizing a fair percentage of the minimum clearance. In order to insure strict interchangeability, the functional gage for the male component should never be larger than the functional gage for its companion female component. In general, if the functional gages never invade this minimum clearance more than fifty per cent, we shall remain on the

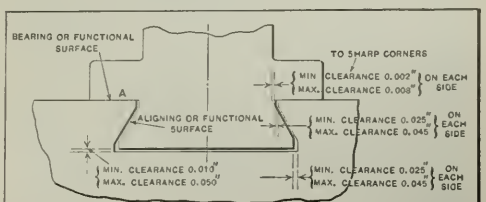


Fig. 13. Sketch showing Functional Requirements of Dovetail Slide

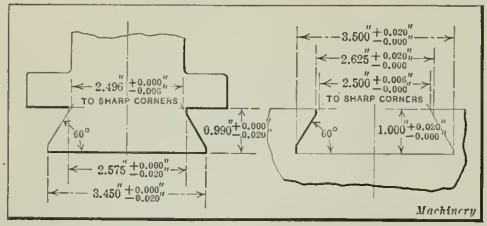


Fig. 14. Correct Dimensioning of Dovetail Slide shown in Fig. 13

safe side. Conditions sometimes arise, of course, where it is desirable to utilize a greater percentage on one component and a correspondingly lesser percentage on the other. For the purposes of this discussion, however, we shall assume that the conditions are such that a maximum of fifty per cent for each component represents a fair distribution.

The dimensions for functional gages to check the parts shown in Fig. 10 are given in Fig. 12. The various dimensions of the parts should first be checked as elementary surfaces with limit gages representing the specified limits. This functional gage would then be employed to test the relative alignment of these surfaces necessary to insure interchangeability.

Dimensioning Composite Surfaces

Thus far we have been considering parts whose surfaces are susceptible of individual checking as elementary surfaces. We must also consider parts whose surfaces cannot be resolved into elementary ones and checked as such. Take, for example, a dovetail slide, such as shown in Fig. 13, which introduces an angular surface. Such angular surfaces are almost always composite ones. Great care must be exercised in such cases to avoid compound tolerances.

A compound tolerance exists when the application of a tolerance on one dimension develops a variation in another dimen-

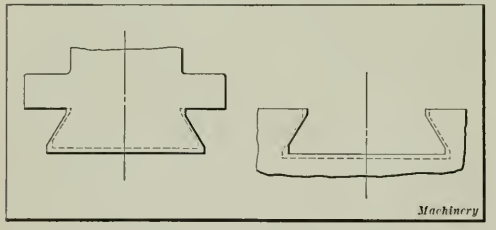


Fig. 15. Graphical Illustration of Application of Tolerances

sion which also has a tolerance specified. Such a condition immediately raises the question as to whether the resultant variation of both tolerances is permissible or whether the tolerances specified are final and complete for their respective dimensions. In either event, confusion and misunderstanding will result. Here, as with the introduction of more than one dimension in the same straight line (see first law of dimensioning) to locate a given surface, the final results will depend on the sequence of operations adopted, with all the attendant differences. As stated in the article "Principles of Interchangeable Manufacturing," in the July number, in making component drawings, the effort should be made to so give the dimensions and necessary tolerances that it would be possible to lay out one—and only one—representation of the maximum metal condition and one—and only one—minimum metal condition. If such lay-outs were superimposed, the difference between them would represent the permissible variation on every surface. If a few such lay-outs are made, it will soon be evident that there are always a number of dimensions that should be given without tolerances.

A compound tolerance is an error—often a serious one. It can and should always be eliminated. Fig. 14 illustrates a method of dimensioning the dovetail slide shown in Fig. 13 which avoids compound tolerances. The dimensions that control the position of the angular flanks are given to the sharp corners at the top of the dovetail. The tolerances on these dimensions limit the permissible variation of these angular flanks. The angle is given as a flat dimension. As is evident from the functional drawing, Fig. 13, the bearing surface *A* and these angular flanks are the essential functional surfaces of this dovetail. All other surfaces are clearance surfaces, as should be apparent from the extent of the tolerances, Fig. 14, even though the functional drawing were not available. Fig. 15 shows graphically the applications of the tolerances given in Fig. 14. The full lines represent the maximum metal conditions, while the dotted lines indicate the minimum metal conditions.

Compound Tolerances

The dimensioning of tapered plugs and holes introduces a somewhat similar problem which will result in a condition of

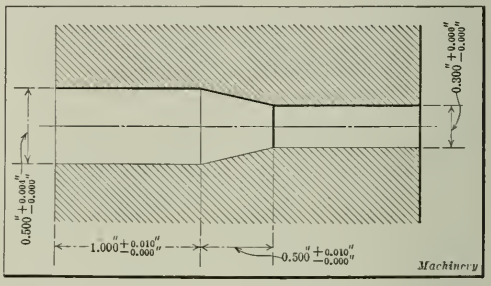


Fig. 16. Incorrect Method of dimensioning Tapered Hole

compound tolerances if great care is not exercised. Fig. 16 shows such a tapered hole as it is usually dimensioned. This method of dimensioning is wrong, as it creates a condition of compound tolerances. With these dimensions, it is impossible to determine what final result is required, since there are so many possible combinations. It is evident that as the diameter of either the large or the small hole varies, the taper will change. This makes an uncertainty about the reamers, as these tools have a fixed taper. If we assume that the taper is constant, questions will be raised as to which combination of limits to employ to establish the taper. If we further assume that the basic dimensions are to be used for this purpose, the next question will be whether this taper, considered as a constant, is required to remain in the position indicated by the dimension 1.000 inch $+0.010_{-0.000}$ under all conditions, or whether it can also vary in addition by the amount resulting from the variations in diameters. Also a tolerance is given on the length of the taper. This is entirely meaningless. It cannot be measured readily even with an elaborate laboratory equipment and there is no use for this tolerance in the course of manufacture. With a fixed taper, the variation in this length is controlled absolutely by

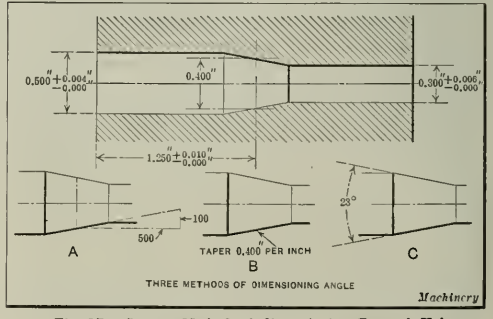


Fig. 17. Correct Method of dimensioning Tapered Hole

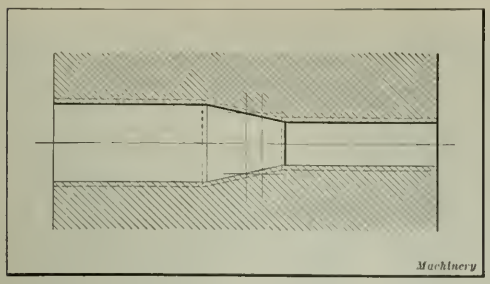


Fig. 18. Graphical Illustration of Application of Tolerance

the relative sizes of the holes. All in all, as the drawing stands, it is a puzzle without any solution.

We will assume that the intent of Fig. 16 is to indicate a constant taper with a tolerance of +0.010 inch in regard to its position. Fig. 17 shows the correct method of dimensioning such a surface to maintain such a condition. An arbitrary point is taken on the taper and a fixed dimension given for its diameter at that point. The location of this fixed diameter is dimensioned with the tolerance. Three methods of dimensioning this taper are shown. Either of the first two, *A* or *B*, is preferable to the third, *C*, because any reference figures desired can be readily computed from them without recourse to trigonometry or any tables or handbooks.

Fig. 17 gives the manufacturer definite information which he can use and which he can use in only one way. The tolerances given on each dimension apply only to the specific surface in question. No tolerance can be given on the diameter of the taper nor on the angle without introducing compound tolerances again, with resultant confusion. The permissible variations on this tapered surface are fully established by the tolerance given on its location. Fig. 18 shows graphically the maximum and minimum metal conditions established by the dimensions and tolerances given in Fig. 17. It will be noted that a parallel zone for the permissible variations has been established on every surface. When this has been accomplished, no further tolerances should be given.

The method of dimensioning a taper shown in Fig. 17 usually meets with more or less opposition from the shop men. The objection is raised that more dimensions are necessary in order to make up the proper reamers, etc. Although the needed dimensions can be readily computed, it is desirable to reduce the amount of such computations in the shop as much as possible. This objection can be eliminated in several ways. First, if a drawing is made for the reamers, all the additional checking dimensions can appear on these drawings. Second, if operation drawings are provided, these dimensions would appear there. Third, if neither of the two foregoing practices is adopted, the required dimensions may appear on the component drawing in parentheses, and may be marked "Basic" or "Reference." It should be clearly understood, however, that such dimensions are supplementary and apply only in connection with the other basic dimensions given. No tolerances should under any circumstances be given on such reference figures. As far as possible they should be eliminated from the drawing.

* * *

INTENSIFY PRODUCTION

An eight-hour day and a living wage—it is a good slogan. A living wage should mean more than a wage that merely feeds and clothes and houses. It should mean a wage that makes living healthful, comfortable, and happy. But if that is to be true, then an eight-hour day must mean a day of honest labor, in which the worker's full capacity for production is exercised without arbitrary restraint. This lesson must be driven home upon organized labor. It is fundamental. Only what is produced by the combined efforts of capital and labor can be divided between them.

To demand a shorter day and higher wages means that labor must produce more than it has been producing and in less time. It is easily possible, if arbitrary restrictions are abolished upon the quantity of work a man may do in a given period. But if labor demands a shorter day, and then rules that the union man may do in that day only a fraction of the work he is capable of doing, it is creating a situation that must become impossible and will end in disaster.

Labor argues that by limiting the amount of work a man may do in a day it can multiply the job opportunities for workers. But that argument is only superficially true. It should be obvious that if 100 men produce only as much as 75 could produce, each of the 100 must get a smaller share than each of the 75 would be entitled to. But labor not only wants to use 100 men to do the work of 75; it wants also that each of the 100 should be paid as much as each of the 75 can earn. It cannot be done.

Increase production and the purchasing value of the dollar will increase with it. If this be not done sooner or later, we will run into trouble more serious than any we have yet seen. For a time the 5,000,000 organized workers of the United States who are pushing wages higher and higher may be able to sustain the high-price structure that is being reared simultaneously. But they cannot sustain it indefinitely. Presently, the decreased consumption of many millions more of unorganized workers is going to be felt, and the structure will collapse.—From an editorial in the *Chicago Evening Post*.

* * *

THREADING TAPERED SPINDLES

The illustration shows the method employed by the S. A. Potter Tool & Machine Works, New York City, for threading tapered spindles which are made from ⅝-inch hexagonal cold-rolled steel bars. The spindles taper from ⅝ to ½ inch in diameter, the length of the tapered end being 2¼ inches. The first operation in machining these spindles is performed on a Cleveland automatic screw machine and consists of turning the tapered end and cutting the piece from the stock to the correct length of 4¼ inches. The threading operation is performed on an engine lathe, the hexagonal end of the spindle being held in a three-jaw chuck. A Landis thread chaser *A* is used to generate the threads, the chaser being held in a specially designed toolpost. The tapered end of the spindle is supported during the cutting operation by the V-block *B*, which may be adjusted to suit the spindle. This V-block is attached to the under side of a special fixture which has a tapered shank that is held in the tailstock spindle.

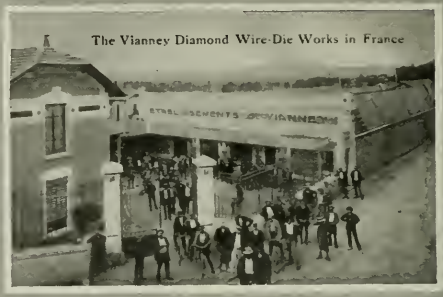
This has proved an efficient and rapid way of producing these spindles. The chaser cuts smoothly, frequent grindings are not required, and only four revolutions of the work are necessary to permit the chaser to cut the full depth of the threads. By this method an average of 100 spindles per eight-hour day has been produced, on an open-belt machine operated by unskilled help. A. B.



Method of using Landis Chaser for cutting Taper Threads

Making Diamond Wire-Drawing Dies

Edward K. Hammond



Preparing, Setting and Refinishing Diamond Dies

DIAMOND dies are quite extensively used for drawing small wire made of all kinds of metal. They are now employed almost exclusively for sizes ranging from 0.080 inch down to 0.0004 inch in diameter; and owing to their durability and other advantageous features, diamond dies are now finding quite a wide application for drawing larger sizes of wire. When they are properly made, the use of these dies is an economical practice. Although their first cost is high, diamond dies retain their accuracy for a long time and they can be repeatedly recut, so that the item of die cost which must be charged against the expense of manufacturing wire, is distributed over a very large quantity of the product and becomes almost a negligible factor. For this reason, diamond dies have largely replaced the use of dies made from steel, iron, ruby, or sapphire. Most diamond dies are made of rough diamonds from the South African and Australian mines, the diamonds used for this purpose being of a grade which is unsuitable for use in jewelry. Diamonds from the mines are shipped chiefly to London, and from that market they are exported to different cities in France where the majority of the dies used in wire-drawing are made.

History of Diamond Dies

Trevoux, where the Vianney Wire-Die Works are located, is a small town in France on the Saone River a few miles above Lyons, the latter city being well known for its silk industry. Fine gold and silver wires are woven with silk for making various types of church decorations, military and naval epaulets, etc. Much of the gold and silver wire used for this purpose was produced by the Richard wire factory in Trevoux. The dies used for drawing this wire were made of rubies or sapphires until Joseph Vianney, who was employed in the plant, thought of making diamond dies, owing to the fact that diamond is harder than either ruby or sapphire. Their use proved so successful that they were soon universally employed in the gold wire industry and later, the application of diamond dies extended to plants manufacturing copper, brass, and steel wire. Today diamond dies are employed for making fine gages of wire from practically all metals; and their use has proved exceptionally valuable in drawing tungsten wire for the filaments of incandescent electric light bulbs. Stones weighing up to 20 karats are used for the purpose. Owing to their successful application in numerous lines of industry, M. Vianney organized the Vianney Wire-Die Works at Trevoux to engage in diamond die manufacture. This firm now has a thoroughly modern plant which is shown in the heading illustration of this article. From 75 to 100 expert diamond drillers and polishers are employed. All of the work of making Vianney diamond dies is done in France with the exception of the mounting, which is done at the New York offices at 1 Union Square, which are in charge of V. J. Boulin. Orders for refinishing diamond dies to a larger size can also be executed in the company's New York offices.

An important feature of this firm's manufacturing practice is the adoption of standard sizes of diamonds from which the different diameters of dies are made. For instance, dies ranging from 0.0131 to 0.0150 inch are made from diamonds weighing 1 karat; dies from 0.0151 to 0.0170 inch are made from 1¼ karat diamonds, etc. As a result of this standardization, the purchaser of dies made by this firm is able to buy any specified size at a uniform price, because the diamonds from which these dies are made are of the same weight. Such a practice in making diamond dies is only possible where a firm does a business of considerable magnitude, because it necessitates the purchase of large numbers of diamonds which may be sorted out into the various standard sizes to which reference has just been made. The unit of weight known as a "karat," which is ordinarily used in designating the size of diamonds, is equal to 200 milligrams or 3.086 grains troy.

Preparing Rough Diamonds

"Diamond cut diamond" has become a popular expression, as it is a matter of fairly general knowledge that diamond is the hardest material known to science, and that nothing can cut a diamond except another stone of the same kind. Consequently, the work of making diamond wire-drawing dies must be done by cutting the stones

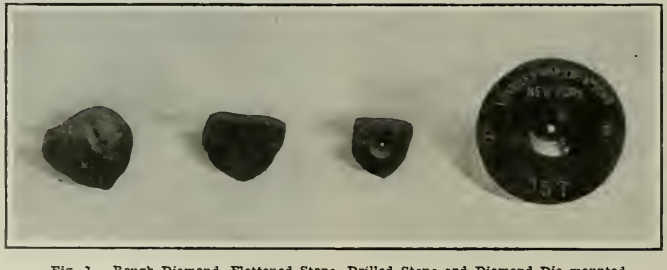


Fig. 1. Rough Diamond, Flattened Stone, Drilled Stone and Diamond Die mounted Ready for Use in drawing Wire

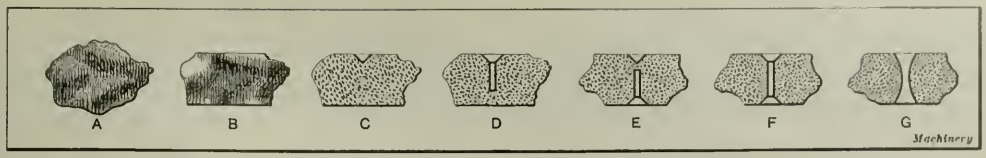


Fig. 2. Rough Diamond A and Cross-sectional Views showing Successive Steps in the Process of making Wire-drawing Die

with some form of diamond. The first step is to take a stone and flatten it on two opposite sides, in order to make provision for holding the diamond for subsequent cutting operations, and for setting it in the mounting after the cutting has been completed. This flattening of the diamond is done with laps charged with diamond dust, made by pulverizing small-sized diamonds, or chips from larger stones, and then grading this dust by sifting it through sieves with various numbers of meshes per square inch. This operation brings the stone to the condition shown at *B* in Fig. 2.

The first step in cutting the die opening is to chuck the diamond on the faceplate of a special drilling machine and cut a conical-shaped opening, as indicated at *C*. This opening is made by means of a diamond chip held by hand between the points of a pair of long-nosed pliers. The drilling machine is so designed that the table rotates and also has a vertical reciprocating motion imparted to it. After the conical hole has been cut, the drilling operation is started by means of a tool carried in the spindle of the machine. This spindle rotates in the opposite direction to the faceplate, and also has a reciprocating motion. It is important to note, however, that the reciprocal movement of both the table and drill is very slight. The term "drilling" is used to denote the work of making die-openings, although the cutting tool used for this purpose is more like a lap. It consists of a steel point that runs down into the conical-shaped opening *C* cut in the diamond after this opening has been filled with diamond dust mixed with oil. The tool pushes this diamond dust down into the opening, and as the tool rotates it carries the dust around with it and gradually produces the required hole.

After the hole has been drilled about three-fourths of the way through the diamond, as indicated at *D*, the work is removed from the machine and turned over, after which it is reset and a diamond chip held with a pair of long-nosed pliers is used to cut a conical opening in the opposite side of the diamond, as indicated at *E*. This opening is carefully located exactly opposite the hole which has been drilled in the work, and the next step is to drill from the bottom of this conical opening to make a connection with the hole entering the stone from the opposite side, thus bringing the piece into the form indicated at *F*. Those who are familiar with the business of wire-drawing, know that it is a matter of great importance to have the inside of the die absolutely smooth, in order to prevent forming seams in the work, and also that the bell-mouth of the die must be formed in such a way that the metal will pass into the die without undue frictional resistance. If there were a sharp edge between the bell-mouth and the throat or smallest sized opening in the die, there would be a great deal of frictional resistance in drawing the wire through, and satisfactory results could not be obtained.

The final cutting operation in diamond die making is to bring the die to the condition shown at *G*, for the reasons which have just been mentioned. It will be noticed from the cross-sectional views, that the inlet to the so-called "bearing" or throat of the die is made larger than the outlet at the back. This operation calls for the maximum skill on the part of the diemaker, and is always done by a man of wide experience. The cut is taken with a diamond chip held between the points of a pair of long-nosed pliers, and it will be evident that working in this apparently crude way, a great deal of dexterity is required to form the bell-mouth at each side of the die with a gradual curve coming tangent to the throat. After the die opening has been completely formed, the entire surface must be highly polished in order that frictional resistance of the wire passing through the die may be reduced to a minimum. Great care must be taken in making these dies, and even the most experienced workmen require from three to four days to make a die of average size.

Setting Diamond Dies

Diamond dies made by the Vianney Wire-Die Works are set in brass mounts which are made of blanks *A*, Fig. 3, cut from a cold-drawn brass bar. The die mounts are usually 1 inch in diameter by ⅜ or ½ inch in thickness. A socket is bored from one side of each of these disks, as shown at *B*, which is of sufficient size to receive the diamond; and then a central hole is drilled from the opposite side of the disk *C*, this hole being of the same size as the diameter of the wire which is to be drawn. After the diamond has been dropped into place in the socket, a small steel pin or mandrel is passed through both the drilled

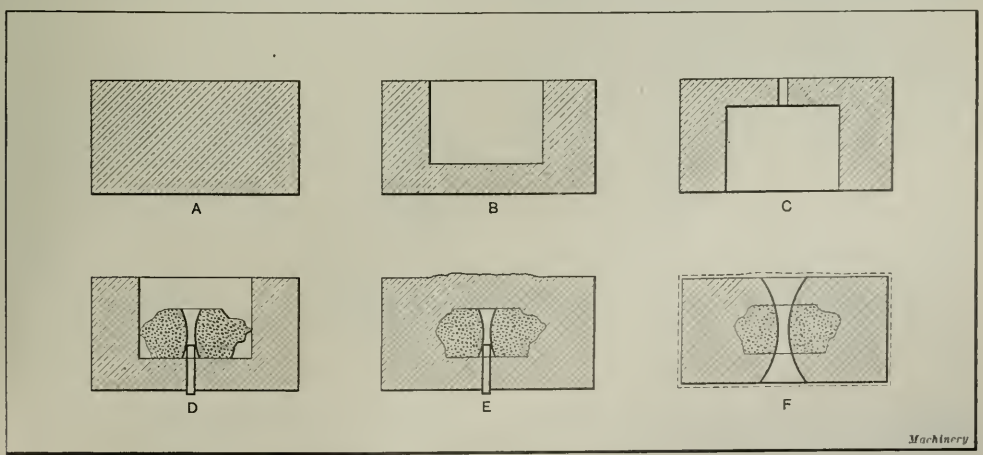


Fig. 3. Cross-sectional Views showing Successive Steps in making the Mount and mounting a Diamond Wire-drawing Die

hole and the die opening, as shown at *D*. The die-holder is next placed on a small brazing stand, and a disk of brass is placed on top of the diamond to prevent the hole in the die from becoming filled with spelter, after which a vertical clamp is fastened down on top of the brass disk. The clamp is made of steel, with a small point bearing down on the brass.

The die-holder is then heated with a gas and air blow-torch until it is red-hot, after which spelter and borax to act as a flux are placed on top of the socket containing the diamond, and the flame is applied to this spelter until it melts and completely fills the space surrounding the diamond. Then the work is allowed to cool, after which the holder is set up on a small jeweler's lathe, locating it from a mandrel through the drilled hole and the opening in the diamond, to bring the circumference of the mount concentric with the hole in the die, after which the holder is machined all over. The work is then chucked from its outside diameter, and the hole which was drilled from one side extending through the diamond die opening is drilled the remainder of the way through the holder. This hole is then bored out at each side, so that a bell-mouthed opening of uniform curvature is produced. This brings the work to the condition shown at *F* in Fig. 3. When the work has been brought to this point, the final steps are to stamp it with the size of the die opening and with the manufacturer's trade name. But no matter how carefully a setting is made, it cannot take the place of a thick wall of diamond. This fact has been proved in plants engaged in drawing tungsten wire, which is the most severe service in which diamond dies are employed.



Fig. 4. Special Type of Lathe used for refinishing an Unmounted Diamond Wire-drawing Die



Fig. 5. Special Type of Lathe used for refinishing a Mounted Diamond Wire-drawing Die

Refinishing Diamond Dies

A feature of diamond dies, which makes it possible for them to be used more economically than dies made of steel, cast iron, or some other inexpensive material, is that the extreme hardness of the diamond enables it to give a far greater amount of service before the tool is worn out. This resistance against wear is also the means of maintaining greater uniformity in the diameter of the wire that is drawn through the die. No material is hard enough to be proof against wear, and so the opening in the diamond die finally becomes too large to produce wire that comes within the specified limits of tolerance. When this point has been reached, the die must be recut, which is done by the use of a steel lapping tool charged with diamond dust, which is of similar form to the ones that were used for cutting new dies. The amount by which the diameter is increased will vary according to the size of the die. The smaller the opening, the less the amount by which the diameter will be increased. For medium sized dies, 0.005 inch increase in diameter will be made at each cutting. When the die has been recut, the bell-mouthed opening must again be carefully finished to bring it tangent to the new throat which has been cut in the die, after which the inner surface must once more be carefully polished to make the die fit for subsequent service.

Figs. 4 and 5 show a special type of lathe which is used by the Vianney Wire-Die Works for refinishing diamond dies. There is nothing exceptionally noteworthy about the design except the provision which is made for lifting both the spindle and work out of the head in order to facilitate gaging the diameter of the die opening. It will be seen that a cone pulley *A* is mounted directly on the spindle and that the steps of this pulley are grooved to carry a small cord that serves as a driving belt. At its left-hand end the spindle is centered to receive the point of a center *B;* and at the right-hand end, a journal on the spindle fits into a bearing box. Reference to Fig. 4 will show that the housing in which this bearing is mounted is arranged in such a way that by turning button *C* an eccentric latch enters the slot in locking member *D* and holds the bearing cap down on the spindle. When it is required to remove the spindle and work, this is done by simply turning button *C* and raising the bearing cap.

Lathes of this type are used for finishing diamond dies both before and after they have been mounted. Fig. 4 shows an unmounted stone set up for refinishing, and in Fig. 5 a mounted stone is shown in place on the machine spindle. It is interesting to note that in the diamond die industry, a diamond in which the die opening has been drilled and completely finished is called a "drilled stone" until such time as the stone has been mounted. Then the complete stone and its mounting are known as a "diamond die." At the right-hand end of the spindle there is a cup-shaped opening with a small notch *E* cut in the edge, as shown in Fig. 4. For holding an unmounted stone for refinishing, use is made of a small disk of metal that has a projection on one side, which is of just the right diameter so that it can be pressed into the cup with the thumb and index finger. The diamond to be refinished is secured to the face of this metal disk by means of sealing wax or very thick shellac. A hole is drilled through the center of the disk on which the stone is mounted, so that during the process of refinishing, a wire of known diameter may be drawn through the die as soon as the opening has been enlarged sufficiently to make this possible. The work of enlarging the die opening proceeds very slowly and frequent attempts are made to pass the master wire through the die. Directly this result is accomplished the only remaining work is to polish the die opening. For refinishing mounted dies, as shown in Fig. 5, a similar metal disk is used to enter the cupped end of the lathe spindle. The die is secured to this disk by means of shellac or some other suitable adhesive. When it is desired to remove either a mounted or an unmounted stone from the machine spindle, this is done by entering a pin into the slot *E*, Fig. 4, and then prying the metal disk out of the cup on the spindle.

The processes described, being quite different from the ordinary methods used by the machinist in his everyday work, will doubtless prove interesting to many.

LETTERS ON PRACTICAL SUBJECTS

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INTERSECTION OF TAPERS

The following article shows the deduction of the general formula for finding the point of intersection of two tapers with reference to measured diameters on those tapers. Referring to the diagram,

L = the distance between the two measured diameters and d;

X = the required distance from one measured diameter to the intersection of tapers;

a = angle of long taper;

a_1 = angle of short taper.

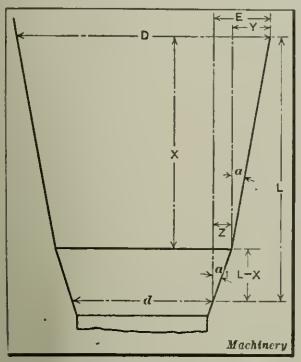


Diagram illustrating Deduction of General Formula for finding Point of Intersection of Tapers

Then

$$E = \frac{D-d}{2} = Z + Y$$

$$Z = (L - X) \tan a_1$$

$$Y = X \tan a$$

Therefore:

$$\frac{D-d}{2} = (L - X) \tan a_1 + X \tan a$$

and

$$D - d = 2 \tan a_1 (L - X) + 2X \tan a \qquad (1)$$

But

$$2 \tan a_1 = T_1 \text{ and } 2 \tan a = T$$

in which T and T_1 represent the long and short tapers per inch, respectively.

Therefore from Equation (1)

$$D - d = T_1 (L - X) + TX$$

$$D - d = T_1 L - T_1 X + TX$$

$$X (T_1 - T) = T_1 L - (D - d)$$

$$X = \frac{T_1 L - (D - d)}{T_1 - T}$$

Richmond College, Va. V. E. AYRE

EQUIPMENT FOR FINISHING INSIDE OF BOX PATTERNS

The tooling equipment for finishing the inside surfaces of an aluminum pattern is shown in Fig. 2 as it appears when set up, and the tool-carrying spindle which is used in performing the work is shown in detail in Fig. 1. The pattern itself is of box construction, 16 inches long, 10 inches wide, and 9 inches deep, having an offset extending across one entire side, forming a knee inside the pattern about 4 inches high. Thousands of castings were to be made from this pattern, the walls of which were required to be kept within a specified thickness—a fact which warranted the building of the special machining tools. The available material was limited; therefore the equipment was made and attached in the following manner.

A 16-inch shaper was available, and an angle-plate, which had been made for use in planing the regular casting (and therefore which was of sufficient dimensions) was also made use of to clamp the pattern on the shaper. The tool-holding spindle was made from a piece of gas pipe of the required length. This pipe A, Fig. 1, was bored out at each end and a bronze bushing B inserted. The bushing at the pulley end

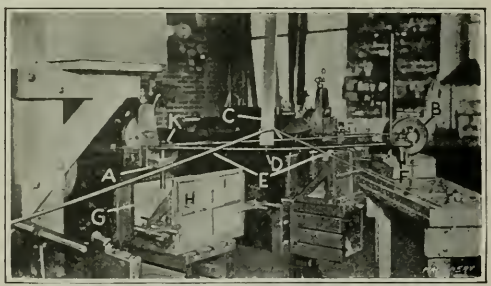


Fig. 2. Set-up, showing Method of employing Shaper to mill the Pattern

was bored out to 5/16 inch in diameter, and the bushing at the cutter end was taper-bored to fit the tapered sleeve E. The cutter-shaft D was made of 5/16-inch drill rod, on one end of which a cold-rolled collar or cutter-holder C was shrunk and pinned at L, after which the hardened steel tapered sleeve E was forced on the shaft, bearing against the cutter-holder. The opposite end of the cutter-shaft was

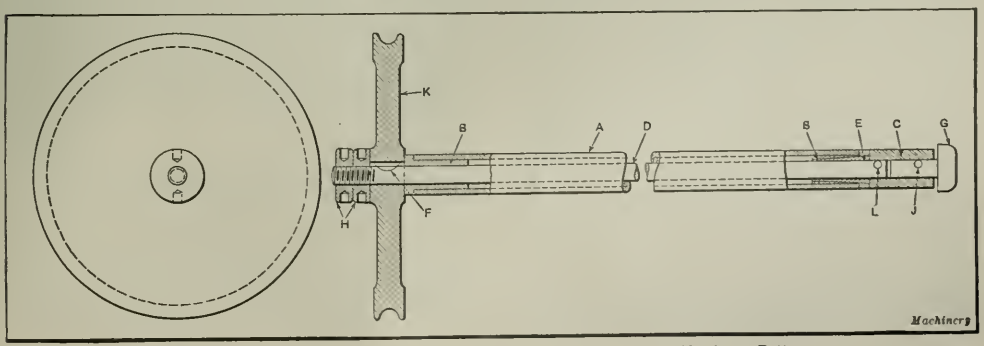


Fig. 1. Improvised Tool-carrying Spindle used in finishing Interior of an Aluminum Pattern

threaded and splined about an inch from the end for a small Woodruff key. The cutter G was then inserted in the holder and secured by means of a tapered pin J, after which the shaft, with holder C, cutter G, and sleeve E assembled, was placed in the gas pipe. The grooved pulley K was next assembled on the shaft by means of the key F, the entire unit being held in place by means of the check-nuts H. A further function of these check-nuts is to hold the tapered sleeve E and the bushing B in contact, the action being similar to that of a draw-in collet chuck. The space between the shaft and the inside of the gas pipe was partly filled with light grease for lubricating purposes. The cutters were hand made, as a milling machine was not available, and were shaped to fit the fillet in the inside of the pattern.

A cast-iron bracket A, Fig. 2, was made to hold the spindle, and was attached to the tool-head of the shaper by means of a special bolt, which was made to fit the toolpost hole. The drive was furnished by running a round belt from a ¼ horsepower motor B, mounted on an adjacent bench, to the pulley K on the spindle, the power being furnished by the lighting system. The pulley F was used to prevent the belt from slipping off the motor pulley. A pole or "mule" C was hooked to a ceiling joist, so that it could swing, and at its lower end carried a small idler pulley D. The function of this arrangement was to exert a constant pressure on the belt as the distance between the motor and the pulley increased or decreased with the traverse of the cutter-spindle. The pulley D was kept in contact with the belt by means of the tension exerted by weights attached to two pieces of rope E.

With the work G in place, clamped to the angle-plate H, the operation was performed by feeding the platen crosswise, using the shaper cross-feed handle, and by obtaining the forward and backward traverse by throwing the belt off the cone pulley and operating the ram by means of the stroke-setting handle. While the work was not finished in production time, it was a quicker method than scraping and much more accurate. This device has since been used on several similar jobs and has been found a satisfactory and efficient equipment.

St. Louis, Mo. J. W. GERDEL

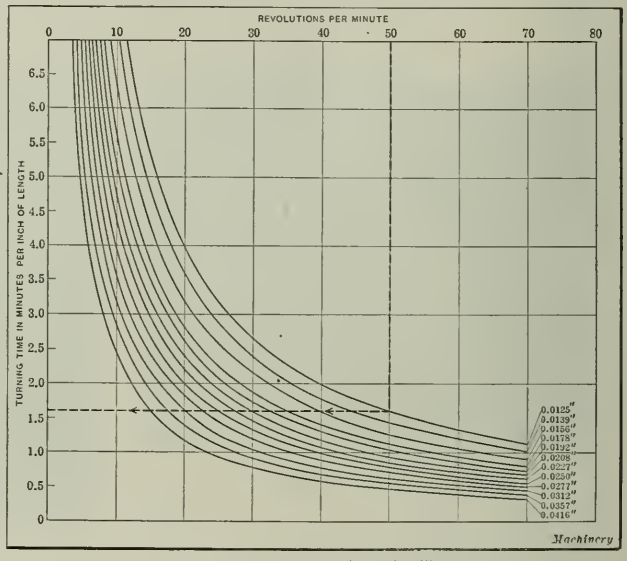


Chart used to obtain Lathe-turning Time

CHART FOR ESTIMATING TURNING TIME

Charts for finding the time required to perform a turning operation in a lathe may be readily constructed as shown in the accompanying illustration. The vertical lines represent the number of revolutions per minute of the work, as indicated by the notations at the top of the chart; while the horizontal lines indicate the time in minutes required for turning one inch of length. Although this particular chart was designed for use when estimating time consumed in performing work on a Hendey engine lathe, the feeds given in the lower right-hand corner of the chart and the curves corresponding to them may be varied to suit the style and size of the lathe in use. In order to obtain the total time for turning a given length, the time obtained from the chart must be multiplied by the total length of the work, since the chart is based on lengths of one inch.

Such a chart may be arranged for use in connection with thread cutting, provided the number of cuts required and the other conditions entering into the operation of thread cutting are taken into consideration. For instance, it would be necessary to multiply the time obtained from the chart by the number of cuts taken and to include the carriage return time. It will be seen, therefore, that the most dependable use to which such charts may be adapted is for turning rather than for thread cutting, owing to the numerous factors which must be considered when estimating thread cutting time. On rough work, such as bolts, nuts, and similar parts, there are not so many cuts required as, for instance, on the more accurate precision screws and thread gages. No definite rules govern this, however, except as may be decided upon by good shop practice.

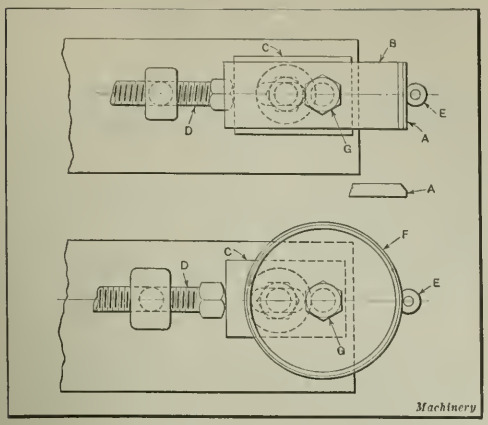
In making the chart it will be found convenient to tabulate the spindle speeds for various sizes of lathes, as taken from the specifications of the machine. If a great variety of speeds is used, those charts which include the higher numbers of revolutions per minute should be made to scales which will take care of the corresponding decrease in time, so that the curves will not blend into each other at the lower right-hand corner of the chart. Data of this kind, when arranged in chart form, will be found helpful in the drawing and planning departments, where much estimating is done, which will result in a saving of time that would otherwise be consumed in working out formulas.

No detailed explanation of the use of the chart should be necessary, but the following example shows the direct advantages of such a chart. It is required to take one cut over a steel shaft 10 inches long. If the work revolves at fifty revolutions per minute and if the recommended feed for this speed is 0.0125 inch, the time for cutting one inch of length at this rate may be found by following the curve corresponding to this feed until it intersects the vertical line marked fifty revolutions per minute; then following horizontally to the left-hand margin, the time 1.6 minutes is read off. Multiplying this by 10 inches, the length of the shaft, the total time required is 16 minutes.

Plainfield, N. J. J. B. CONWAY

CIRCULAR BLADE FOR CUTTING OFF WIRE

Standard wire-working machines are usually furnished with a cutting-off arrangement similar to that shown in the upper part of the accompanying illustration. However, the continued use of a flat tool, such as B, will cause the cutting edge A to become dull and worn, requiring frequent regrinding. This results in loss of time and consequently of



Circular Blade attached to Cut-off Slide of a Wire-working Machine

considerable production, since several minutes are required to resharpen the cut-off and to replace it on block *C*. This block must also be reset every time a blade is reground, so that the cutting edge will just pass beyond the hole in the quill *E*. An improvement over this type of cutting-off blade is shown in the lower part of the illustration. Instead of a groove being cut in block *C* to hold the flat cut-off *B*, as in the first design, the block is finished with a flat face. A circular cut-off *F* is then substituted for the flat blade and is held stationary by means of a screw *G*. The block is set by adjusting screw *D* the same as when the flat blade is used.

The advantage of this attachment is that no adjustment and no regrinding are required when the cutting edge is renewed. When the cutting edge becomes dull, the screw *G* is simply loosened, and the circular blade slightly revolved and again clamped in position. A cut-off of this type will wear for several years without having to be removed from the machine. The writer recalls one instance in which such a cutter was used continuously for more than four years without being resharpened.

Baltimore, Md. S. B. Royal

WHY DON'T MORE PEOPLE USE LOGARITHMS?

One is often told that a practical knowledge of trigonometry and logarithms can be obtained only in colleges, but in more than forty years acquaintance with machinists, the writer has known of many men handling these subjects as easily and skillfully as the common tools of their trade, whose knowledge and facility were acquired in that popular and inexpensive institution—the College of the Midnight Lamp. There are, however, many persons, thoroughly familiar with the application of logarithms, who seldom or never employ them in their everyday work, even when considerable time would be saved by their use. The following example shows clearly the advantages gained by employing the logarithmic method of solving a practical problem in trigonometry.

The problem presented in the accompanying illustration is to determine the diameter *D* of a plug, which when laid in the gage, will be exactly flush with its top. The formula for the diameter required is found as follows: First construct the diagram shown at the right, making line *HK* equal to the distance from *A* to *B*, or 0.750 inch; then from point *H* draw line *HG*, making angle *GHK* equal to angle *FBP*. The magnitude of this angle is found by adding 90 degrees to 18 degrees 45 minutes, and subtracting the sum from 180 degrees, which gives 71 degrees 15 minutes. In a similar manner, determine angle *EAC*, which is found to be 76 degrees 30 minutes. Now draw line *KG*, making angle *HKG* equal to 76 degrees 30 minutes. Next draw two lines bisecting angles *GHK* and *GKH*, respectively, and through *L*, the point of intersection of the two bisecting lines, draw *LM* perpendicular to *HK*. It is evident that *LM* will be the radius of an inscribed circle and therefore will equal one-half the required diameter *D*. In triangle *HLK*, we have three known elements: Angle *LHK* equals 35 degrees 37 minutes 30 seconds, or one-half *GHK*; angle *LKH* equals 38 degrees 15 minutes; and angle *HLK* equals 106 degrees 7 minutes 30 seconds (180 degrees—35 degrees 37 minutes 30 seconds—38 degrees 15 minutes). Now in the oblique triangle *HLK*,

$$HL = \frac{0.750 \times \sin 38 \text{ degrees } 15 \text{ minutes}}{\sin 106 \text{ degrees } 7 \text{ minutes } 30 \text{ seconds}}$$

Then in triangle *HLM*, side *LM* equals side *HL* × sin 35 degrees 37 minutes 30 seconds. From these two equations it is evident that

$$LM = \frac{0.750 \sin 38 \text{ deg. } 15 \text{ min.}}{\sin 106 \text{ deg. } 7 \text{ min. } 30 \text{ sec.}} \times \sin 35 \text{ deg. } 37 \text{ min. } 30 \text{ sec.}$$

and as *LM* equals one-half the required diameter,

$$D = 2 \times \frac{0.750 \sin 38 \text{ deg. } 15 \text{ min. } \sin 35 \text{ deg. } 37 \text{ min. } 30 \text{ sec.}}{\sin 106 \text{ deg. } 7 \text{ min. } 30 \text{ sec.}}$$

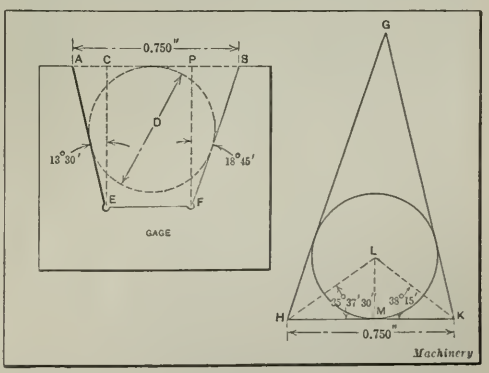
from which

$$D = \frac{1.5 \times 0.61909 \times 0.58248}{0.96066} = 0.563062 \text{ inch}$$

Thus to make the necessary calculations by natural numbers using five-place functions, calls for three multiplications and one division, requiring the use of more than a hundred figures. To solve the same problem using six-place logarithms, necessitates the making of only thirty-five figures not including the answer, thus:

Log 1.5	0.176091
Log sin 38 deg. 15 min.	9.791757
Log sin 35 deg. 37 min. 30 sec.	9.765279
Colog sin 106 deg. 7 min. 30 sec.	0.017431
Log diameter	9.750558
Diameter	0.563064 inch

From this example it will be clearly seen that the logarithmic method is not only simpler and easier than the arithmetical method, but also that more accurate results may be obtained. A still more striking example of the value of the logarithmic method is presented by a problem recently brought to the writer's attention, in which it was necessary to calculate the diameters of steel balls to weigh, respectively, 9/16, 7/16, 3/8, and 5/16 as much as a sample ball 1.3625 inches in diameter. Instead of extracting the cube root of each of these fractions and multiplying 1.3625 by the several roots, the simpler method of dividing the logarithm of each



Problem in Trigonometry and Diagram employed to derive Formula for its Solution

fraction by three and adding each quotient to the logarithm of 1.3625 was used, thus obtaining the required logarithm for each diameter.

New London, N. H. GUY H. GARDNER

REMOVING RUST FROM TOOLS

Tools which have become very rusty should be treated with a chemical solution, instead of trying to scour the rust off by means of emery cloth. A good solution for removing rust may be made as follows: Into one quart of distilled water dissolve, little by little, sufficient chloride of tin to obtain a saturated solution, that is, until the water will not dissolve any more of the salts. Put the tool into a receptacle containing the solution and let it stand over night. In the morning rinse the solution off in running water and dry thoroughly with a piece of chamois or cloth.

Youngstown, Ohio W. S. STANDIFORD

PUNCH PRESS OPERATIONS ON T-IRON BARS

In the July number of MACHINERY, page 1068, there appeared an article describing several punches and dies used in cutting operations on T-iron bars. Another punch and die which has performed similar operations satisfactorily is presented in this article. In this case, two operations are performed on one machine. The first consists of cutting out the web of the T-iron bar as shown at *A* in Fig. 1, the flange of the bar being cut off as shown at *B* by the second operation. The die *C* is employed in performing these operations. The dot-and-dash lines *X* indicate the position of the T-iron bar during the first operation. After this operation has been performed, the bar is turned and placed with one edge of the flange against the flat bar *D* as shown by the dot-and-dash lines *Y*, while the end of the T-iron bar is located against a stop in order to gage the length of the piece to be cut off. This stop is not illustrated. The bar is then properly located for performing the second operation. The tool-steel dies *E* are hardened and ground, and are secured to the cast-iron die-bed *F* by means of fillister-head screws and the dowel-pin *G*. The tool-steel pieces *H* relieve these screws and dowel-pin from end thrusts during the cutting operations. The die-bed has four holes to afford means for bolting to the press bolster. The T-iron bars are held in such a manner that they cannot move during the operations, and cuts without burrs are produced.

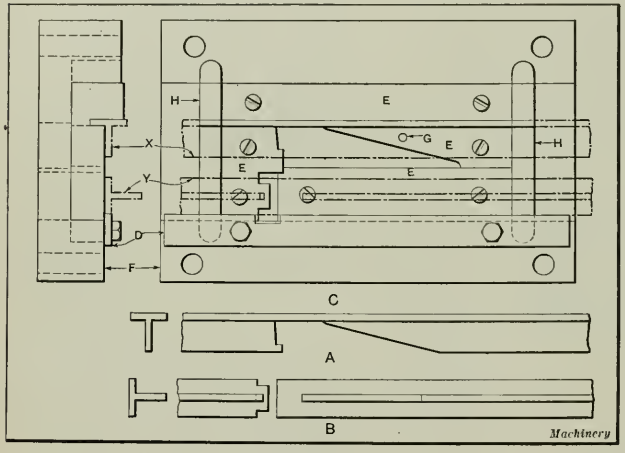


Fig. 1. Die for cutting T-iron Bars as shown at A and B

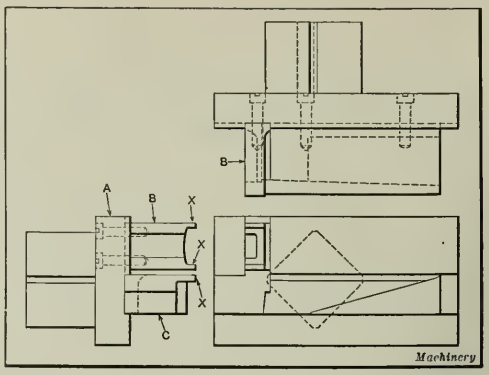


Fig. 2. Cutting Tools used in Connection with Die shown in Fig. 1

The punches and punch-holder employed in connection with this die are illustrated in Fig. 2. The cut-off punch *B* and the web-cutting punch *C* are held in slots in the holder *A* by means of fillister-head screws. The ends *X* of the cutting tools enter the die as the press ram descends and serve as guides during the cutting operations, thus preventing the tools from moving, while holder *A* has a square shank which prevents the holder from turning.

Fig. 3 shows a die which could have been used for performing the first two operations upon the T-iron bar in the article previously referred to. The construction of this die is similar to the one just described. As in that die, the bar is placed in the position indicated by the dot-and-dash lines *X* for the first operation. This operation leaves a portion *B* of the flange between the angular cuts on the web of the bar, which can be clearly seen in the detail of the bar shown at *A*. This metal is sheared out by a second operation after the bar has been placed in the position indicated by the dot-and-dash lines *Y*. By the use of this die, rapid production is obtained, as a finished piece is produced with every two strokes of the punch, and the cost of tools is reduced because both operations are performed on one machine.

New Britain, Conn. JOHN CLARKSON

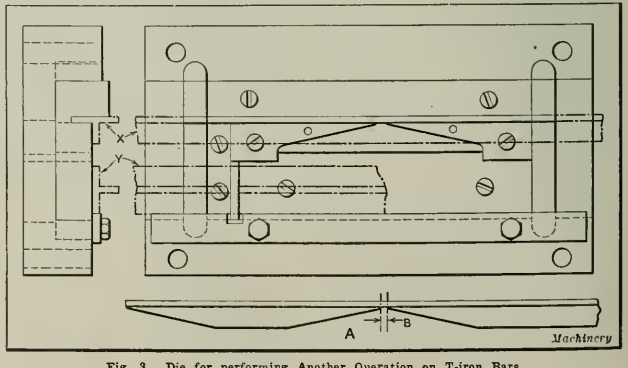


Fig. 3. Die for performing Another Operation on T-iron Bars

RAPID CALCULATION OF PIECE-WORK EARNINGS

A punch-card like that shown in Fig. 1 is used by men in a certain shop who are working by the piece work system. The workmen fill out the headings on the cards, after which the correct number of accepted pieces is punched in the card either by the foreman or by the inspector. A column is provided on the card to indicate the quantity of rejected pieces, and is used for the purpose of finding the costs of spoiled and defective pieces. If the number of finished pieces is greater than can be taken care of on one card, the surplus is punched on another card, and both are then attached to the time card for the day. In order that the card may be properly classified in the payroll department, it will be noted that the rate per piece is indicated at the bottom of the card.

A number of rate blocks such as shown in Fig. 2 are kept in racks, which are so situated as to be easily available for the payroll clerk. There should be a sufficient quantity of these blocks to cover all rates in active use in the shop, that is, one block for each different rate per piece, and each block carrying the rate marked on it. These rate blocks are simply pieces of hard wood over which transparent celluloid is stretched and fastened by means of brass strips and screws.

1013-76364

MAN John Doe NO. 420

OPERATION 471- 3rd DATE 5-27-19.

										REJ.
1	26	51	76	101	126	151	176	201	226	1
2	27	52	77	102	127	152	177	202	227	2
3	28	53	78	103	128	153	178	203	228	3
4	29	54	79	104	129	154	179	204	229	4
5	30	55	80	105	130	155	180	205	230	5
6	31	56	81	106	131	156	181	206	231	6
7	32	57	82	107	132	157	182	207	232	7
8	33	58	83	108	133	158	183	208	233	8
9	34	59	84	109	134	159	184	209	234	9
10	35	60	85	110	135	160	185	210	235	10
11	36	61	86	111	136	161	186	211	236	11
12	37	62	87	112	137	162	187	212	237	12
13	38	63	88	113	138	163	188	213	238	13
14	39	64	89	114	139	164	189	214	239	14
15	40	65	90	115	140	165	190	215	240	15
16	41	66	91	116	141	166	191	216	241	16
17	42	67	92	117	142	167	192	217	242	17
18	43	68	93	118	143	168	193	218	243	18
19	44	69	94	119	144	169	194	219	244	19
20	45	70	95	120	145	170	195	220	245	20
21	46	71	96	121	146	171	196	221	246	21
22	47	72	97	122	147	172	197	222	247	22
23	48	73	98	123	148	173	198	223	248	23
24	49	74	99	124	149	174	199	224	249	24
25	50	75	100	125	150	175	200	225	250	25

RATE-0.02

Fig. 1. Punch-card used in calculating Earnings of Piece-workers

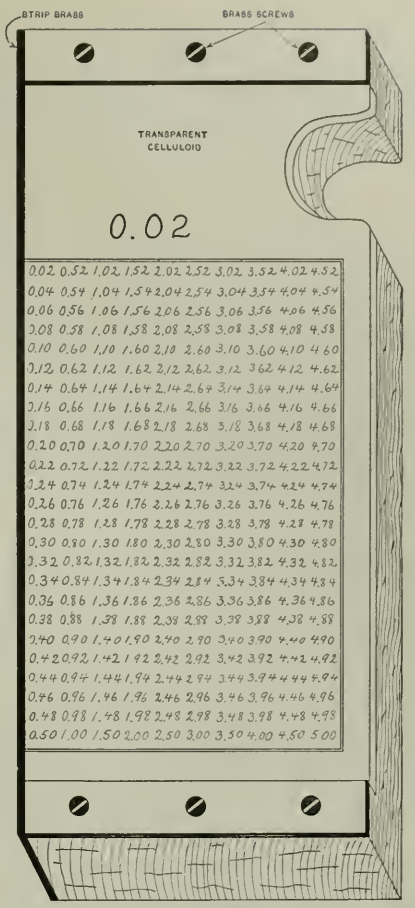


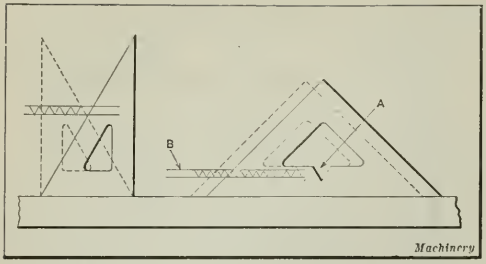
Fig. 2. Rate Block used in Connection with Punch-card shown in Fig. 1 for determining Amount a Workman earns at a Certain Rate on a Piece-work Basis

The amount a man would earn under a certain rate, from 1 to 250 pieces, is marked in ink on the celluloid sheet of the block corresponding to that rate, and in exactly the same position as the numbers appear on the punch-card. When the clerk inserts the punch-card under the celluloid on the rate block, the amount due the workman appears directly over the punch mark on the punch card. Although the block shown in the illustration is used for the easily computed rate of 2 cents, it will be seen that for rates such as $0.062, the possibility of an error occurring in computing the piece-work earnings is quite great. This simple scheme has proved valuable as a time-saver, and has practically eliminated mistakes in the payroll department.

Bellows Falls, Vt. S. P. KEATOR

KINK FOR DRAWING SCREW THREADS

When laying out a standard V-thread, it is customary to use a 60-degree triangle in the manner shown at the left in the accompanying illustration. In order to save time and simplify the operation, a small 60-degree angle *A* may be cut in the central opening of a triangle as shown at the right in the illustration, using an ordinary knife or file for the purpose. In constructing a screw thread, lay out two lines *B* to represent the depth of the thread and place the triangle on the T-square so that the 60-degree notch lies di-



Triangle with V-notch for Use in drawing Screw Threads

rectly over the two construction lines, then simply shift the triangle to the right and left alternately as required, using the sides of the notch as a ruling edge in drawing the thread. Similar notches may be cut in opposite positions on the triangle; the angle on drill ends, flat-head screws, etc., may then be represented in the same manner as previously described. Although a 45-degree triangle is used in the illustration, it is evident that any triangle may be employed equally as well. This method will prove a great convenience as well as a time-saver to the draftsman.

Toledo, Ohio — R. C. Eastin

KEEPING THE SLIDE-RULE IN GOOD CONDITION

The writer has found the following treatment to be a simple means of keeping a slide-rule in good working order. Clean thoroughly with kerosene and, after drying, sprinkle the contact surfaces of the slide with talcum powder. While applying the powder, work the slide in and out of the rule in order to spread the powder. This treatment will produce a smooth sliding action and render the rule less susceptible to the influence of varying climatic conditions which affect the degree of frictional resistance of the slide.

Philadelphia, Pa. — Thomas P. Laycock, Jr.

AREA OF A SEGMENT

The area of a segment may be found by employing the following formula, which is somewhat different from that given in Machinery's Handbook, page 132, and is much simpler in form, and therefore more convenient to use.

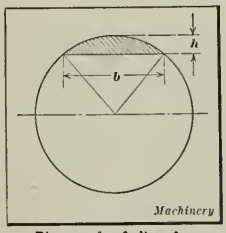


Diagram for finding Area of a Segment

Referring to the diagram:

$$A = \frac{h^3}{2b} + 0.6604\,hb$$

in which

h = height of the segment;
b = length;
A = area.

R. L. Friess
Bowling Green, Ohio

FIXTURE FOR CENTERING ECCENTRIC WORK

The fixture shown in Fig. 1 is for use on milling machines when centering work which has more than one center, such as a crankshaft. The device consists of a circular base A having two ears by means of which it is strapped to the machine table. There is a central plug B about which the V-block casting C may pivot, and a circular T-slot in which the heads of the clamping bolts travel when the position of the top part of the fixture is changed. The V-block casting holds the work while it is being centered, and carries a locating plug D which engages one of the four bushed holes, equally spaced in the base, so that the work may be indexed at every 90-degree turn of the fixture.

In use, after the fixture has been attached to the table of the machine, the work is clamped in the V-block with an equal overhang on each side, and with the center line of the wrist coincident with that of the machine spindle and directly above the center line of the shaft, as shown in Fig. 2. After the first center has been made, the table is raised an amount equal to the throw of the crank, using the machine dial to accurately locate the second center. To center the work at the opposite end, it is only necessary to loosen the clamping bolts in the base, remove the plug D, index the

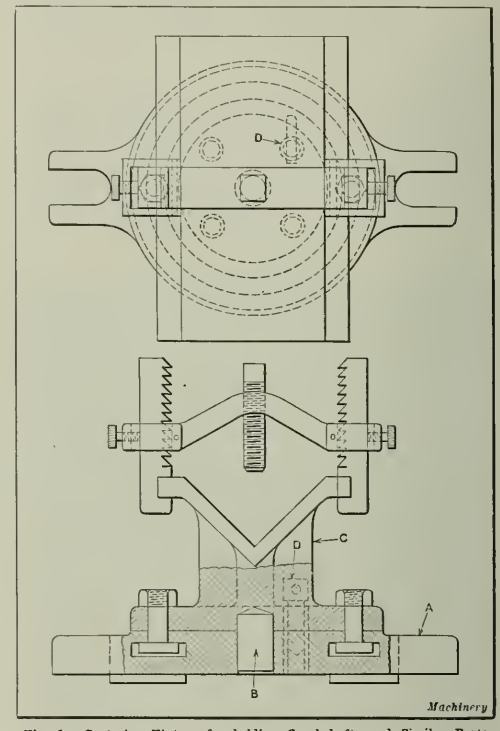


Fig. 1. Centering Fixture for holding Crankshafts and Similar Parts when centering

work-holding block 180 degrees, replace the plug and repeat the centering operation, but, of course, in this case, in the reverse order.

Many uses may be made of a holding fixture of this type. It will be found useful when centering special arbors such as used when machining cams and similar parts having a number of centers, and it may also be employed for clamping parts of various shapes when performing light operations

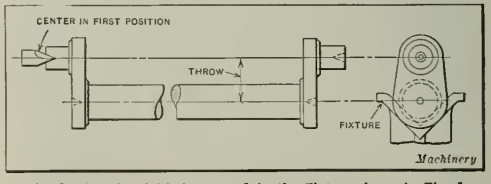


Fig. 2. Sample of Work centered in the Fixture shown in Fig. 1

on the ends of the work. Accuracy and a saving of time are two valuable advantages derived from the use of a fixture of this type.

Beverly, Mass. — John T. Clark

HOW AND WHY

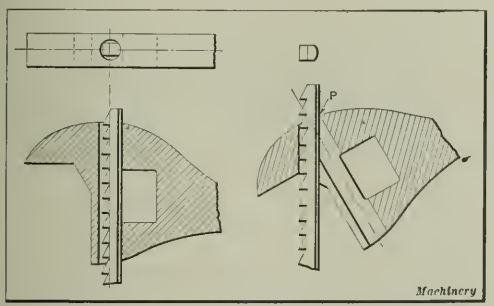
QUESTIONS ON PRACTICAL SUBJECTS OF GENERAL INTEREST

PRODUCTION PROBLEM FOR THE MACHINE SHOP

M. M. S.—What is the best method to employ, on a production basis, in removing stock from a wrench head in which the movable jaw of the wrench operates, as shown in the illustration on page 1086 in the July number of MACHINERY? The stock removed forms a slot which cuts into the previously drilled hole for the jaw rack.

ANSWERED BY CHARLES D. FOLSOM, JR., WHITESTONE, N. Y.

Several suggestions for the solution of this problem appeared in the August number of MACHINERY, but only one method was suggested by which it would be possible to perform the work as per specifications in a single operation. However, the job might also be performed in one operation on a keyseater. A broach-like cutter such as shown in the accompanying illustration should be used, although a standard keyway cutter might be adapted to the requirements of the job by rounding the back edge to the radius of the hole so as to obtain greater rigidity. A fixture would be required which should be designed after the same general principle as that illustrated in the August number, page 1182. The view at the left in the accompanying illustration shows the position of the cutter and work at the beginning of the operation, while at the right the position of the work is shown



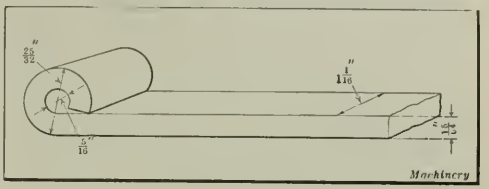
Relative Position of Cutter and Work before and after Performance of Operation

at the completion of the operation. While the cutter is reciprocating, the work should be swung around on the fixture with point P as an axis. A support for the cutter would be required and should be located immediately above the work in such a way as to be unaffected by the swing of the work around axis P. On account of the slenderness of the cutter, the latter provision should not be overlooked. A relieving device should also be incorporated in the support for the cutter, so as to operate on the upward stroke of the machine.

It would not be practicable to take heavy cuts with such a slender cutter. However, with a suitable holding fixture, the job could be put upon a production basis, using a simple inexpensive machine, which could be operated by unskilled help, and at the same time would maintain a rate of production which, in the opinion of the writer, would be somewhat higher than by any other method so far proposed.

PRODUCTION PROBLEM FOR THE FORGE SHOP

H. C. T.—The end of a steel bar must be rolled to the shape shown in the accompanying illustration. These pieces are in lengths of 150 millimeters (about $5\frac{29}{32}$ inches) and 200 millimeters (about $7\frac{7}{8}$ inches). The size of the stock is 27 millimeters wide ($1\frac{1}{16}$ inches) and 6 millimeters thick (about



Bar with Rolled End for the Manufacture of which Suitable Dies and Information are required

$\frac{15}{64}$ inch); the diameter of the rolled end is 20 millimeters (about $\frac{25}{32}$ inch), and the diameter of the eye is 8 millimeters (about $\frac{5}{16}$ inch). These ends have previously been handforged, but it is desired to increase production and decrease manufacturing expense by equipping a power press with a suitable die. The table of the power press upon which it is desired to perform this operation is 500 millimeters long (about $19\frac{11}{16}$ inches) and 480 millimeters wide (about $18\frac{29}{32}$ inches); the length of the die-holder is 350 millimeters (about $13\frac{25}{32}$ inches); and the space between the table and the die-holder is 490 millimeters (about $19\frac{5}{16}$ inches). This production problem is submitted to the readers of MACHINERY with the hope that some valuable suggestion may be offered as to the construction of suitable dies to use and advice as to whether or not this job could be performed cold.

A GEOMETRICAL PROBLEM

H. H. B.—A problem quite often encountered in lay-out work is illustrated in the accompanying diagram. It is required to find the values of x and y, these lengths being measured from the intersection of the perpendicular h with the base c. The three sides of the triangle are the only known values. Formulas for obtaining these values are desired, which do not involve numerous or long arithmetical computations.

ANSWERED BY ELMER LATSHAW, WEST PHILADELPHIA, PA.

The method that might first suggest itself is to find the angle A (or B) by some such formula as

$$\cos A = \frac{b^2 + c^2 - a^2}{2bc} \qquad (1)$$

and then solve the right triangle for y by the formula

$$y = b \cos A \qquad (2)$$

Formulas (1) and (2) can be combined as follows

$$y = \frac{b^2 + c^2 - a^2}{2c} \qquad (3)$$

The value of x can be determined in a similar manner.

The solution of a formula of this type is simple enough when a, b, and c are values having but two or three digits,

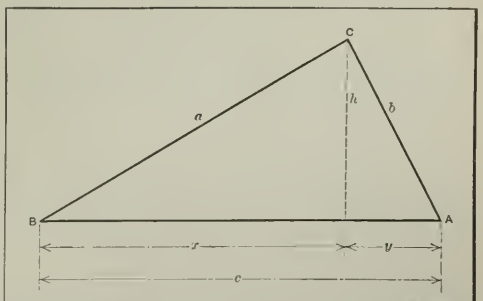


Diagram illustrating the simple Solution of a Geometrical Problem

or if they are simple integers, but if they contain four or five figures each, the work becomes laborious and mistakes are likely to occur when squaring these numbers.

Simpler formulas, as far as the numerical calculations are concerned, may be deduced as follows:

$$a^2 - x^2 = b^2 - y^2$$

Transposing and factoring the above equation

$$(x - y)\ (x + y) = (a - b)\ (a + b)$$

from which

$$x - y = \frac{(a - b)\ (a + b)}{x + y}$$

Since $x + y = c$, if we let $x - y = K$, this equation may be expressed thus:

$$K = \frac{(a - b)\ (a + b)}{c} \qquad (4)$$

But

$$x = \frac{(x + y) + (x - y)}{2}$$

and

$$y = \frac{(x + y) - (x - y)}{2}$$

Then substituting for $(x + y)$ and $(x - y)$

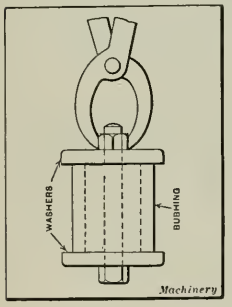
$$x = \frac{c + K}{2} \qquad (5)$$

$$y = \frac{c - K}{2} \qquad (6)$$

Now by examining Formula (4) it may be seen that only one multiplication and one division need be made, the other calculations consisting of simple addition and subtraction. This is a condition that will greatly reduce the liability of mistakes when solving the problem. The actual work required when solving by this method involves simply the solution of Equation (4), from which the value of K is substituted in Equations (5) and (6) when solving for x and y.

TO REDUCE A BUSHING THAT HAS BEEN MADE OVER SIZE

R. V. L.—If a jig bushing, say ¾-inch inside diameter, has been made a few thousandths inch over size, how could it be heat-treated and reharddened so as to reduce it to size or a few thousandths inch under size?



ANSWERED BY M. JACKER
SAN FRANCISCO, CAL.

This bushing could be reduced in size by the following method: Bolt an iron or steel washer securely against each end of the bushing as shown in the illustration; then heat slowly to a cherry red, and plunge into a cooling bath; this will reduce the size.

FORMING DEEP CORRUGATIONS

H. A. A.—Corrugated parts similar to the one illustrated in the June number of MACHINERY, page 978, are required in large quantities. How can they be produced? Copper having a thickness of about 1/64 inch is to be used.

ANSWERED BY JOHN J. POLE, GENEVA, N. Y.

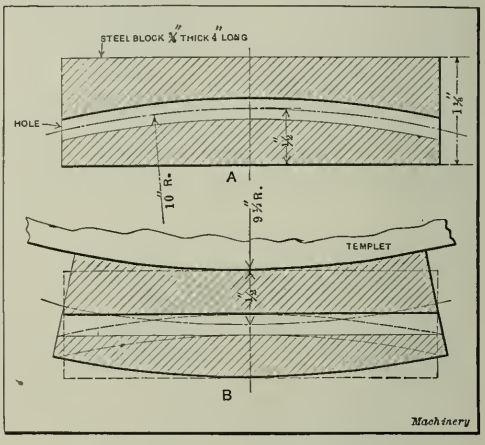
Referring to the manufacturing problem which was submitted in the June number of MACHINERY and answered in the August number, it is the writer's opinion that the method outlined for performing the operation would be rather expensive, and the following suggestion is offered in its place: Form the piece between two sets of rollers of such diameters that the inside set may pass through the piece when the work is completed. Provision would have to be made to space the rollers properly and to close them up as the work progressed. One set of rollers could be mounted on the lathe spindle and the other set fed up, the work being between the two sets of rollers. The inside set of rollers would drive the work if the outside set were fed up carefully.

A MACHINIST'S PROBLEM

L. M.—How can the hole shown at *A* in the accompanying illustration be machined? The hole is approximately ¼ inch in diameter and the curvature of its longitudinal center line must conform to that of an arc having a 10-inch radius.

ANSWERED BY AUGUST LEJEUNE, AMBRIDGE, PA.

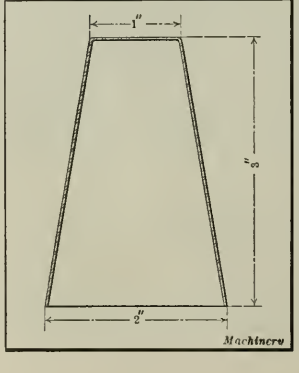
First make a templet the contour of which is determined by an arc having a radius equal to the difference between



Method of producing a Curved Hole in a Steel Block

10 inches and ½ inch (the required distance from the center line to the edge of the stock), or 9½ inches. Then bend the steel block to fit the templet, as shown at *B*. The hole can now be drilled straight through the block as indicated. The dimensions given in the illustration at *B* show the proper location of the hole. Upon straightening out the stock, the hole will have the required curvature as indicated by the dotted lines.

SHELL DRAWING OPERATION



O. J. L.—A shell of the dimensions shown in the accompanying illustration is to be drawn from No. 26 gage aluminum. It would no doubt be of general interest to the readers of MACHINERY if anyone who has performed drawing operations on the power press on shells of this or similar shape and size can furnish illustrations and a description of the dies which have actually been used in performing such work.

National Machine Tool Builders' Convention

THE annual convention of the National Machine Tool Builders' Association, held at the Hotel Astor, New York City, Wednesday and Thursday, October 15 and 16, was probably attended by a larger number of machine tool builders than any previous convention. Addresses were made by President Newton; William R. Basset (Miller, Franklin, Basset Co., New York City); Bainbridge Colby, New York City; George B. Mallon, Bankers' Trust Co., New York City; and by Alexander Luchars, publisher of MACHINERY. President Newton referred briefly to the great value of the machine tool industry and what it has accomplished. The importance of increased production as an essential factor in solving present difficulties was emphasized, and also in this connection the necessity of new and faster producing tool equipment as a means of compensating for high wages and inadequate labor supply.

Mr. Basset's address was on "Uniform Cost Accounting," and was confined principally to fundamental points rather than to the details of cost-finding methods. Stress was laid upon the necessity of including in costs every item of expense. It was pointed out that there are some items which the average manufacturer almost invariably overlooks. In machine tool building, as an example, there is the matter of spoiling work in process of manufacture. The common practice is to determine costs of parts by obtaining the operation costs for labor and overhead, but neglecting the cost of spoiled parts. This element of spoilage is mentioned as one of possibly several hundred items which the average machine tool builder may not consider when devising a cost system. The question of profit-sharing, which has been discussed considerably within recent years, was also considered by Mr. Basset, who emphasized the point that any sharing of the profits should be done in such a way that it becomes a direct incentive and traceable to the work done by each employe. Incidentally, labor bonuses frequently are not included in the costs. Mr. Basset also referred to the necessity at the present time of so handling the cost accounting problem that sufficient provision be made to pay the heavy federal taxes, which cannot be included in costs. Another important point regarding uniform cost was that manufacturers who do not know about their costs are to be feared, since this represents unintelligent competition.

Mr. Colby's topic was "World Relations and Markets." One of the vital points referred to was the utter lack of men in the United States who are competent to deal properly with foreign trade problems. While the advantages of foreign trade and of locating the world's financial control in this country are appreciated, we do not understand clearly the processes and methods by which the desired results may be obtained. "America," said Mr. Colby, "is by no means out of the van in many important commercial and financial fields, but we are not proficient. For instance, we are far behind European nations in a knowledge of the principles and fundamentals of international banking. Throughout the period of the war, London, despite reeling blows dealt British credit and the enormous strains of financing great war loans, was able to maintain a discount rate somewhat less than one-half the prevailing rate in New York. This was done by understanding the subject of credit. The American banker thinks after he has loaned 80 per cent of his cash resources that he has done all that can be expected. The boundary of his usefulness is determined by the amount of money in the bank over and above legal reserve. That is not the view of the British banker, who does not rate a depositor according to the amount of his balance, but upon his value in the legitimate utilization of the bank's resources and credit. The British banker will float some great loan without touching his cash resources, simply because he has marshalled the credit, whereas the American institution would practically have to pledge its cash resources and then sell the securities." Mr. Colby also referred to the value of a thorough knowledge of foreign languages, and other points closely related to foreign trade development.

The address by Mr. Mallon was on "International Finance," but the labor question and causes of social unrest were also discussed. In dealing with the subject of finance, attention was called to the fact that our rates of exchange are now against all the European countries that offer us the best markets; that such a condition tends to limit our exports to absolute necessities and that Europe needs long-term credits, and it is vitally important that America furnish them, in order to develop export business. Reference was made to the widespread realization of the necessity for a broad market for foreign securities in this country to facilitate export trade, and that such securities must be made not only safe to command public confidence, but also attractive to the investor. Mr. Mallon also referred to the demand at the present time for a type of corporation that is able to finance any kind of export business so that the American producer and the European consumer may sell and buy at once. This would be a stock company and in effect a banking corporation doing a foreign exchange business on long-time credits. Some such plan is being considered and it seems probable that something of this kind will be devised.

Alexander Luchars, who had recently returned from Europe, where he had investigated machine tool conditions as Trade Commissioner of the Department of Commerce, spoke on his experiences in Europe and about the conditions that prevailed in the machine tool trade there, summarizing the information given in his reports.

On Thursday morning, the session was devoted exclusively to committee meetings, and the Thursday afternoon session, to election of officers, etc. The officers for the past year were all re-elected, and are as follows: A. E. Newton, Reed-Prentice Co., Worcester, Mass., president; A. H. Teuchter, Cincinnati Bickford Tool Co., Cincinnati, Ohio, first vice-president; E. J. Kearney, Kearney & Trecker Co., Milwaukee, Wis., second vice-president; C. Wood Walters, Cincinnati Milling Machine Co., Cincinnati, Ohio, secretary; Winslow Blanchard, Blanchard Machine Co., Cambridge, Mass., treasurer; and C. E. Hildreth, Whitcomb-Blaisdell Machine Tool Co., Worcester, Mass., general manager.

* * *

The Westinghouse Electric & Mfg. Co. is erecting at its East Pittsburg plant a restaurant seating about 3,500 people. The building is of three-story brick construction, located adjacent to the two main shop entrances. The first two floors will have cafeteria service and will seat 2,500 people. The third floor has a table service restaurant and seats over 1,000 people. This floor can also be used for meetings of various organizations and committees. Interesting mechanical features are being developed in connection with this restaurant. The cafeteria counters have moving conveyor belts which carry the trays of food placed upon them, and several other features which combine engineering with restaurant service have been introduced.

American Gear Manufacturers' Convention

First Steps in Important Standardization Work

THE American Gear Manufacturers' Association held its semi-annual convention at the Copley-Plaza Hotel, Boston, Mass., October 13 to 16, at which meeting a number of important matters, particularly with regard to the society's work in the standardization of gearing, were taken up. At the opening meeting the president of the association, F. W. Sinram, of Cleveland, Ohio, made a brief address relating mainly to the progress of the association. The members were then welcomed to Boston by Frank Burgess, of the Boston Gear Works, who spoke on behalf of the New England gear manufacturers. Various reports were then read by which it was shown that the society is growing in every direction, being now composed of sixty-nine member companies.

At the meetings during the following days papers were read on "Hindley Worms Gears," by H. Fleckenstein, of the Hindley Gear Co., Philadelphia, Pa.; "Uniform Cost Accounting," by A. A. Alles, Jr., of the Fawcus Machine Co., Pittsburg, Pa.; "System and Organization as They Fit Commercial Activities," by S. L. Nicholson, of the Westinghouse Electric & Mfg. Co., Pittsburg, Pa.; "The Individual and Associations," by H. D. Sayre, secretary of the National Metal Trades Association, Chicago, Ill.; "The Labor Problem," by Rodger W. Babson, Wellesley Hills, Mass.; and "Herringbone Gears," by A. F. Cooke, of the Fawcus Machine Co., Pittsburg, Pa.

Standardization Activities

Several of the sessions were devoted to the question of standardization, and the recommended practice for composition gearing, as proposed at the third annual meeting held at Cleveland last spring and now prepared and proposed for adoption as a definite standard of design, was accepted with slight changes. Another report prepared on gears and pinions for electric railway service was accepted as recommended practice. The subject of bevel gearing was also dealt with, and part of the report prepared and proposed by the committee having this matter in hand was accepted as recommended practice. Finally, there was also submitted by the special committee on limits for holes a recommended practice for holes, which was accepted. All of these standards of design or recommended practices will be published in coming numbers of MACHINERY.

The society appears to have definitely begun its work on standardization, and to have accomplished a great deal in the comparatively short time during which this work has been in progress. The standards and the recommended practice accepted by the association will be submitted to the American Engineering Standards Committee with the idea that the standards adopted for gearing may reach a much broader usefulness and be accepted as standards of practice in a much more extended field than that covered by the association itself.

Standardization Methods of the American Gear Manufacturers' Association

The methods in standardizing designs, adopted by the American Gear Manufacturers' Association, classify proposed practice in three different ways as follows: (1) as adopted standards; (2) as recommended practice; and (3) as suggested standards for future design.

Adopted Standards—Any rule, definition, practice, or basis of test adopted by the American Gear Manufacturers' Association as a definite standard shall be known as an "adopted standard." Adopted standards shall be adopted only upon unanimous vote of the members present at a general meeting, following four weeks' notice. An adopted standard may only be rescinded or amended following four weeks' notice, by a two-thirds vote of the entire membership, or upon unanimous vote of the members present at a general meeting. Gears made in compliance with the adopted standards of the American Gear Manufacturers' Association may bear a distinguishing mark to that effect.

Recommended Practice—Any suggestion or practice with reference to which it is impracticable to require rigid acceptance by each member of the American Gear Manufacturers' Association, but with reference to which it is desirable to recommend uniform practice, shall be approved and known as "recommended practice." Recommended practice shall be adopted only upon two-thirds vote of the members present at a general meeting, following four weeks' advance notice. The notice shall state specifically that the rule is being submitted as "recommended practice." Suggestions of recommended practice may be rescinded or amended by a majority vote of those present at any general meeting, following four weeks' advance notice.

Suggested Standards for Future Design—Any rule or standard which cannot be approved either as an adopted standard or as recommended practice, but is merely recommended for future designs, shall be adopted and known as "suggested standard for future design." The same vote is required for suggested standards for future design as specified for recommended practice. Suggested standards for future design can be rescinded or amended by majority vote of those present at any general meeting, following four weeks' advance notice.

Abstract of Paper on Hindley Worm-gearing

In his paper on Hindley worm-gearing, Mr. Fleckenstein mentioned that the first machine designed for the commercial production of Hindley worm-gears was built about 1878, when Stephen A. Morse became interested in a patent on a machine for cutting Hindley worm-gears. He obtained the right to build one of these machines, and proceeded to have one made. After the usual complications met with in building a new type of machine, he finally developed a successful machine, about 1880, and at that time cut Hindley worm-gears on this machine. Later several machines were built and all worm-geared elevators manufactured by Morse, Williams & Co., were equipped with Hindley worm-gears, and much of the success of these elevators was due to the type of gearing used, which had an unusually long life. About 1883, the United States Government recognized the merits of the Hindley worm-gears, and began using them on steering engines, windlasses, turrets, valve motions, etc., where a drive was required that would carry heavy loads subjected to shocks, or where it was essential to eliminate lost motion. Since that time, the applications for Hindley worm-gears have been multiplied, and some application of this type of gearing is now found in practically every industry.

The advantages of Hindley gears, as pointed out by Mr. Fleckenstein, are as follows: (1) They have a greater number of teeth in contact for a given pitch. (2) They can be made with a greater depth of tooth. (3) The teeth on the wheels have a straight side, which produces a flat bearing surface between the threads on the worm and the wheel teeth. On account of this fact, they have a greater bearing surface, and slide together correctly. Hindley worm-gears are especially adaptable for large reductions and high speeds.

The social side of the convention was, as usual at the Gear Manufacturers' meetings, well taken care of. The visiting members and guests were entertained at luncheon on the first day of the meeting by the New England members, and sightseeing trips and the usual informal dinner concluded this part of the program.

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW AMERICAN METAL-WORKING MACHINERY

Becker Die-Sinking Machine. Becker Milling Machine Co., Hyde Park, Boston, Mass. 277
Precision Thread Grinder. Precision & Thread Grinder Mfg. Co., 1932-1934 Arch St., Philadelphia, Pa. 278
P. E. Chapman Armature Winding Machine. P. E. Chapman Electrical Works, Tenth and Walnut Sts., St. Louis, Mo. 278
Lafayette Universal Grinder. Lafayette Tool & Equipment Co., 21 S. 12th St., Philadelphia, Pa. 279
W. J. Pine Straightening Machine. W. J. Pine Machine Co., 411-415 Jenne St., Kenosha, Wis. 280
"Namco" Bar Pointing Machine. National Acme Co., Cleveland, Ohio 280
Whitney Motor-driven Saw Bench. Baxter D. Whitney & Son, Winchendon, Mass. 281
Surface Combustion Oven Furnace. Surface Combustion Co., 366-368 Girard Ave., Bronx, N. Y. 281
Cylinder Testing Machine. Federal Products Corporation, 393 Harris Ave., Providence, R. I. 282
Giddings & Lewis Boring Machines. Giddings & Lewis Mfg. Co., Fond du Lac, Wis. 282
Rockwell Hardness Tester. S. P. Rockwell, 122 Dickerson St., Syracuse, N. Y. 283
Ott Internal Grinding Machine. Ott Grinder Co., 217 W. 10th St., Indianapolis, Ind. 284
Stockbridge Shaper Attachment. Stockbridge Machine Co., Worcester, Mass. 285
Dreses Simplex Radial Drilling Machine. Dreses Machine Tool Co., Cincinnati, Ohio. 285
General Electric Rivet Heater. General Electric Co., Schenectady, N. Y. 286
Kremer-Cummins Mechanical Belt Shifter. Kremer-Cummins Machine Co., 1831-1833 E. 55th St., Cleveland, Ohio. 286

Becker Die-Sinking Machine

A model D-1 die-sinker has recently been added to the line of milling machines built by the Becker Milling Machine Co., Hyde Park, Boston, Mass., which is said to have an exceptionally wide range and capacity. This machine was designed primarily for die-sinking, where an ample range is required owing to the size of the largest dies which run up to 10 tons in weight, and at the same time is capable of performing accurate die-sinking operations. The light spindle allows great ease of manipulation, which is necessary to get the delicate adjustment required to "follow the line" with convenience to the operator. This machine incorporates most of the improved features of the later types of milling machines manufactured by this company, together with many new and valuable improvements. It is rigidly constructed, and the knee, saddle, and table have been made exceptionally rugged. The knee, which is of great width, is elevated and lowered through two telescopic screws that are connected by gearing to move simultaneously, and being perfectly coordinated they are controlled by a single lever. In order to correct the alignment of the table, due to wear of the mechanism, an adjustment is provided on each screw. These screws also provide a double support for the knee, each screw being well out from the center of the machine to prevent undue deflection in the table, caused by the numerous stresses incident to the large overhang when the table is moved to its extreme limit on either side. The knee is also supported by the frame or column of the machine by means of the Becker patented knee gibbing. A horizontal cross-section of this gibbing is shown in Fig. 2. From this illustration it will be noticed that the forward pull on the gib is not carried by the screws holding the gib in place but by the locking construction of the gib itself, thus distributing the strain along the entire bearing surface of the frame.

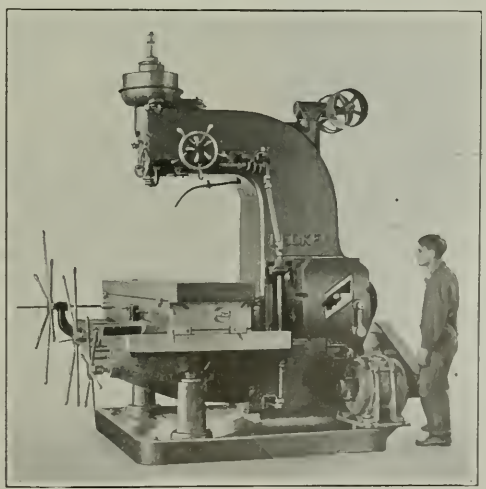


Fig. 1. Model D-1 Die-sinker built by the Becker Milling Machine Co.

The knee is reinforced by heavy ribs running in both directions, which are cast on the inside, and the spaces between the ribs on the top surface are closed by hand hole covers which prevent the accumulation of dirt and chips. The saddle is the same length as the table; namely, 96 inches, and slides on a tapered gib at the center of the knee, having in addition a wide flat way at each end; thus providing five generous bearing surfaces. The table is attached to the saddle by a straight gib and has a bearing the full length of the working surface, and it is provided with power rapid traverse in either direction; also a fine hand adjustment which is controlled from the front of the knee or at either end of the table. There are three ¾-inch T-slots in the table, oil-grooves on the side, and an oil-pan at each end for collecting the cutting lubricant which is returned to a tank cast in the base of the column by means of a flexible metallic tube.

A particular feature of this machine is the centralized control, which allows the operator, standing in his position at the front of the machine, to operate all hand and power feeds conveniently. Adjustable stops are provided for all of the various movements. The spindle is back-geared and driven by a 4-inch double waterproof belt, which transmits power to the spindle quite uniformly and gives to the work the smooth finish so much desired in die-sinking and similar work. The spindle is of the "barrel type" of construction and is provided with an adjustable automatic stop, a micrometer stop gage, fine hand adjustment, and a quick-return mechanism. The construction of the head is shown in Fig. 3. The spindle is made of crucible steel and it is carried in a conical sleeve bushed with hard bronze bearings. Collars are provided for adjusting to compensate for wear in the bearings. The end thrust is carried upon ball thrust bearings supported on

the end of the conical sleeve. This construction prevents the possible seizure of the spindle due to unequal expansion of the bronze and iron. The micrometer stop is located directly on the front of the spindle, this position having been found very convenient for setting operations. The stop and the slot in which it runs can be seen on the front of the spindle head in Fig. 1. In working out the design of this machine, the back-gears are located on the upper part of the head directly under the spindle driving pulley, and they are operated by a small lever projecting from the bottom of the bowl-shaped casting just beneath the spindle pulley. The feed-box is of the positive gear type. The feed is obtained from the lower drive shaft by a gear train to the feed-box. Eight feeds are obtained for each motor speed in geometrical progression, making it convenient to obtain any feed that may be most suitable for the particular job that is being done.

There are thirty-two feeds obtainable with a multi-speed motor and fifty-six feeds with the constant-speed motor, as follows: With an open belt, varying from 0.0024 to 0.0621 inch per spindle revolution, and with back-gears from 0.0126 to 0.3260 inch per spindle revolution.

There are fourteen spindle speeds obtainable when the power is supplied from lineshafting through the speed-box or from a constant-speed motor direct connected to the speed-box, varying from 73 to 438 revolutions per minute with open belt, and 14 to 83 revolutions per minute with back-gears. Eight spindle speeds are obtainable when the power is supplied by a multi-speed motor varying from 149 to 447 revolutions per minute with the open belt, and from 28 to 84 revolutions per minute with the back-gears.

The spindle is provided with a draw-bar and is stopped and started by a treadle at the left of the base, when constant speed is provided. The moving member of the clutches for engaging the power rapid traverse to the table is so made that it is impossible for both to be engaged at the same time. When motor drive is desired, the motor is placed on an extension of the base of the machine at the right side at the rear. A 7½-horsepower constant-speed motor running at 1200 revolutions per minute, or a 7½-horsepower multi-speed motor with speeds of 600, 900, 1200 and 1800 revolutions per minute, or a 7½-horsepower variable-speed motor having a ratio of 3 to 1, is recommended. When either a multi-speed or a variable-speed motor is used, the speed-box is not necessary.

Extras, such as arbor supports, an oil-pump with connections, a rotary table with a circular top graduated to 360 degrees, having a working surface 30 inches in diameter and a draw-in chuck for holding cutters, can be furnished. Another important device is the cherrying attachment for die-sinking.

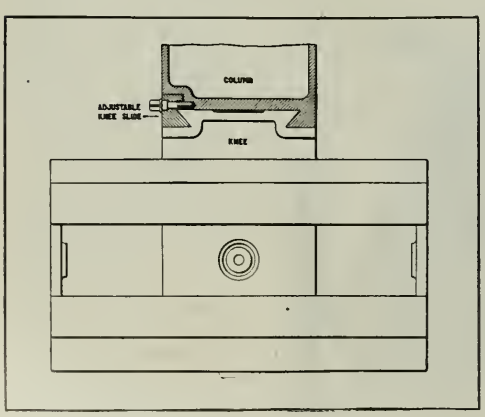


Fig. 2. Horizontal Cross-section of the Gibbing in the Knee

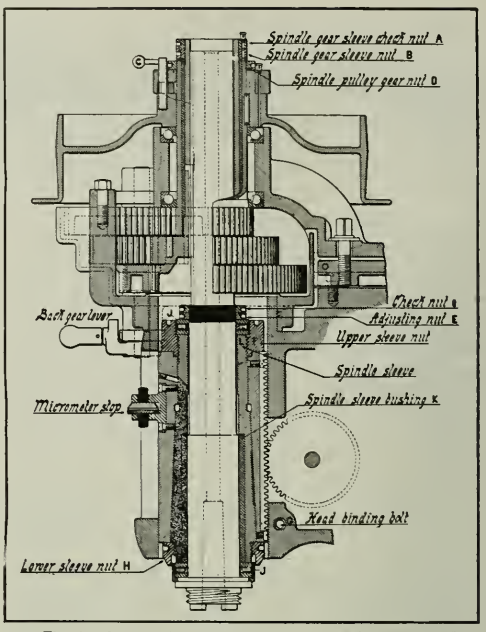


Fig. 3. Construction of the Head of the Becker Model D-1 Die-sinker

PRECISION THREAD GRINDER

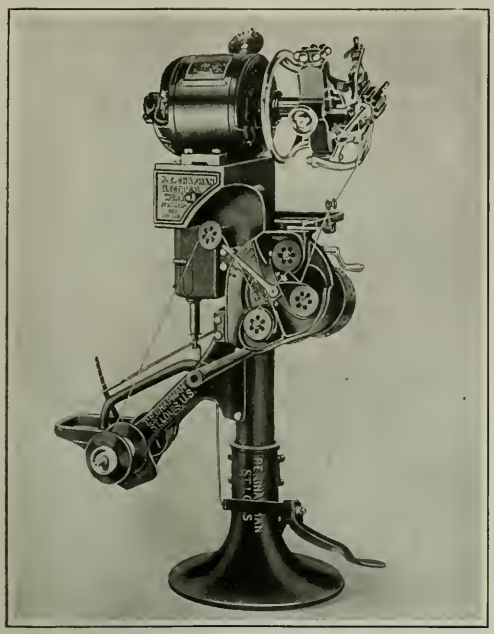
The thread grinding machine built by the Precision & Thread Grinder Mfg. Co., 1932-1934 Arch St., Philadelphia, Pa., has been improved by attaching the arm used when dressing the wheel to the base of the machine, instead of to the housing slide. The advantage gained by this arrangement is that the correct angle can be obtained when dressing the wheel, because of the accurate alignment which is made possible with the axis of the work. The new arrangement of the arm also permits a 5-inch wheel to be used.

The adjusting screws for the slide are made with finer pitch than formerly, and they are also made left-hand so as to be more handy to operate. An electric switch has been placed in the line, within a few inches of the machine, so that the power for the motor can be controlled without the operator moving away from the machine. Stop-pins have been introduced on the arm used for dressing the wheel at 60-degree and 55-degree positions, so that rapid settings may be made for dressing the wheels for grinding either the U. S. standard or Whitworth standard threads.

P. E. CHAPMAN ARMATURE WINDING MACHINE

The P. E. Chapman Electrical Works, Tenth and Walnut Sts., St. Louis, Mo., announce a much more complete model of the Chapman adjustable bipolar drum armature winding machine, in the Style 3 equipment as shown herewith. This model, in addition to being adjustable in a few minutes for any style and size of random wound bipolar drum armatures and any size of wire from No. 20 to No. 36, has some special features enabling it to wind a very great amount of wire into armature slots without pounding the wire, and it also has some unique lead forming and handling features for reducing the labor on this part of armature winding. The driving motor, controller, turn counter and other necessary members are all integral parts of the machine; in fact, the machine is self contained.

A new automatic dynamometer controlled reel-holder and tension device has been perfected, which it is claimed stops



Armature Winding Machine built by the P. E. Chapman Electrical Works

all spool troubles and enables quick starting, high speed, great tension and quick stops, so that only about five seconds are required to wind in a coil. This reel-holder and tension device are simultaneously adjusted for any sizes of wire by a simple crank, and once adjusted need no further attention until the reel is empty. It is said that the announcement of this device has been held back long enough to prove the machine a success in actual practice. In one case an output of nearly 600 per day was obtained where the estimate was 200 to 250. It is claimed that the output of the machine runs into hundreds of armatures per day on many sizes and kinds of armatures; that the saving over hand winding usually is anywhere from 10 to 30 to 1 or even better, and that the machine is easy to operate, well and strongly built; that it is useful both in the jobbing shop and in the factory. The machine is also useful for winding field coils, smaller armature coils, etc.

LAFAYETTE UNIVERSAL GRINDER

The Lafayette Tool & Equipment Co., 21 S. 12th St., Philadelphia, Pa., has recently placed on the market a universal grinder for precision tool-room work. This machine is illustrated in Fig. 1. While one of its most obvious applications is on a tool-room lathe for both internal and external thread gage grinding, this machine is also intended as a grinding machine when used on the bench, and as a grinding attachment to be applied to lathes, milling machines, shapers, planers, etc., to handle a variety of work. The grinding wheel spindle bearing housing has a longitudinal movement in a saddle, which in turn has a vertical movement on the column. A swivel is provided with a protractor of a large radius for inclining the grinding wheel spindle, when thread grinding, to suit the helix angle. Micrometer dials are provided for both longitudinal and vertical adjustments, making it very convenient to obtain accurate settings whenever required for precision work. This machine is designed and manufactured for grinding within 0.0001 inch, and all of its parts are interchangeable.

Realizing the importance of service rendered by the spindle construction in a precision grinder running at 25,000 revolutions per minute, which is required to produce work that is accurate within 0.0001 inch, the manufacturers have developed a style of spindle which they claim to be entirely free from vibration, even under the most severe working conditions, and one which will produce an unusually smooth finish. The spindle is made of a special analysis steel, hardened and ground, and the bearings are of Non-Gran bronze, lubricated from a reservoir of oil and protected against oil leakage, dirt and grit by felt washers. The bearings are tapered and readily adjustable for wear. The driving shaft is independent of the grinding wheel spindle, preventing transmission of pull from the driving belt and allowing the wheel perfect freedom of operation. Adjustment is provided for belt tension, and the grinding wheel has downward action, so there is no danger to the eyes of the operator. A General Electric universal motor is furnished, which can operate from any 110-volt circuit whether direct or alternating current.

Means which are provided for truing the grinding wheel make this machine very suitable for thread gage grinding as well as for general purposes. The wheel truing device is designed to accommodate three diamonds, and graduations at the base of the truing device permit of setting it at any angle. Adjustable stops as well as means for locking are provided, and the truing device bracket is adjustable vertically in reference to the column to secure proper alignment. It will be noted that when thread grinding, the wheel is trued in the horizontal plane of the center line of the work and lathe spindle. It sometimes happens, particularly when grinding internal threads, that there is no room for the truing attachment when actually grinding. An adjustable stop is furnished which enables the truing device bracket to be rapidly attached to the column at the proper height. The bracket is quickly clamped to the column by a stud with an interrupted thread.

For grinding deep holes and long internal threads, the manufacturers have developed an extension spindle and an extension spindle bearing housing. The application of these features to the Lafayette universal grinder is illustrated in Fig. 2. Non-Gran bronze bearings are also used in the extension spindle bearing housing. When used together with a surface plate, this machine is very suitable for surface grinding. Fig. 3 shows the adaptation of the Lafayette universal grinder to the grinding of circular forming tools. With the use of other simple adapters, securing the work to the rack, this machine can be used for a variety of bench grinding. With the use of an extra rack holding device, it



Fig. 1. Universal Grinding Machine built by the Lafayette Tool & Equipment Co.

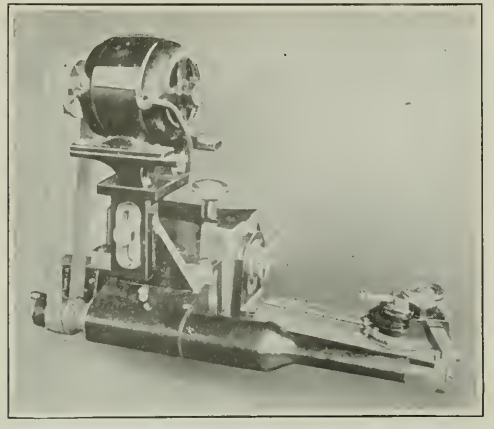


Fig. 2. Lafayette Universal Grinder equipped for handling Internal Work

is not necessary to remove the work in order to true the wheel, and the diamonds are always in the correct position for truing.

In addition to the specific uses referred to in the foregoing, this machine when applied to a lathe, may be used for cylindrical, taper, and internal grinding. Used with the relieving attachment on the lathe, taps, cutters, etc., are relieved by grinding after hardening. This grinder may be used for grinding cutters in position on the milling machine, and when clamped to the overarm of the milling machine, it may be used for surface grinding, or clamped vertically to the overarm bracket of the milling machine, it may be used for finishing dies of various kinds. The use of pencil grinding wheels is recommended for the grinding of dies. This machine may also be attached to shapers and planers for surface grinding and a variety of other purposes. It will be readily seen that the machine is quite universal in character and that its many applications make it possible to adapt it to a great many uses either in tool-room or special work or in precision manufacturing processes.

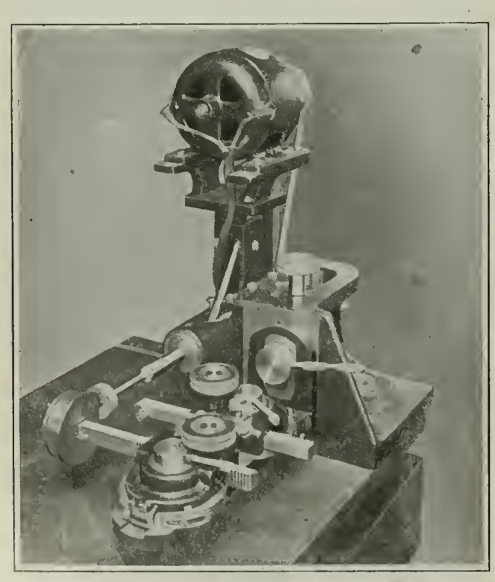
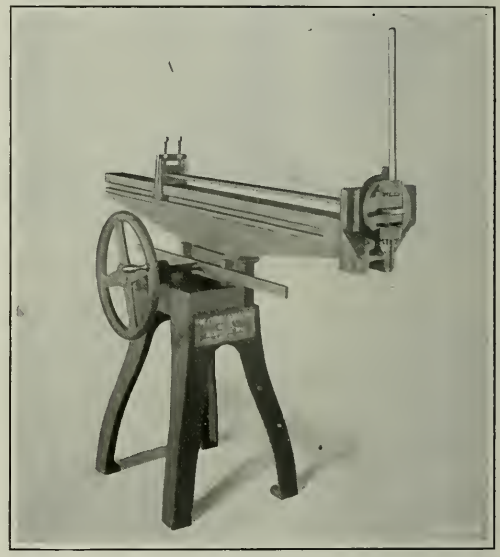


Fig. 3. Lafayette Universal Grinder in Use grinding a Circular Formed Tool

W. J. PINE STRAIGHTENING MACHINE

A machine for use in straightening flat or square cold-rolled steel and which also takes the twist out of the material is shown in the accompanying illustration. Every user of cold-rolled steel knows of the necessity for having it straightened ready for use, as there are likely to be kinks and twists which would cause trouble if an attempt were made to work the material while irregularities of form were present. It is impracticable to use cold-rolled flat or square stock where one edge or side is to be broken the full length, owing to the existence of strains which will cause the stock to bow. Cold-rolled flat stock could be used to advantage for a great many purposes where it is not now employed, if a practical machine for straightening were available, and it is claimed that the present machine affords a satisfactory method by the application of pressure on the long side of a kink in the work, which contracts the long side and elongates the short side. There is an upper bar or testing table on which stock is laid to find the kinks, after which it is



Machine built by the W. J. Pine Machine Co. for straightening Square or Flat Cold-rolled Steel

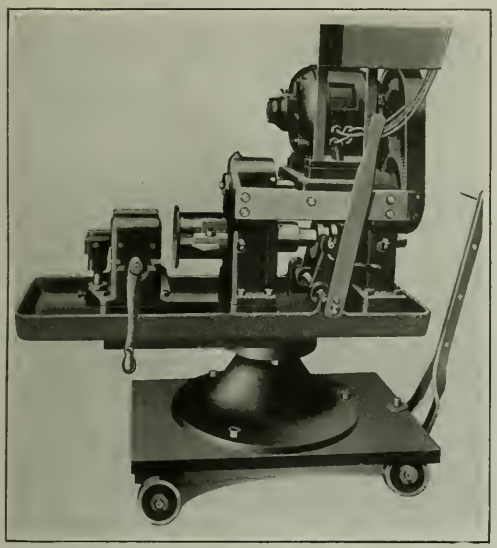
placed under the pressure screw which is conveniently arranged for the purpose. When used to take the twist out of stock, one end of the work is clamped in a yoke vise, and the other in the twisting head vise. This machine also provides a convenient means for the performance of such operations as offsetting connecting-rods and bars, and bending irregular shapes in forms or dies, where the application of pressure is required. Machines of this type are built in four sizes with testing tables 6, 8, 10 and 12 feet in length, and all sizes except the smallest have the straightening screw and twisting head compounded to afford the increased leverage that is required in handling larger stock. This machine is a recent product of the W. J. Pine Machine Co., 411-415 Jenne St., Kenosha, Wis.

"NAMCO" BAR POINTING MACHINE

For preparing raw material for use on automatic machines of its manufacture, the National Acme Co., Cleveland, Ohio, has recently perfected and placed upon the market the "Namco" bar pointing machine, which is here illustrated and described. This machine was first built to meet the requirements of the National Acme Co.'s screw machine product business, which includes the cutting from the bar of vast

quantities of different classes of work. The design of this machine is therefore based upon this company's experience in operating automatics, and the constant effort which is made in its plant to discover faster methods of manufacture where quantity production is desired.

On this bar pointing machine, the operating mechanism is of a very simple design, consisting mainly of a gear-driven spindle carrying a plain turning tool in a revolving cutter-head, a chuck, and a hand-lever. The chuck is provided with jaws which are quickly adjustable to accommodate practically all diameters and shapes of bars. Round bars are pushed into the chuck, gripped, and the tool fed to the bar by the hand-lever. Hexagonal and square stock is even easier to handle than round bars, as no gripping is required. It is simply pushed against the tool, which revolves in one position, and withdrawn, requiring only one movement of the operator.

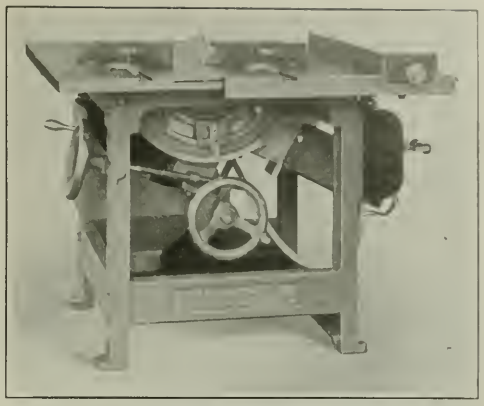


"Namco" Bar Pointing Machine built by the National Acme Co.

Where quantities of work are handled by two machines operating end to end, advantageous results may be obtained. Two men who hold the bar near opposite ends lift it to one machine and then to the other, thus pointing both ends with two movements. On heavy work, two men on two machines point nearly twice the number of bars that can be done on a single machine. The machine is mounted on a truck for convenient hauling from one stock-bin to another, and is frequently used as the stock is taken from the freight cars, thus saving much of the expense of a second handling. It is driven by a 1-horsepower motor.

WHITNEY MOTOR-DRIVEN SAW BENCH

Baxter D. Whitney & Son, Winchendon, Mass., have recently added to their line of woodworking machinery a direct motor-driven saw bench with a tilting arbor. In the construction of this machine, the same motor drive has been employed that is successfully used on other machinery of this company's manufacture. Two motors having a speed of 3450 revolutions per minute are mounted directly on the saw arbor. The motor housings are a part of the yoke carrying the saw arbor and the ball bearings, all of which are tilted as a single unit to secure the desired bevel of cut for the saw, instead of employing the method of tilting the table. The frame of the machine is so designed that it



Motor-driven Saw Bench built by Baxter D. Whitney & Son

allows easy access to all working parts, and permits the operator to get close up to the saw. Guiding of the yoke that carries the saw arbor and motors is accomplished by a circular groove having a wide bearing surface. It is also raised or lowered independently in dovetailed ways. By means of a handwheel the saw arbor can be tilted to saw at any desired angle up to 45 degrees.

SURFACE COMBUSTION OVEN FURNACE

In the accompanying illustration there is shown a Type A-25 oven furnace built by the Surface Combustion Co., 366-368 Girard Ave., Bronx, N. Y. This furnace is equipped with a special door-lifting mechanism that has recently been developed, the design of which was worked out after a careful study of practical requirements. A link motion is employed for this purpose, which not only allows the door to move up and down vertically, but effectually prevents it from making any other movement. Simplicity and compactness of construction are claimed for this mechanism, and it is stated that a furnace door equipped in this way tends to remain either in the open or closed position without relying on friction to hold it there.



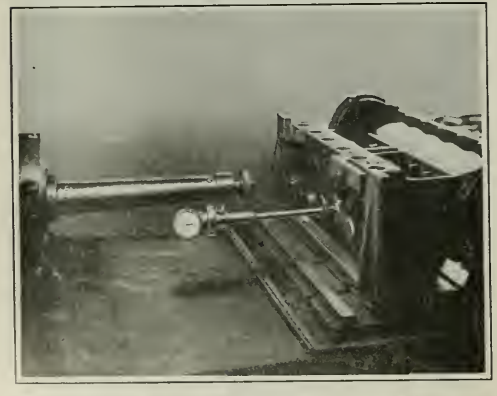
Type A-25 Oven Furnace built by the Surface Combustion Co.

This furnace is equipped with an automatic air and gas proportioner, which has a one-valve control. This equipment is the means of constantly mixing air and gas in the proper ratio for complete and perfect combustion. To increase the temperature of the furnace, this one valve is opened wider, and to decrease the heat, the valve opening is reduced. A perfect mixture of gas and air is maintained and the proportioner is arranged so that it is independent of either skill or carelessness of the workmen.

CYLINDER TESTING MACHINE

For use in testing the bore of gas engine cylinders when accuracy of the bore must be held within close limits, the Federal Products Corporation, 393 Harris Ave., Providence, R. I., has developed a gage which determines the magnitude of any errors which exist. The chief advantage claimed for this tool is that there are feelers in the cylinder which detect existing variations in the diameter, and these are indicated by a dial which is outside the cylinder within clear view of the operator. The general arrangement of the gage will be readily understood by referring to the accompanying illustration, where it is shown in place in an automobile engine cylinder.

The method of operating this gage is as follows: Any existing variations in the diameter result in movement of the gage feelers, the inner ends of which are held against a cone cam by means of springs. This cam is directly connected with a steel rod running through the outer casing to a rack and spur movement, which moves a needle over the gage dial. A lever is also attached to the steel rod by means of which the cone cam is lowered, thus permitting the feelers to recede sufficiently to be inserted in the cylinder. After the feelers have been entered in the bore, pressure on the lever is withdrawn and the feelers are automatically released against the inside of the cylinder. A centralizing support holds the apparatus in position, this support being placed at the mouth of the cylinder. It has three fingers which bind firmly against the wall of the cylinder. The gage body turns freely, and slides in and out through the centralizing support, thus permitting the feelers to bear against the cylinder wall at any desired position. Graduations of the gage dial represent 0.001 inch, and the dial can be turned to any position on its axis so that readings can be taken where the light will illuminate the dial most favorably. The feelers are set to a master gage corresponding to the bore of the cylinder, the dial of which is turned so that the hand points to zero. Then when the feelers are moved about in the cylinder, all variations from the correct dimensions are indicated on the dial.



Cylinder Bore Testing Gage manufactured by the Federal Products Corporation

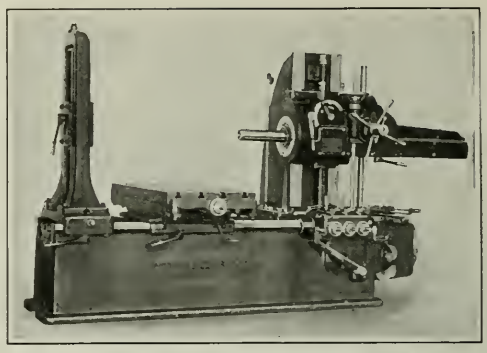


Fig. 1. No. 45 Horizontal Boring, Drilling, and Milling Machine built by the Giddings & Lewis Mfg. Co.

GIDDINGS & LEWIS BORING MACHINES

The Giddings & Lewis Mfg. Co., Fond Du Lac, Wis., is now building a No. 45 horizontal boring, drilling, and milling machine. The body is of box section, with a continuous trussed bottom and direct ribbing, arranged in such a way that all strains are adequately supported and a stable, self-contained, three-point bearing foundation is afforded for the machine. This type of bed eliminates the necessity of preparing a special foundation, and adapts the machine for use on upper floors of manufacturing plants. A box section was also adopted in designing the column, and it is made with a liberal spread in both directions at the base. Not only is a liberal bearing provided for the headstock on the column with a minimum overhang of the spindle, but the design has been worked out to combine the features of long inner guide ways located close to the center of gravity, two square locked gibs and a counterweight, in addition to which there are several features of the design that are entirely distinctive in this machine.

The stub-toothed spindle driving gears are cut from carbon steel forgings, and they are mounted on high-carbon steel shafts running in bronze bearings. Power is transmitted from the spindle sleeve to the spindle through two long opposed keys, the spindle sleeve being supported by tapered bronze take-up journals. At the front end, the spindle is bored to receive standard Morse taper shanks, and it is slotted to receive a retaining key and drift. A take-up device at both extreme ends of the sleeve provides for accurately maintaining the spindle alignment. The spindle control is directly in front of the operator, which is an important feature, as it permits absolute control of the spindle while guiding the tool into the cut. This pilot contains a quick-acting positive knock-out clutch which is a part of the self-locking worm-gearing, and is coupled directly to the pinion, meshing with the rack that leads back to the ram. A positive binder is provided for locking the spindle feed, and also a handwheel for making slow precision adjustments.

For handling extra large work, the end support can be quickly removed and replaced without affecting the alignment. Accurate alignment between the outer support and the spindle is assured; and should this alignment be affected, means of making a fine adjustment are provided at the top of the suspended elevating screw. A strongly ribbed, one-piece casting is used in making the table which is provided with a cutting solution trough, and deep T-slots are provided for securing the work, and also a positive binder for locking. The table is fed along narrow guide ways by means of a screw provided with ball thrust bearings at each end, and the ways are gibbed to provide for making adjustments. The front edge of the table is always at right angles to the spindle.

Square locked gibs are provided on the long and narrow saddle ways, which are positioned at an ample distance

apart to assure a rigid construction. Perfect support is provided for the table without the use of complex compound bearings. Adjustable stops provide for accurately regulating both extremes of the feed movement.

Power for the speed case is provided by a single pulley with an outboard bearing support. This pulley can be quickly moved to the end or rear, thus eliminating the necessity of ever having a twisted belt. Independent of the driving pulley, and inside of the oil-tight case, there is a reversing friction clutch for the whole machine, which is controlled by a single lever positioned close to the operator. Speed changes are provided by wide-faced stub-toothed gears made of heat-treated chrome-nickel steel. Power for the feed mechanism is furnished through a set of change-gears by means of which any rate of feed not shown on the index-plate can be readily obtained. As in the case of the speed gears, these feed-gears are also made of heat-treated chrome-nickel steel, and have stub teeth. The rapid traverse takes its power direct from the initial speed shaft through large diameter steel spur gears, thus producing a constant rapid power adjustment which is brought into action by disengaging the positive feed clutch and engaging the large diameter friction.

An independent feed reverse is available, which is so designed that it engages the rapid traverse only in the opposite direction to the feed. The transmission case receives its power through a patented pressure adjusting speed device. A separate lever is provided for each selective feed, the levers being interlocked. On the front end of each transverse shaft there is placed a micrometer dial marked to 0.001 inch, to facilitate hand setting. Each shank has a clutch for engaging a safety hand-crank, and the screws leading from this case are of large diameter and coarse pitch. All operating levers on the machine are located within a horizontal space of approximately two feet and high enough from the floor to avoid the necessity of having the operator stoop under the working position.

When conditions are favorable, it will be found economical to equip machines of this type with a secondary opposed spindle as shown in Fig. 2. Such an arrangement is provided for by making a left-hand headstock and column. In the saddle there is contained the necessary gearing to operate this end of the machine, either independently or in unison with the opposite end. The gearing required to feed or rapidly traverse this saddle along the bed is also contained in the saddle. It receives its speed movement from the standard transmission case, and consequently has the same arrangement of feeds and rapid traverse movements. The feeds can be reversed at either end of the machine. Power for the speed mechanism is taken from the final shaft in the standard speed case, and therefore provides the same range of speeds which are available at the opposite end. Reversal can be accomplished from either end of the machine. A secondary table and saddle can also be provided, which will feed in unison or independently.

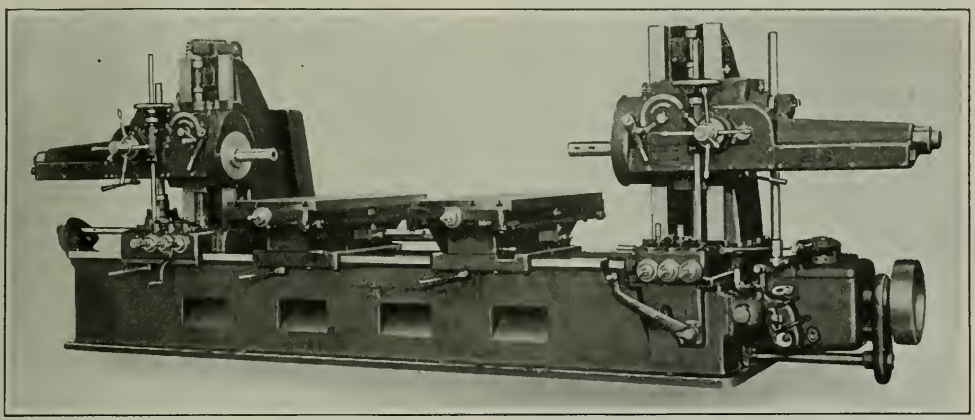


Fig. 2. Giddings & Lewis Duplex Boring, Drilling, and Milling Machine equipped with Opposed Spindles and Two Work-tables

ROCKWELL HARDNESS TESTER

For use in testing the hardness of all kinds of metals by the Brinell method, S. P. Rockwell, 122 Dickerson St., Syracuse, N. Y., is now making a testing machine which is here illustrated and described. It is claimed that this machine gives very accurate results and that it is adapted for testing both curved or flat surfaces and either thin or thick sections. It operates rapidly, and may be carried around without trouble. Another important feature is that it does not excessively mark or destroy the work on which a test is made, and that the machine is adapted for testing the hardness of all metals ranging from lead to hardened steel. The machine consists of a sturdy hollow cast frame and a plunger, which holds the testing point at one end and abuts against a delicate measuring device at the other end. A series of levers with knife-edges connects this plunger with a weight, and by shifting the position of the weight, more or less force may be applied to the testing point to suit conditions.

A vertical moveable chuck holds the piece on which a hardness test is to be made, this chuck being actuated by a handwheel. The piece to be tested is placed in this chuck and raised by the handwheel until it comes into contact with the testing point. At this moment, the initial pressure is applied through the point to the work, in order to cause the point to break through the light scale, decarbonization, etc., so that it may more clearly test the condition of the true metal beneath. Upward movement of the work is continued until the plunger has actuated the measuring device to a degree sufficient for testing; then the final weight is applied by a hand-lever, and the hardness is read direct by the difference of the testing point's position as indicated by a measuring device. The elasticity of the metal may also be determined by the test point's difference of position from final pressure to initial pressure.

With an equipment of this kind, an average operator can readily make six tests per minute. The greatest value of this machine for shop use is as a comparative tester. For such work, hardness limits are established by the Brinell, scleroscope, file, or working tests, and the Rockwell hardness tester is then set for the particular class of work on which it is to be used, and its limits are established. If so



Hardness Testing Machine built by S. P. Rockwell

desired, the indicating dial can be calibrated in Brinell, scleroscope, or percentage hardness numbers, using electrolytic iron as zero per cent soft. Such dials are available as a special equipment. All work has allowable variations in hardness, and for fast operation of this instrument an extra pointer may be provided. The angular difference in the position of the two pointers represents the allowable hardness variation; and if in operation the two pointers straddle the graduation indicating mean hardness, the work comes within the specified limits. Failure to straddle the mean graduation indicates that the work is too hard if the pointers are on one side, or too soft if they are at the opposite side.

In view of the increasing need for readily applicable means for hardness testing, convenient and simple to operate, the machine described constitutes an interesting development which will, in addition to other means already available, make it possible to control the quality of manufactured articles, especially those subjected to various heat-treatments.

OTT INTERNAL GRINDING MACHINE

The Ott Grinder Co., 217 W. 10th St., Indianapolis, Ind., is now building for the market a 6- by 6-inch internal grinder which was designed by George L. Scoville, chief engineer of the company. This machine has been in operation at the Ott plant for a period of eight months and during the trial it is claimed that very satisfactory results have been obtained. It is also stated that the design has been simplified as far as it was possible to do, and still provide for the rapid and accurate grinding of straight and tapered holes that come within the capacity of this machine.

The headstock or work-head is of box construction, with the tight and loose pulleys enclosed. At a single motion the operator shifts the driving belt to the loose pulley and applies a brake to the tight pulley, thus stopping the work. The loose pulley is mounted on Hyatt roller bearings. Provision is made for swiveling the base of the headstock 60 degrees on each side of the center line for the performance of taper grinding operations. Four work-speeds, covering a range of 85 to 425 revolutions per minute are provided. The spindle is made of high-carbon steel heat-treated and ground to size. It revolves in Non-Gran bearings which are adjustable for wear. These bearings are fully protected from grit, and ample means of lubrication are provided. The diameter of the spindle is 2 inches in the bearings, and the nose is threaded with a 2-inch diameter for a distance of 4½ inches.

The minimum bore through the spindle is 1¼ inches in diameter and the nose is tapered inside to receive spring chucks or collets having a range for work from ⅛ to 1 inch in diameter. A quick-closing lever-operated device is provided for use with these collets and also for use with a 9-inch adjustable three-jaw collet chuck. It is claimed that this device will grip each piece of work equally hard or light as desired. The 9-inch adjustable collet chuck is a regular equipment and will hold work of all diameters from ½ to 9 inches. Work 10 inches in diameter can be swung inside of the water guard, and pieces up to 12 inches in diameter can be handled outside of the guard.

A single solid casting is employed for making the wheel-spindle head, in which the wheel-spindle is mounted on three double row S. K. F. ball bearings. This head also carries the jack pulley which increases the speed from the countershaft to the wheel-spindle. This pulley is mounted on Hyatt high-speed roller bearings and swings on an adjustable arm to compensate for the stretch of the endless belt. Changes of wheel speed are accomplished through this pulley and cover a range from 8,000 to 20,000 revolutions per minute. The spindle is designed to grind holes from ½ inch to 6 inches in diameter and to a depth of 6 inches. Various sizes of holes are ground by using suitable quills which screw on the tapered spindle nose and eliminate the need of buying several complete heads and spindles. When withdrawn from the work, the wheel is automatically covered by a guard which is adjustable for different lengths of quills. A wheel truing device is provided, which is mounted on a sliding bridge on the table. The wheel can be dressed with either a straight face or a concave or convex face up to a 3-inch radius.

The table drive is accomplished through a steel worm and bronze worm-wheel, which are driven from a four-speed transmission case to a steel rack and pinion connected to the sliding table. Accuracy of reversal of the sliding table is accomplished by a non-centering device in the transmission case which operates the reversing clutches. Hand feed is graduated to 0.00025 inch and will automatically feed from a minimum of 0.00025 to 0.003 inch at each reversal of the table. The ratchet feed dial is made of steel, hardened and ground to size, and the ratchet pawl is hardened and follows the dial in the same arc of the circle, thus eliminating wear. The water tank and Fulflo pump are bolted to the

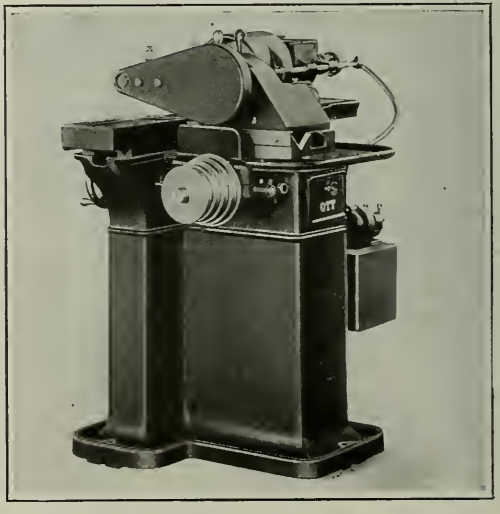


Fig. 1. Internal Grinding Machine built by the Ott Grinder Co.

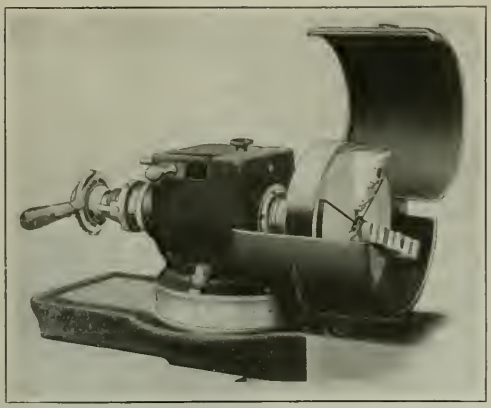
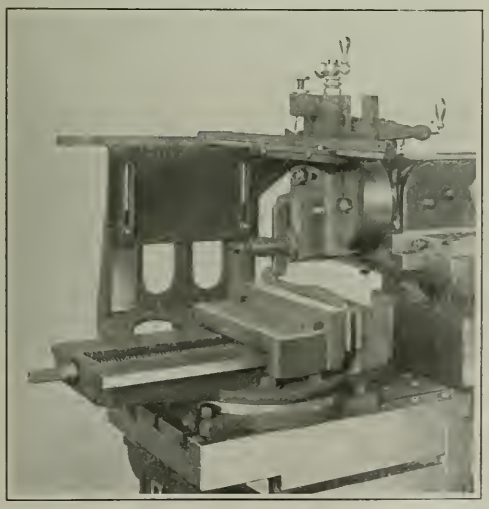


Fig. 2. Close View of Headstock of Ott Internal Grinding Machine

base of the machine, and a metal flexible hose is used to bring water to the work from either the rear and through the spindle, or directly to the work from the front.

STOCKBRIDGE SHAPER ATTACHMENT

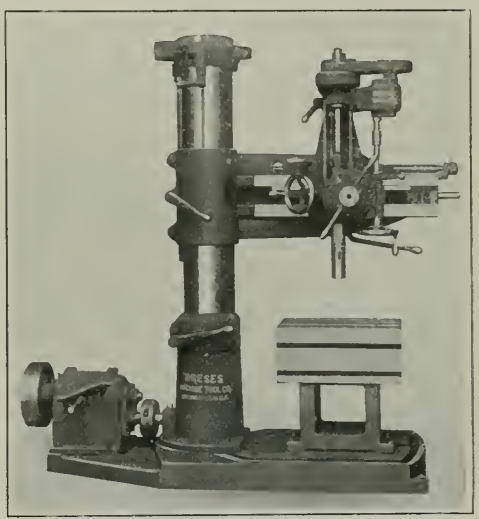
For use in following irregular curves with a shaper, the Stockbridge Machine Co., Worcester, Mass., has developed a device known as an irregular curving attachment, which is adapted for use on shapers of standard design. Such operations have to be performed on split dies and many other classes of work; and the range of angles and curves that this attachment will machine is quite broad. In addition to its application on various forms of dies, this device is also useful in machining bending forms, formed tools, etc. In operation, the principle is for the tool to reproduce the curve of a templet, and the reproduction can be repeated as many times as necessary. The templet is carried on the cross-slide holder and is usually made from about ½ by ¼ inch stock shaped to the required outline of the work to be cut. The cutting tool is located directly beneath the follower, and is raised or lowered as the follower moves along on the surface of the templet, thus reproducing its curves and angles. Attachments of this type can be furnished for use on all sizes of Stockbridge shapers, and are interchangeable with the regular Stockbridge shaper head. They can be furnished either on the shaper without the regular head, or as an addition to the head.



Shaper Attachment built by the Stockbridge Machine Co. for following Irregular Shaped Outlines

DRESES SIMPLEX RADIAL DRILLING MACHINE

The accompanying illustration shows a radial drilling machine which is built in 2-, 2½- and 3-foot sizes by the Dreses Machine Tool Co., Cincinnati, Ohio. These radial drilling machines have been so designed that they are adapted for operation at high speed, and for handling heavy-duty work; also, the design is so simple that the machines may be operated by unskilled labor. All parts of the mechanism are centralized, and the number of parts has been reduced as far as possible. Noiseless operation is attained by the use of a helical gear drive, with metal gears meshing with fabric gears. The outer column swings on a fixed inner column reaching to the top, and in addition to the upper and lower bearings there is a third bearing at the middle that gives additional strength and rigidity to the machine. A convenient feature is that of having the clamping handle follow the arm, so that it is always within reach of the operator. The outer column rests on a ball thrust bearing on the top of the inner column, which insures easy swinging of the arm; and the arm is lowered and raised at a ratio of 2 to 1 by a conveniently located handle which is locked to avoid accidental engagement of the mechanism.



Radial Drilling Machine built in 2-, 2½- and 3-foot Sizes by the Dreses Machine Tool Co.

Liberally proportioned bearings are provided for the head on the arm, and the head is moved by means of a spiral pinion. Clamping is accomplished by one lever operating two screws. The spindle runs in bronze bearings, and its thrust is received by a ball bearing. There are four changes of feed, any of which is obtained by manipulating a knob on the head feed shaft. Feed and speed plates are attached in conspicuous positions on the machine. The automatic stop used on this machine is of the dial index type, and a safety release is provided at the end of the rack. Quick-return movements are obtained by either of the two handles which engage and disengage the mechanism through a positive clutch. Frictions are used in starting, stopping, and reversing, with the friction bevel gears encased in the back

of the head. These gears run in oil. There are six changes of speed, and a convenient form of shock absorber overcomes all jars while speed changes are being made. The gears in the speed variator are of the 20-degree pointed type. All bearings are lined with removable bronze bushings.

GENERAL ELECTRIC RIVET HEATER

In an effort to overcome the difficulties involved in heating rivets previous to their being driven and riveted, the General Electric Co., Schenectady, N. Y., has designed an electric rivet heater which is intended to combine the features of simplicity of operation, fool-proofness of construction, and maximum efficiency. This is accomplished in the following design: A transformer rated at 15 kilowatts is mounted on angle-iron legs, which may be fitted with wheels. At the front of the transformer, two copper bars are fitted with heavy air-cooled electrode blocks of cast copper, and under these is another copper block which acts as a support and electrical connection for two rivets in series. When a rivet is stood up on the block and the electrodes are allowed to drop on the head of the rivet, the circuit is completed and heating begins. The two electrodes may be raised independently by two foot pedals, gravity being sufficient to lower the electrodes when the foot is removed. A primary tap switch mounted on the back legs of the machine gives all the variation needed for different lengths and diameters of rivets and for the rate of heating which is desired.

The advantages claimed for this rivet heater are as follows: Higher efficiency in localizing the heat energy in the rivet, resulting in less heat radiation; better heat regulation in proportion to the quantity of rivets used and that energy is used only when heating rivets; cleanliness of operation because no smoke or gases are formed; no time is wasted in starting production; rivets are heated from the inside, giving greater uniformity and better conditions for upsetting; wastage of rivets is reduced to a minimum; the heater is portable and it takes any rivet up to ⅞ by 5 inches without adjustment; only two power lines are required to each



Electric Rivet Heater manufactured by the General Electric Co.

heater; five pounds of rivets are heated per kilowatt hour. The heaters so far developed are a 5-kilowatt two-jaw type for rivets up to ½ inch in diameter, and a 15-kilowatt two-jaw type for rivets up to ⅞ inch diameter. The two-jaw heaters are intended for one gang use; however, under actual test the 15-kilowatt machine heated five hundred ½- by 1¼-inch rivets in one hour, which is ordinarily enough for two gangs of gun riveters.

KREMER-CUMMINS MECHANICAL BELT SHIFTER

The Kremer-Cummins Machine Co., 1831-1833 E. 55th St., Cleveland, Ohio, is now making a mechanical belt shifter which is of extremely simple design and efficient in operation. The operating mechanism of this device comprises a length of structural steel channel having rack teeth formed along one edge. Slidably mounted upon the channel there is a cast iron bracket carrying a gear or sprocket in mesh with the teeth of the channel, and extending from one side of the bracket there is an arm enlarged at its outer end to encircle the machine belt. Any size of belt, from 1½ to 6 inches wide may be shifted, depending only on the size of opening in the arm. Castings are provided at each end of the steel channel for attachment to an iron pipe frame which supports this mechanism close to the overhead countershaft. Extending downward from the gear or sprocket in mesh with the channel member, there is a shaft equipped at its lower end with an operating handle. A length of pipe extends downward from the overhead sliding bracket and carries at its lower extremity a casting having a slot surrounding the machine belt and provided with a handle for traversing the belt. The last mentioned part may be placed very close to the machine cone pulley, minimizing the force required to shift the belt.



Mechanical Belt Shifter built by the Kremer-Cummins Machine Co.

In manipulating this device, the machine operator first shifts the belt to the desired step on the machine cone pulley by moving the handle provided for the purpose. This operation is immediately followed by traversing the upper belt guide along the steel channel member until the belt is running on the desired step of the overhead cone pulley. This second operation is accomplished by means of the conveniently placed handle on the shaft of the operating gear or sprocket. The above mentioned gear or sprocket may be arranged for either right- or left-hand rotation, as desired. The device is strong enough for shifting any ordinary machine belt. The belt guides, the only parts it is necessary to change in adapting this device to various widths of belts, are furnished to the customer's specifications.

It is believed that mechanical belt shifters make for increased efficiency and greater production in the shop, and there are at least five states where the use of permanently attached mechanical belt shifters is required by law. No parts of the belt shifter are applied directly to the machine tool, and the entire work of installation is reduced to a minimum. The operating mechanism is supported on an iron piping frame, and the lower belt guide, with its handle,

is carried by a piece of tubing; the operating handle, by a piece of cold-rolled steel ½ inch in diameter. These two last mentioned pieces, together with the overhead frame, are supplied by the customer. Since it is necessary for him to obtain the measurements from his particular installation of machinery, and being materials which can be readily obtained, it is probable that the customer can secure them himself at the lowest possible price. This reduces the expense and confines the customer's investment to belt shifting mechanism entirely.

ZINC SHEATHING METAL

For use in lining packing cases for export shipment, the Church Appliance Mfg. Co., La Salle, Ill., is now making a product known as zinc metal sheathing, which was used extensively by the United States Government during the war to line munition cases, powder boxes, etc. This zinc metal sheathing consists of thin, pliable sheets of pure zinc, which are very light in weight and easy to handle. It is claimed that this zinc will last as long as copper, and it is the property of this metal not to rust. The sheathing is said to be clean, sanitary, permanent, fire-resisting, vermin-proof, and weather-proof.

NEW MACHINERY AND TOOLS NOTES

Starting Switch: Electric Controller & Mfg. Co., Cleveland, Ohio. A starting switch for induction motors which is operated by push-buttons. This switch is enclosed in a steel box, and is provided with conduit connections for all wires.

Slotting Attachment: Walsh & Allen, Wilbur Ave., Brooklyn, N. Y. A slotting attachment for use on drilling machines, this attachment being secured to the table. Power is derived from the drilling machine spindle, and an abundant range of speeds is obtainable.

Boiler Tube Expanders: J. Faessler Mfg. Co., Moberly, Mo. Two boiler tube expanders of somewhat different design, although both are intended for the same work, their function being to roll the tube tight into the sheet and flare the end, without removing the tool.

Air Drill: Duntley-Dayton Co., 1416 Michigan Ave., Chicago, Ill. A multiple cylinder air drill equipped with a motor of the rotating cylinder type which has three cylinders. The pistons are of large diameter, and have a short stroke, making them suitable for operation at high speed.

Grinding Machine: Draper & Hall Co., Middletown, Conn. A No. 1 surface grinding machine on which the sliding table has no overhang. The table is supported for its entire length by the longitudinal slide. Grinding wheels 6 inches in diameter by ½ inch face width are used in this machine.

Portable Arc Welding Machine: Ohio Brass Co., Mansfield, Ohio. This machine was designed primarily for application in welding rail bonds, and is intended for use in mines where the space is likely to be quite restricted. It is also found useful as a shop tool because the machine can be easily carried by two men.

Motor-driven Keyseating Machine: Bucher-Smith Co., East Liverpool, Ohio. A motor-driven keyseating machine which is of similar design to the machine of this company's manufacture which was illustrated and described in the November, 1917, number of MACHINERY, except that it is equipped with individual motor drive.

Precision Bench Lathe: Urban Machine & Tool Co., 2424 St. Clair Ave., Cleveland, Ohio. A self-contained precision bench lathe of unusual design. It has a cylindrical body ground to accurate size and provided on the under side with a ground guide bar for guiding the carriage and tailstock. The machine swings 8 inches over the bed.

Stay-bolt Heading Attachment: Liberty Tool Co., Munsey Bldg., Baltimore, Md. A stay-bolt heading attachment for use in railroad and boiler shops for riveting stay-bolts, stay-rods, or countersunk rivets on steam-, oil- or water-tight work. This attachment fits on a standard air "gun" which is commonly used in shops of this character.

Cincinnati Milling Machine: Cincinnati Milling Machine Co., Cincinnati, Ohio. A No. 4 high-power horizontal milling machine made in both plain and universal types. The design of these machines is similar to that of the No. 5 machine of this company's manufacture, which was illustrated and described in the June number of MACHINERY.

Pipe Cutting Machine: Fox Machine Co., Jackson, Mich. This is known as a No. 10 pipe cutter and was designed to meet the demand for increased production in handling such work. The machine operates on the power-driven revolving cutter principle, and the pipe rests on broad rollers. The cutter is brought into contact with the pipe by means of a foot-treadle.

Rivet Heating Furnace: Liberty Tool Co., Munsey Bldg., Baltimore, Md. A self-contained tank and heating torch for use in railroad shops and other plants where the work is of a similar nature. A torch is operated from the tank, with only one line of hose leading to the burner. Compressed air furnished from an outside source is employed to give the required pressure of oil in the burner.

Direct-current Motors: Allis-Chalmers Mfg. Co., Milwaukee, Wis. A line of commutator direct-current motors of rugged and compact design, which are said to possess excellent operating characteristics. As the ratings and speeds of the constant-speed motors are identical with those of the 60-cycle induction motors, they can be used interchangeably without requiring adjustment of the gear ratios.

Toolmaker's Vise: Austin Tool & Machine Co., Inc., Pittsburg, Pa. A bench vise adapted for the use of tool-, instrument-, and model-makers. The body of this vise is designed to withstand heavy strains, and its outline is made square on five sides, which adds to its convenience and eliminates projections that are likely to catch the clothing of men passing the bench, and prove inconvenient in other ways.

Tire Rim Contracting Machine: Charles Grotnes Machine Works, 128 N. Jefferson St., Chicago, Ill. It is a common practice to weld tire rims to a diameter less than the required size and subsequently expand them to the required diameter. A substitute method is made possible by the use of a machine built by this company, by which the rims are welded over size and then contracted to the required diameter.

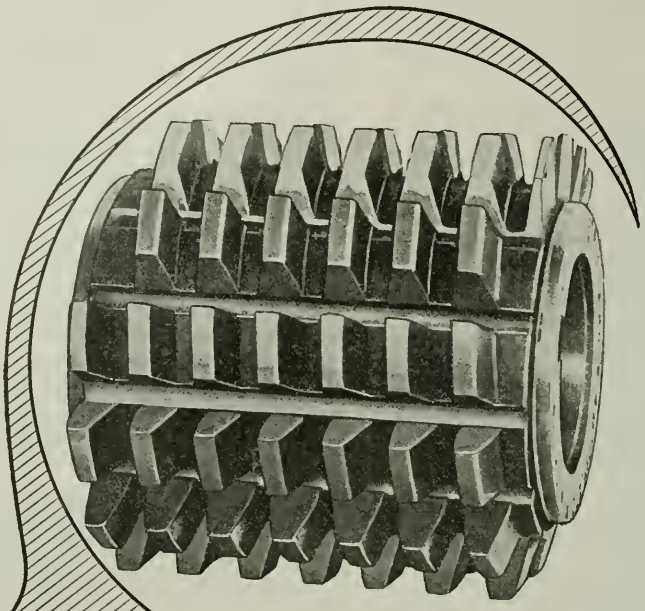
Continuous Milling Machines: Ingersoll Milling Machine Co., Rockford, Ill. Vertical and horizontal milling machines which are adapted for application of the continuous principle of milling in the machining of large castings. With machines of this type there is practically no idle time for either the machines or the operators, because work can be set up and removed while operations are being performed on castings that are passing the cutters.

Die-sinking Machine: Riverside Machinery Depot, 17 St. Aubin, Ave., Detroit, Mich. A combination die-sinking, milling, and cherrying machine sold by this firm, for use in machining drop-forging dies. It has a variety of labor-saving features which effect substantial economies in the time of handling work of this kind. Among these, mention is made of the unusually smooth finish imparted by the cutter, and the rapid operation of the machine.

Measuring Machine: Taft-Peirce Mfg. Co., Woonsocket, R. I. A machine for use in making accurate measurements on a commercial scale, which is especially adapted for such operations as checking the dimensions of plug gages and similar tools. Accuracy of measurement by this machine is dependent only upon a measuring bar and measuring screw, and this simplicity of design is said to make it improbable that the machine will get out of adjustment.

Portable Drilling Press: Liberty Tool Co., Munsey Bldg., Baltimore, Md. Two portable drilling and countersinking presses for use in connection with air-drill work. One of these is designed to fit any make or shape of pneumatic drill, and is equipped with a 2¾-inch air cylinder at its base, which provides a pneumatic feed of the work to the tool. The other machine is provided with a double-cylinder air feeding device, which represents still a further development of the same principle of machine design.

Multiple-spindle Drilling Machine: Lima Drill Press Co., Lima, Ohio. A multiple-spindle drilling machine of the magazine type, which embodies some interesting principles in its design. This machine is adapted for use in tool-rooms and other shops where a number of different sized drills, reamers, and countersinks are required. There are sixteen spindles in the magazine, which serves as a tool rack for holding this number of different sizes of tools, either of which can be immediately brought into operating position.



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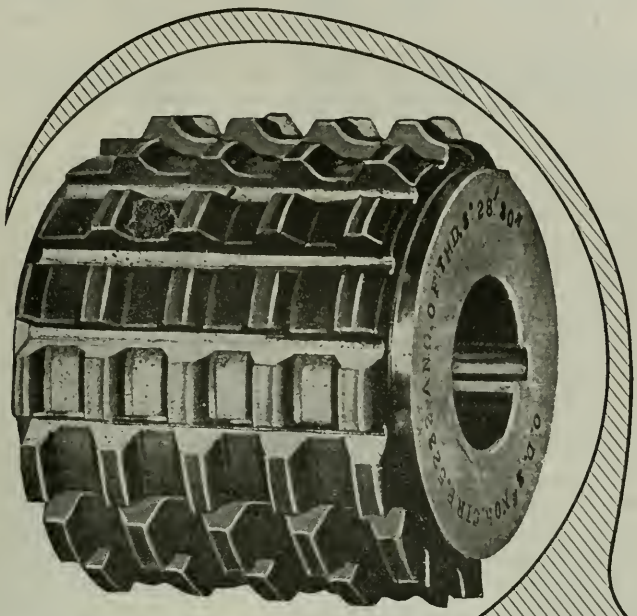
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CHECKING JIG AND FIXTURE DRAWINGS

By ROBERT MAWSON

Drawings of jigs, fixtures, and special tools are usually checked before being sent to the shop, and the care with which the checking is done determines to a considerable extent whether or not the tool will be found satisfactory when completed. It is less expensive to make corrections on paper than on machine parts and for this reason all drawings should be carefully checked in order to eliminate the necessity for correcting mistakes in design, either in the pattern shop or tool-room. The checking should be done systematically, as otherwise some error may be overlooked by the checker. In the following, the points which should be checked are first tabulated, after which brief notes on some of the most important points are given.

1. Is lay-out of piece in tool or fixture correct?
2. Is work properly located?
3. Is there sufficient clearance between work and tool?
4. Can work be loaded or unloaded without interference?
5. The design should not permit the work to be inserted in a reversed or inverted position.
6. Whenever possible have the clamping screws inside of a geometrical figure formed by drawing lines connecting the extreme ends of the locating points.
7. Are feet on jig or fixture of sufficient length?
8. Check grinding allowances on piece to be machined.
9. Are all dimensions given which are required in machining the piece?
10. Are seats, stops, clamps, binding screws, bushings, and locating devices properly designed, dimensioned, and located?
11. Can stock parts be used in making the jig or fixture?
12. Are tolerances and decimal dimensions correct?
13. Can fixture be assembled and can piece be put into tool in more ways than one?
14. Do all clamping bolts, especially hook-bolts, clear the piece at all positions?
15. Is it possible to machine all parts?
16. Is method of clamping such that work will not be distorted?
17. Are finish marks shown on all surfaces which are to be machined?
18. Are the projections of all views correct?
19. Do dimensions scale correctly?
20. Is scale size given on drawing?
21. Do the detail dimensions total correctly with the overall dimensions?
22. Are notes and references for grinding correct?
23. Does fixture fit machine and are bolt holes provided for fastening it in place?
24. Do cutting tools interfere?
25. Are cutting tools or bars of sufficient length?
26. Will cutting tools pass through bushings?
27. Do bushings fit tools properly?
28. Is marking pad provided?
29. Is stock and material list complete?
30. Are title, piece, pattern, sheet, tool, and tool sub-numbers given?
31. Are provisions made on milling fixtures for gaging or locating the fixtures in their correct positions on the machine table?

The importance of most of these points will be apparent, but brief notes on some of them may be necessary. Points (1) and (2) should be checked carefully, because if the part to be machined is laid out or located incorrectly, interference may occur between the tool and the fixture. For the same reason points (3) and (4) should be carefully noted. Point (5) must obviously be carefully considered in order to have the fixture fool-proof. If the condition outlined in point (6) does not prevail, the piece is likely to become distorted when the clamps are fastened down.

If the feet on drill jigs (7) are not of sufficent length to prevent any part of the piece or clamping device from touching the machine table, the holes to be machined will not be in the correct position or at the proper angle; hence, the only surfaces which should be allowed to rest on the table are the ends of the feet. The toolmaker needs the correct dimensions for the elements covered in (10) and these should be supplied by the designer. Stock parts should be used whenever possible, as they are cheaper because they can be produced in quantities and the tool can also be built quicker and at less expense. Limits should be given on important dimensions. If the proper tolerances (12) are not expressed the toolmaker is likely to use others that are incorrect. Make sure that the tools are so designed that they can be made. The importance of finish marks (17) to the patternmaker and toolmaker is evident, and these should not be overlooked. The drawings (18) should always be made in the third-angle projection. The importance of providing bolt holes for fixtures (23) is appreciated by anyone who has attempted to fasten a tool on a machine without such mediums. The importance of giving the stock list of materials (29) is well known though sometimes overlooked. Such a list enables a man to get out all the standard parts needed, and their location on the tool drawing should be noted. This will save much time and confusion when assembling the tool.

Point (31) needs a word of explanation. It is good practice to use, wherever possible, some standard size of gaging block, say 3/8 inch or 1/2 inch, and this size should be stamped on the gaging pad that is machined on the fixture. In this way the operator becomes accustomed to a certain size of gage-block, and these can also be made up in quantities to reduce expense. In conclusion, it might be added that if the checker will inspect the drawings with a system such as given, he may be confident that the work is not only done thoroughly, but also that the tools will be made with the greatest satisfaction to all.

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LONG SERVICE RECORD WITH ONE CONCERN

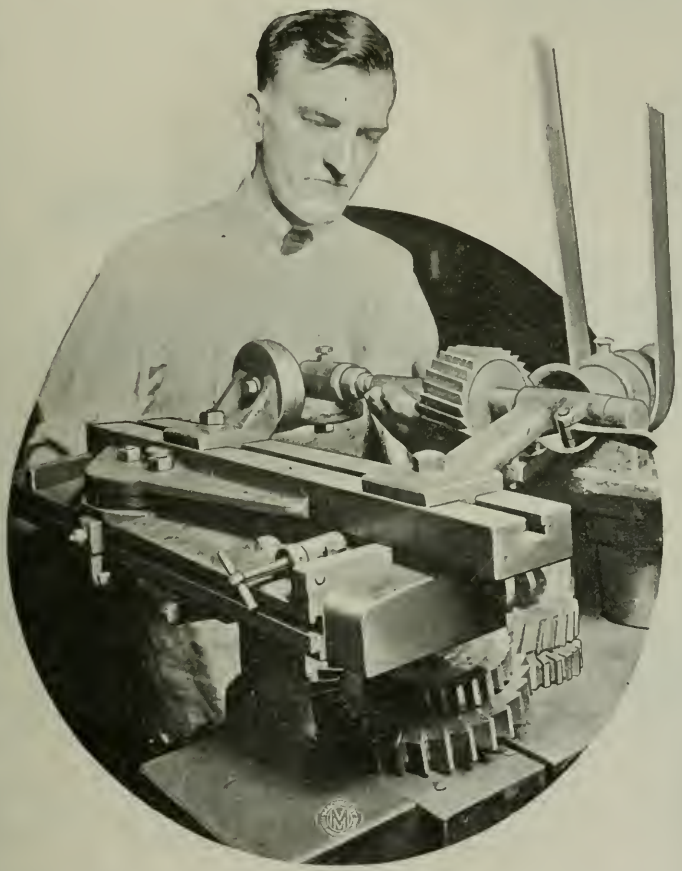
William Smith recently celebrated the fiftieth anniversary of his employment with the Automatic Machine Co., Bridgeport, Conn., at practically the same time as he celebrated his eightieth birthday. Mr. Smith was born in Scotland, and at the age of twelve years went to England to learn the machinist's trade and came to the United States when he was thirty years old. At that time he entered the employ of the Pacific Iron Works, which plant was absorbed in 1908 by the Automatic Machine Co., and he has been working continuously for fifty years for the same employer. On the occasion of the fiftieth anniversary of his employment with the concern and his eightieth birthday, he was given a luncheon by the Foremen's Club of the Automatic Machine Co. to celebrate the dual anniversary and was also presented with a purse of gold. It is stated that Mr. Smith is just as good a mechanic as he ever was; in spite of his age, he is on the job every day, running his lathe, and is well preserved physically with a keen alert mind.

* * *

INTERNATIONAL TRADE CONFERENCE

The International Trade Conference held at Atlantic City, beginning Wednesday, October 22, was attended by business men from the leading nations in the world, foreign visiting missions from Great Britain, France, Italy, and Belgium being present. The conference was called by the Chamber of Commerce of the United States with the object of laying before the business men of this country the commercial needs and aspirations of the foreign nations represented. Following a five-day conference, the foreign delegates toured the important industrial centers of the United States and were enabled to inspect industries of interest to them, to form business acquaintances with American business men, and to gain a comprehensive idea of American methods.

CINCINNATI
CUTTER GRINDERS



"It's the handiest little grinder I ever came across, and the best equipped with REAL attachments," said the toolroom foreman.

This Cincinnati grinder at the plant of the Consolidated Mfg. Co., Toledo, not only grinds all the cutters for more than a dozen Cincinnati millers but does a lot of tool and gage work besides. That's the kind of cutter grinder every shop wants.

Cincinnati cutter grinders are made in two sizes; the No. 1 Plain mentioned above, and the No. 1½ Plain and Universal. Both are fully described in the New Cincinnati Grinder Book—a complete treatise on cutter grinders and successful tool grinding. Write for a copy.

THE CINCINNATI MILLING MACHINE CO.

CINCINNATI OHIO, U. S. A.

THE POSTAL ZONE LAW

By SENATOR ARTHUR CAPPER, of Kansas

It has been argued that the postal zone increases apply only to the advertising sections of magazines. This is perfectly true as a statement of the mere words of the postal zone law. It is not true as a statement of facts. For a periodical or a newspaper is a unit from cover to cover. It is one unit of bulk that is never broken. The argument that the increased postage merely affects advertising is virtually the same as if it were argued that the postal zone legislation had provided that the upper half of a magazine should pay postal zone rates and the lower half flat rates. It would be a mere bookkeeping separation *that would not in the least affect the postage cost to the reader*, for the reader—who is the ultimate consumer—takes the magazine as it comes, and the cost of the magazine is its cost *as a unit*, and its postage cost to him is its entire cost as a unit, no matter how ingeniously or intricately one may subdivide the component parts.

Advertising is the one great factor in modern wealth production that enables wealth to be distributed almost instantaneously; a generation or so ago the same result could not have been accomplished without years of hand-to-hand selling, and expensive, slow, personal salesmanship. Congress itself saw this, and when means of war taxation were being carefully discussed and every channel was being developed, it was deliberately decided that the destructive economic effects that would follow the taxation of advertising would be too great and too dangerous to attempt.

Now then, as to the allegations of the cost of transmission of this second-class matter through the mails. The figures upon which the absurd allegations of second-class deficits are made were compiled by the Post Office Department in 1908 and 1909—eleven years ago! So unreliable were they even then that, when the U. S. Postal Commission, headed by the Hon. Charles E. Hughes, investigated them two years after their compilation, they were officially discredited as being no indication of what the costs were for the various divisions of second-class matter! Moreover, the Post Office Department since that date has taken pride in stating that it has in enormous and basic ways cheapened the postal cost of second-class matter.

The most unfortunate part of this postal zone legislation is that it is an insidious and dangerous attempt to set back postal history seventy years and re-establish the universally condemned principle of postal cost determining the postal rates. It abolishes the sound postal principle of equal postage to all parts of our nation. The rural free delivery—one of the most vital and important postal functions—is conducted at almost a total loss, and if this vicious and unsound cost principle is once established, the demoralization of our splendid postal principles is only a matter of logic and time.

* * *

ERICSSON-DeLAMATER MEMORIAL MEETING

The American Society of Mechanical Engineers, in conjunction with a number of technical societies and civic organizations will hold a memorial meeting at 8 o'clock on the evening of December 3, at the Engineering Societies' Building, 29 W. 39th St., New York City, to commemorate the work of John Ericsson and Cornelius H. DeLamater, whose contributions to the progress of naval architecture and industrial engineering are well known to every engineer. It is suggested that those who possess prints or documents relating to the work of these two men, or to the Phoenix Foundry which stood on West St., between Vestry and Laight St., from 1838 to 1851, and the DeLamater Iron Works located at the foot of W. 13th St., from 1851 to 1889, would confer a favor upon the committee for the commemoration by communicating with the chairman of the committee, H. F. J. Porter, American Society of Mechanical Engineers, 29 W. 39th St., New York City, with the view of possibly lending such documents as they may have in their possession to the society for the duration of the memorial meeting.

* * *

An investigation undertaken for the purpose of determining whether magnetic analysis is practicable for detecting flaws in rifle barrel steel, showed that this method is amply sensitive for detecting and locating flaws. A large number of bars were examined for magnetic uniformity along their whole length by means of a special apparatus. In spite of the fact that these bars were taken from material which had previously been rejected as a result of drilling tests, not one was found which contained a pipe. Further investigation is necessary to determine to what degree the sensitiveness of the apparatus should be reduced in order not to cause the rejection of material which is suitable for all practical purposes, and also to determine the kind and magnitude of the effect which will be produced by a pipe. This experimental work is being carried on at the plant of the Winchester Repeating Arms Co.

PERSONALS

O. H. Root, former acting secretary of the Kelly Reamer Co., Cleveland, Ohio, has resigned his position, and George H. Moore has been made assistant secretary.

C. W. Cross has been appointed by the Chicago Pneumatic Tool Co. manager of western railroad sales, with headquarters in the Fisher Building, Chicago, Ill.

Harry T. Calkins has joined the sales force of the Tacony Steel Co., Philadelphia, Pa. Mr. Calkins will be connected with the New York office, but will sell in Connecticut exclusively.

Sergeant Edward W. Keefer, who was formerly eastern traveling representative of the Bearings Co. of America, Lancaster, Pa., has returned to his former position with the company.

E. W. Thompson, who for the last eleven years has represented the Standard Tool Co. in Illinois, will take charge of the sales of the Davidson Tool Mfg. Corporation in Illinois, his headquarters being located in Chicago.

V. B. Taylor, for some time connected with the general sales department of the Lyon Metallic Mfg. Co., Aurora, Ill., has been appointed manager of the Pittsburgh district sales office, having offices in the Oliver Building.

William E. Kelly, president and general manager of the Kelly Reamer Co., Cleveland, Ohio, has retired from active management of the company's affairs, and his duties have been turned over to J. M. Davie, assistant general manager.

George Roemer Woods, who recently resigned from the Allied Machinery Co. of America, has been appointed manager of the New York office of R. S. Stokvis & Zonen Ltd., of Rotterdam, Holland, which is located at 17 Battery Place, New York City.

G. E. Anderson, formerly assistant to the vice-president of the American Locomotive Co., has been appointed assistant eastern sales manager of the Duff Mfg. Co., with headquarters at the eastern sales office, 50 Church St., New York.

Oscar W. Miess has been appointed production engineer with the United Shoe Machinery Co. of Canada, Ltd., Montreal, Canada. Before going overseas with the Sixth United States Engineers, he was in charge of tool designing and construction with this concern.

George W. Snyder, who for several years has represented the Haynes Stellite Co. in western Ohio, has been made sales engineer with the Davidson Tool Mfg. Corporation, New York, representing the company in western Ohio and Indiana. His office will be located in Cincinnati.

O. P. Wilson, for several years assistant general manager of the Norma Co. of America, New York City, was elected vice-president of the company at a recent meeting of the directors. W. M. Nones will continue as president and treasurer in executive charge of the company's affairs.

J. W. Badgley has recently been appointed Cleveland representative of the Erie Crucible Steel Co., Erie, Pa. Mr. Badgley was first lieutenant with the 90th Division of the U. S. Army, and served for a year and a half in France. Prior to entering the service, he was connected with the Sherwin-Williams Co.

L. F. Tankard, who has recently returned from overseas, has associated himself with Messrs. MacNutt and Watts in a general electrical engineering and contracting business under the firm name of MacNutt, Watts & Tankard, Inc., having offices, stock-room, and general repair shops at 9 Great Jones St., New York City.

William Ford Upson has been appointed Trade Commissioner to Vienna, by the Bureau of Foreign and Domestic Commerce, Department of Commerce, Washington, D. C. As soon as circumstances permit, he will proceed to his post to conduct an investigation of general commercial and economic conditions in Austria and Serbia.

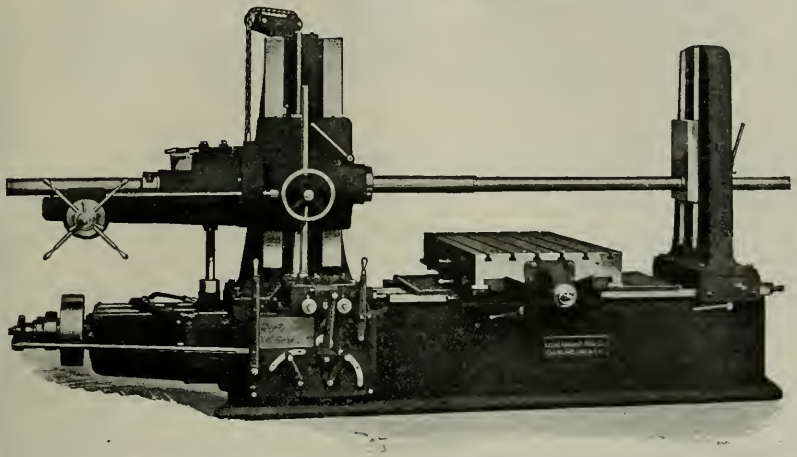
Joseph H. Hazley, who has been sales engineer and service man in charge of the eastern territory for the Wilmarth & Morman Co., Grand Rapids, Mich., for the last eight years, has become associated with the Jacobs Mfg. Co., Hartford, Conn., manufacturer of chucks, and the Rhodes Mfg. Co. of Hartford, manufacturer of shapers.

Edward R. Abbott has joined the sales force of H. W. Cotton, Inc., Brooklyn, N. Y. He will have charge of the western business, making his headquarters for the present in the Woolworth Building, New York City, and later at Cleveland, Ohio. Mr. Abbott was formerly a member of the sales force of the Taft-Peirce Mfg. Co. in the New York office.

E. G. Buckwell, secretary and manager of sales of the Cleveland Twist Drill Co., Cleveland, Ohio, has recently returned from a three months' visit to England and the Continent, where he has made a thorough trade investigation in conjunction with the European branch of the company.

The LUCAS "PRECISION" BORING DRILLING MILLING MACHINE

is made in THREE SIZES—



3, 3¾ and 4½ inch spindles respectively, of the same general design and all with the well-known

LUCAS Accuracy and Efficiency

Send for circulars or a salesman

There are circumstances under which it is a

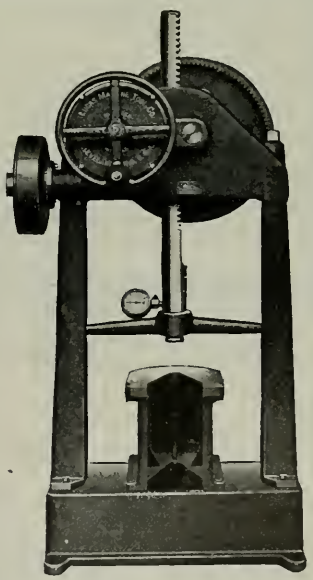
BLESSING

that a machine

STANDS IDLE

We recently visited a shop where we had sold a

Lucas Power Forcing Press



not long before and found it *standing idle.* "What's the matter?" we asked. "This month's work all done, and it used to take us three weeks," was the reply.
(And it was only the 4th day of the month).

LUCAS MACHINE TOOL CO. NOW AND ALWAYS OF **CLEVELAND, OHIO, U.S.A.**

FOREIGN AGENTS: Alfred Herbert, Ltd., Coventry. Societe Anonyme, Alfred Herbert, Paris. Societe Anonyme Belge, Alfred Herbert, Brussels. Allied Machinery Co., Turin, Barcelona, Zurich. Benson Bros., Sydney, Melbourne. V. Lowener, Copenhagen, Christiania, Stockholm. R. S. Stokvis & Zonen, Rotterdam. Andrews & George Co., Tokyo.

C. H. CHAMPION, who has been traveling through England, France, and Italy on behalf of Champion & Ryan, Inc., New York City, importers and exporters, returned to America October 1. Mr. Champion is bringing with him full specifications and particulars of electrical and mechanical supplies and specialties required for the foreign markets in the countries which he has visited, for the purpose of communicating the information to American manufacturers.

A. G. GIBBONS, formerly superintendent of tools and supplies of Winslow Bros. Co., Chicago, Ill., has become affiliated with the Wetmore Reamer Co., 210 Sycamore St., Milwaukee, Wis., in the capacity of production engineer. Mr. Gibbons was also employed by the Cadillac Motor Car Co. and the Brown & Sharpe Mfg. Co. for many years. The Wetmore plant has been rearranged and additional equipment has been installed under Mr. Gibbons' direction, which has considerably increased the production of Wetmore expanding reamers.

B. M. W. HANSON has established an engineering bureau at 570 Park St., Hartford, Conn., and is in a position to place his experience in the designing, building, and marketing of machinery at the service of the manufacturing industries. Mr. Hanson is well known throughout the machine building field in the United States, having for many years been the general manager of the Pratt & Whitney Co., Hartford, Conn., and more recently having held the same position with the Colt's Patent Firearms Mfg. Co., Hartford, Conn.

EARL E. EBY, sales manager for the Hyatt Roller Bearing Co., Industrial Bearings Division, Metropolitan Tower, New York City, has been appointed a member of the board of directors of Hyatt, Ltd., a new company which has been formed to market the Hyatt roller bearing in Europe. Mr. Eby will devote his entire time to this work, and his headquarters will be in New York City. G. O. HELMSTAEDTER, formerly Chicago district manager, has been promoted to the position of sales manager to take the place of Mr. Eby.

ALBERT H. MITCHEL, formerly with the Taft-Peirce Mfg. Co. of Woonsocket, R. I., has become associated with H. W. Cotton, Inc., Brooklyn, N. Y., as vice-president and general sales manager, with headquarters in the New York office in the Woolworth Building. For nine years Mr. Mitchel was in the engineering department of the Taft-Peirce Mfg. Co. at Woonsocket, after which he entered the sales department as Chicago representative. For the last five years he has been in the New York office as district sales manager. H. W. Cotton, Inc., designs and builds jigs, tools, and special machines, and also manufactures parts or complete machines on a contract basis.

HARRY W. WATERFALL has been appointed assistant professor of mechanical engineering at the College of Engineering of the University of Illinois, Urbana, Ill. Mr. Waterfall is a graduate of the Massachusetts Institute of Technology. He was assistant in mechanical engineering at the Massachusetts Institute of Technology from 1911 to 1912 and was assistant to the chief engineer of William Cramp & Sons Shipbuilding Co., Philadelphia, Pa., from 1912 to 1913. From 1913 to 1917, he was instructor in machine design at the University of Illinois, and for the last two years has served as mechanical engineer of the Angus Co., Calcutta, India.

ALFRED LAMAR, assistant director of sales of the United States Government, has returned to Washington from Europe and resumed his duties in the office of the Director of Sales, Washington, D. C. Mr. LaMar will have the immediate supervision of sales of surplus war materials made for export, and will direct the activities of the machine tool section of the office of the Director of Sales. Mr. LaMar went to Europe early in April to survey European markets. He arranged the details of a visit recently made to the United States by a commission from Belgium, which came to this country under the auspices of the Belgian Government with a view to purchasing government-owned machine tools. He also organized the machine tool section of the office of the Director of Sales shortly after the establishment of that office by the Secretary of War.

OBITUARIES

W. P. SPARKS, who has been representative for the past year of the Cleveland Milling Machine Co. at Indianapolis, Ind., died October 10. Mr. Sparks was held in high esteem by the members of the firm and by the trade in general.

H. W. ANDREWS, president of the Andrews & George Co., Tokyo, Japan, importers of machine tools for the Empire of Japan, died at his residence in Yokohama, August 16, aged seventy-four years. Mr. Andrews was Ambassador to China under the administration of President Harrison. After his term expired, he returned to his native home in Cincinnati, Ohio, where he remained about a year, after which he returned to Yokohama, Japan, forming a partnership with Mr. George which has continued unbroken until the present time. The firm will continue as heretofore, his son, R. M. Andrews, succeeding him in the business.

PETER KETTENRING

PETER KETTENRING, founder and president of the Defiance Machine Works, Defiance, Ohio, died at his home in Defiance October 8, aged eighty-three years. He was born in Rheinpfalz, near the city of Strassburg, on January 6, 1836, and when he was three months old his family moved to America, settling in Defiance—then a village of 150 inhabitants—when he was eight years of age. Mr. Kettenring, through the subsequent establishment of the Defiance Machine Works, has been a potent factor in the development of the city. He started work as a molder in a little shop on the corner of Ferry and Third Sts., the site of the present office building of the organization which he founded and of which he was president up to the time of his death. At the age of twenty he became one of the owners of the foundry, from which he developed the present business. Thirty years ago, Mr. Kettenring's three sons, who had been carefully trained in different departments of the business, became a part of the organization. The oldest son died in 1915, but the other two sons are still actively associated with the business. He is survived by four children.

COMING EVENTS

December 1-4—Fourth New York State Safety Congress at Syracuse, N. Y.; headquarters, Hotel Onondaga. Secretary, Edward W. Buckley, State Industrial Commission, Albany, N. Y.

December 2-5—Annual convention of the American Society of Mechanical Engineers at the Engineering Societies Building, 29 W. 39th St., New York City. Secretary, Calvin W. Rice, 29 W. 39th St., New York.

January 6-8, 1920—Annual meeting of the Society of Automotive Engineers, Inc., in New York City, at the Engineering Societies Building, 29 W. 39th St.

February 2-6, 1920—First annual mechanical inspection equipment exposition and convention of the American Society of Mechenical Iospectors at the Hotel Astor, New York City. Secretary, Henry F. Winter, 35 W. 39th St., New York City.

May 15-20, 1920—Seventh national foreign trade convention in San Francisco, Cal. Secretary of the National Foreign Trade Council, O. K. Davis, 1 Hanover Square, New York City.

BOOKS AND PAMPHLETS

1919 Year Book of the Merchants' Association of New York.—306 pages, 7 by 10 inches. Published by the Merchants' Association of New York, 233 Broadway, New York City.

History of the War Activities of the Merchants' Association of New York.—48 pages, 6 by 9 inches. Published by the Merchants' Association of New York, 233 Broadway, New York City.

Protective Metallic Coatings for the Rustproofing of Iron and Steel.—34 pages, 7 by 10 inches. Published by the Department of Commerce, Washington, D. C., as Circular No. 80 of the Bureau of Standards. Price, 10 cents.

Location of Flaws in Rifle-Barrel Steel by Magnetic Analysis.—By R. L. Sanford and William B. Kouwenhoven. 10 pages, 7 by 10 inches. Published by the Department of Commerce, Washington, D. C., as Scientific Paper No. 343 of the Bureau of Standards. Price, 5 cents.

Lubrication of the Motor Car Chassis.—Chart arranged by Victor W. Page. 24 by 38 inches. Published by the Norman W. Henley Publishing Co., 2 W. 45th St., New York City. Price, 35 cents.

This chart presents a plan view of a typical six-cylinder chassis of standard design, outlining all the important bearing points requiring lubrication, and gives instructions for the proper method of lubricating.

Five Hundred Business Books.—Compiled by Ethel Cleland, librarian of the business branch of the Indianapolis Public Library. 72 pages, 6 by 9 inches. Published by the American Library Association, Library War Service, Washington, D. C. Distributed free of charge.

This pamphlet contains a list of business books covering general business, commerce, finance, bookkeeping and accounting, factory organization and management, and other subjects. The names of the publishers, prices, and brief annotations giving an idea of the contents are included.

An Export Order and Allied Topics.—Published by the National Association of Manufacturers, 30 Church St., New York City.

In view of the large number of requests received from manufacturers for copies of this booklet, the National Association of Manufacturers has published a second edition, of which copies will be forwarded upon request to all who are interested in foreign trade. The booklet shows clearly the successive steps involved in the handling of an export order, and explains in a simple manner the methods used. The actual documents, forms, correspondence, and other papers employed in the filling of the order are reproduced and the function of each is explained in a very definite manner.

Operations of the Federal Trade Commission.—Prepared for the National Association of Manufacturers by the Law Department of the association. Published by the secretary of the National Association of Manufacturers, 30 Church St., N. Y. City.

The operations of the Federal Trade Commission have become a study of great importance to business men of the United States. The commission is charged with the administration of the Federal Trade Commission act and with provisions of the Clayton act, and from time to time with investigatory functions and duties that reach into every commercial activity of industry. No attempt has heretofore been made to compile and analyze the decisions of the commission for the purpose of obtaining through them the commission's own viewpoint of the meaning and application of the important statutory duties with which it is charged. The present study is intended to provide the manufacturer with a reference volume which will enable him to understand, through the commission's acts, its own perception of its function.

Techno-Chemical Receipt Book.—By William T. Brannt and William H. Wahl. 495 pages, 5¼ by 7¼ inches; 78 illustrations. Published by Henry Carey Baird & Co., Inc., 116 Nassau St., New York City. Price, $2.50.

This is a revised and enlarged edition of a book containing a large number of approved receipts for use in the arts, the industries, and the household, most of which have been thoroughly tested before being presented to the public. Numerous receipts have been added in the new edition. The book is encyclopedic in form, and the alphabetical arrangement, together

SCREWS

MACHINE, WOOD, CAP, SET, LAG, ETC.

We Have the Assortment and the Quantity

Let us figure on your next specifications. We have managed to "take care" of some very large concerns both in price and delivery.

HAMMACHER, SCHLEMMER & CO.

HARDWARE, TOOLS AND SUPPLIES

NEW YORK SINCE 1848 4th AVENUE and 13th STREET

with a comprehensive table of contents, covering twenty-nine pages, and a detailed index, make reference to any subject or special receipt prompt and easy. Simple language has been employed so that the receipts and processes will be intelligible to the non-technical user. Mention of a few of the subjects covered will serve to give an idea of the wide scope of the book: Alloys; bleaching; boiler incrustations; building materials; cleansing, polishing, and renovating agents; copying and printing; decoration, ornamentation, etc; dyeing; food preparation; glass; household and rural economy; metal industry; manufacture of paper; pharmaceutical preparations; photography; soldering and solders; bookbinding.

Governors and the Governing of Prime Movers.—By W. Trinks, professor of mechanical engineering, Carnegie Institute of Technology, Pittsburgh, Pa. 226 pages, 6 by 9 inches. 140 illustrations. Published by the D. Van Nostrand Co., 25 Park Place, New York City. Price, $3.50, net.

The knowledge of governors and governing among both designing and operating engineers is often incomplete, due to the fact that this subject does not cover a wide enough field to warrant a separate course in engineering schools, and little comprehensive material dealing with it has been published. The aim of the author of the present book is to fill this gap in technical literature. It is not claimed that the book covers the whole subject of the governing of prime movers, as this would be impracticable for a number of reasons. However, essentials and principles are presented, and the mathematical treatment is such as to be mastered by undergraduates. The illustrations have been drawn especially for this book with the idea of showing diagrammatically essential principles and omitting all else. A bibliography is included to assist the student if he desires to do supplementary reading. The book is divided into fifteen chapters headed as follows; General Statements; The Direct Control Governor as a Motor; The Centrifugal Governor as a Measuring Instrument (Speed Counter); Promptness and Traversing Time; Adjustment of Equilibrium Speed; Shaft Governors; Natural Period of Vibration of Governors; Effects of Outside Forces Impressed upon Governors; Interaction between Governor and Prime Mover; Discarded Types of Speed Governors; Rate-of-flow Governors; Pressure Governors; Relay Governing; Governor Troubles and their Remedies; Self-regulating Features of Prime Movers.

Practical Mathematics for Home Study.—By Claude I. Palmer. 493 pages, 5 by 8 inches; 299 illustrations. Published by the McGraw-Hill Book Co., Inc., New York City. Price, $3.

The author of this book has taught classes in practical mathematics in the evening school at the Armour Institute of Technology for the past fifteen years, and is now associate professor of mathematics in this institution. During this period he has had an opportunity to study the needs of men engaged in various practical pursuits, and the results of this experience have been brought together in the present volume which gives the essentials of arithmetic, geometry, algebra, and trigonometry. Many of the examples given are adapted from engineering trade journals and from handbooks of various kinds, while others are from the author's own experience. A great many of the problems are also practical questions proposed by the students in the classes taught by the author. The scope of the book is best indicated by some of the chapter headings: Common Fractions; Decimal Fractions; Short Methods and Checks; Weights and Measures; Percentage and Applications; Ratio and Proportion; Density and Specific Gravity; Power and Roots; Plane Surfaces—Lines and Angles; Triangles; Circles; Graphical Methods; Prisms; Cylinders; Pyramids, Cones, and Frustums; The Sphere; Various Other Solids; Notation and Definitions; Formulas and Translations; Positive and Negative Numbers; Equations and Formulas; Exponents, Powers, and Roots; Quadratic Equations; Variation; Graphics; Logarithms; Angles; Trigonometric Functions; Right Triangles; Relations between Ratios and Plotting; Trigonometric Ratios of More than One Angle; Solution of Oblique Triangles.

Foundry Practice.—By R. H. Palmer. 390 pages, 5½ by 8¼ inches; 217 illustrations. Published by John Wiley & Sons, Inc., New York City. Price, $3.

This is the second edition of the author's text-book for molders, students, and apprentices, partly rewritten and enlarged. The author was formerly instructor in foundry practice at the Worcester Polytechnic Institute, and has practical experience as molder, foreman, and superintendent of foundries; hence, he has recorded in this work his actual practical experience. The additional information given in the second edition is as follows: "Propeller Casting is Essential to Our Defense," giving a description of the rigging, flasks, molding, securing and pouring the mold to produce large propeller wheels economically. "Casting Locomotive Superheater Cylinders," describing the pattern, flasks, cores, molding, setting and securing cores, gating and pouring, analysis of iron, transverse strength, and deflection. "Casting Lathe Beds and Chilling the Ways," describing the pattern, flasks, molding, arrangement of chills, and resulting benefits. "Making Cores for Gasoline Engine and Automobile Cylinders," showing some of the causes of defects in castings. "Molding Large Kettles, used by Manufacturers of Chemicals, Dyestuffs, etc.," showing different methods of producing them, flasks, and special rigging to produce some styles in large quantities economically. The author has endeavored to prepare a text-book for the student, apprentice, and molder, rather than a reference work for the trained foundryman.

Time Studies as a Basis for Rate Setting.—By Dwight V. Merrick. 366 pages, 6¼ by 9¾ inches; 137 illustrations. Published by The Engineering Magazine Co., New York City. Price, $6.

The purpose in preparing this book for rate setting has been to place on record definite information relating to this phase of industrial management, and to lay down the principles covering time study for rate setting, to show the numerous methods that have been helpful in taking observations, and to present some details of practice, particularly in regard to the human relationship involved in the work. The volume is divided into three sections; the first presents the principal methods and implements of time study; the second is an illustration of time study as applied to a line of machine tools, together with a series of tables giving the detail times as established by study; while the final section, in the form of appendices, includes detailed times for a number of other kinds of work, and shows the wide adaptation of the principles and methods outlined. The general scope of the work is best set forth by a review of the chapter headings: Objects and Principles of Time Study; Taking an Operation Time Study; Taking a Production Study to Check Tasks; Production-time Studies on Automatic Machines; Establishing Delay Allowances for Rate Setting; Production-time Study on Variable Operations; Time Studies for Rate Setting on Machine Tools; Preparing Boring Mills to Receive Work; Landing Work, and Operations Preparatory to Machining; Setting Tools and Manipulating Boring Mill to Start Cuts; Machining, Loosening Jaws, and Removal of Work; Developing a Rate from Fundamental Operation Tables; Organizing a Time-study Department; Classification of Time-study Data; Instruction Cards; Rate Tables—Instruction Cards in Tabular Form; Investigations of Molding Processes; Rating for Drop-forging Operations; Investigating a Brass Rolling Mill Process; A Unique Control of Variable Tasks; Rating Tasks by Eliminating Waste; Rating Sawing-off Metal Stock; Rating Operations on an Automatic Dovetail Jointer; Wage Payment Systems. Being exceedingly detailed in character, the book should appeal to men who are actually engaged in time study and rate setting work, because it will answer the detailed questions which such men would ask.

NEW CATALOGUES AND CIRCULARS

Alexander Milburn Co., Baltimore, Md. Circular of Milburn oxy-acetylene welding and cutting apparatus.

Taylor Instrument Companies, Rochester, N. Y. Circular advertising temperature indicating, recording, and controlling instruments.

Warner Elevator Mfg. Co., Cincinnati, Ohio. Bulletin descriptive of Warner traction engines, motors and controllers for elevator service, and elevator cars.

Electric Controller & Mfg. Co., Cleveland, Ohio. Circular listing the principal features of the alternating-current starting switches made by the company.

Sprague Electric Works of General Electric Co., 527 W. 34th St., New York City. Bulletin 47942, giving specifications for "safety" panel boards and cabinets.

Gishalt Machine Co., 9 S. Baldwin St., Madison, Wis. Circular containing data on solid-adjustable shell reamers, hand reamers, and taper shank chucking reamers.

Victor R. Browning & Co., 17701 Lake Shore Blvd., Cleveland, Ohio. Bulletin descriptive of Browning electric hoists, which have capacities of from one-half to twelve tons.

Ingersoll Milling Machine Co., Rockford, Ill. Circular illustrating Ingersoll differential and drum type continuous milling machines in operation milling motor cylinder castings.

Davis-Bournonville Co., Jersey City, N. J. Circular illustrating and describing the Davis-Bournonville decarbonizing outfit for burning out carbon deposits in gas engine cylinders.

Scovill Mfg. Co., Waterbury, Conn. Pamphlet containing the fourth annual report of the industrial hospital maintained by the company for the treatment of sick and injured employes.

Davis-Paurnonville Co., Jersey City, N. J. Circular descriptive of cabinet trucks, large-wheel open trucks, and small-wheel open trucks for oxy-acetylene portable welding and cutting outfits.

National-Acme Co., Cleveland, Ohio. Calendar for 1920, containing on the sheet for each month illustrations of National-Acme automatic screw machines, screw machine products, taps and dies, etc.

Kaief & Co., 4168 W. 25th St., Chicago, Ill. Circular entitled "Short-cut Calculations Solved by the Slide-rule," advertising slide-rules, folding pocket rules, and combination calipers made by this company.

Lawenstein Radio Co., Inc., 397 Bridge St., Brooklyn, N. Y. Circular descriptive of the universal tapping machine made by this company, which combines the features of a horizontal and a vertical machine.

Manufacturers' Hardware Corporation, Milwaukee, Wis. Circular illustrating and describing the Beeman's "time-saver" self-oiling lathe and grinder centers which insure lubrication of the work as it revolves on the center.

Pangborn Corporation, Hagerstown, Md. Catalogue of sand-blast and allied equipment, containing illustrations of the Pangborn organization and interior views of the plant, as well as views of sand-blast installations.

R. D. Nuttall Co., Pittsburgh, Pa. Bulletin 25, on the heat-treatment of steel gears for industrial mining and electric railway purposes. Bulletin 26, on the application and use of the helical type of gearing for electric railway service.

Detroit Reamer & Tool Co., Detroit, Mich., has just issued a new catalogue, 140 pages, 4¾ by 7¼ inches, containing illustrations, prices, sizes and other data relating to the line of cutters and reamers manufactured by this concern.

New Departure Mfg. Co., Bristol, Conn. Circulars 118 FE, 119 FE, 120 FE, and 121 FE, descriptive of the application of ball bearings to gasoline power ice saws, spinning lathe headstocks, special routing machines, and lawn mowers.

School of Mines and Metallurgy of the University of Missouri, Rolla, Mo. Bulletin containing a bibliography on the roasting, leaching, smelting, and electrometallurgy of zinc, compiled by Harold L. Wheeler, librarian of the university.

Cagsdill Mfg. Co., Detroit, Mich. Folder illustrating and describing the "Cegsdrill" combination center drill and reamer—a ground tool made from high-speed steel, having radial relief cutting edges for drilling true and smooth center holes at high speed.

Oliver Instrument Co., Adrian, Mich. Pamphlet entitled "Mere Accurate Dies and Templets at a Greatly Reduced Cost," describing the method of making dies employed by this company, and illustrating the Oliver sawing, filing, and lapping machines for use in die-making.

L. V. Estes, Inc., 202 S. State St., Chicago, Ill. Booklet entitled "Human Relations in Industry," containing a brief discussion of the underlying principles of personal relations and industrial management that are essential to industrial harmony and maximum production.

Smalley-General Co., Inc., Bay City, Mich. Catalogue illustrating and describing the Smalley-General No. 1 flange thread miller, which comprises the company's regular No. 1 thread milling machine equipped with attachments that adapt it for milling threads on pipe flanges.

Staw Mfg. Co., Inc., Binghamton, N. Y. Bulletins 103 and 104, illustrating the line of portable motor-driven tools made by the company, which includes electric drills, grinders, screwdrivers, radial flexible boring machines, etc., as well as flexible shafting for use with these tools.

Esterline Co., Indianapolis, Ind. Booklet entitled "Typical Graphic Records," illustrating and describing the Esterline graphic recording instruments, and showing examples of records, or curves, which have been made on these machines in a large number of different plants and under widely varying conditions.

Delphie Specialty Mfg. Co., Detroit, Mich. Folder illustrating and describing the Delphie jack truck, intended for moving heavily-loaded barrels in factories. With this truck, the barrel need not be lifted onto the truck, but it can be approached from any side, and is then jacked up by the truck and moved as required.

Cutler-Hammer Mfg. Co., Milwaukee, Wis. Four-page folder entitled "Cutler-Hammer Drum Controllers," describing the special features of these controllers, among which are mentioned accessibility, interchangeability of parts, and interchangeability of methods of manipulation. Dimensions, ratings, and other engineering data are given.

Abrasive Co., Philadelphia, Pa. Booklet describing abrasive grinding wheels for the foundry. The terms grain and grade as applied to grinding wheels are explained and tables are given covering abrasive grade list, the selection of the proper grain and grade for wheels for foundry use, grinding wheel speeds, and price lists for straight and taper-side wheels, and rubber wheels.

Cutler-Hammer Mfg. Co., Milwaukee, Wis. Booklet J, illustrating and describing C-H rectangular magnets, which are primarily adapted for handling regular shapes in steel and iron. The booklet shows applications of rectangular magnets for handling ship plates, pipe, cold-rolled steel in coils, and other material. The construction of the magnet is described, and dimensions, lifting capacities, and other engineering data are given.

American Malleable Castings Association, 1900 Euclid Bldg., Cleveland, Ohio. Pamphlet entitled "Malleable Iron, Its Properties and Its Uses," containing an illustrated article on malleable iron, indicating briefly a few of the principles on which the process is based, and pointing out the results that have been obtained through its use. The booklet also describes the work of the association relating to the testing and analyzing of malleable iron castings.

Electric Furnace Co., Alliance, Ohio. Booklet 7-B, descriptive of the company's standard 105-kilowatt tilting electric furnaces for melting brass. Booklet 13-B, containing a reprint of a paper by T. F. Bailey delivered at the Boston meeting of the American Institute of Chemical Engineers, discussing the various electric non-ferrous metal melting furnaces. Bulletin 17-M, descriptive of a special furnace for rolling mills, which is designed for pouring the metal directly into the molds.

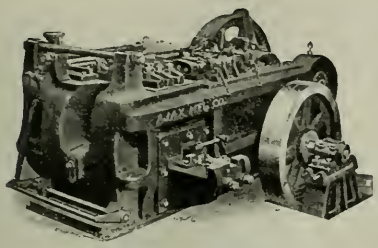
Chain Products Co., Cleveland, Ohio. Catalogue C 30 entitled "Weldless Wire Chains," 111 pages, 8½ by 11 inches. The book is divided into three sections, dealing with coil chain, chain specialties, and miscellaneous attachments, respectively, and contains a complete index. Each size of chain is listed separately, giving the dimensions, prices, weight, strength, etc. The margins of the pages are embellished with a series of drawings, suggesting the many uses for which chains of this kind are adapted.

Boston Pressed Metal Co., Worcester, Mass. Bulletin entitled "The Possibilities of Pressed Metal Engineering," containing illustrations showing actual examples of pressed metal work which has been done by the company for its customers. The examples are typical of what can be accomplished by this process, and include medium seamless drawn shapes, seamless drawn ferrules, tapered drawn shapes, small seamless drawn shapes, irregular seamless drawn shapes, forming and bending, and redevelopment in pressed metal.

Cleveland Punch & Shear Works Co., Cleveland, Ohio. Circular descriptive of the Cleveland system of making punches and dies, which, through the use of standard coupling nuts and sleeves, enables any size hole ranging from ⅛ inch to 1 1/16 inches to be punched with the same nut and punch stem. By

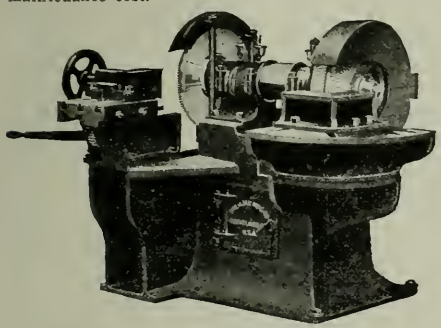
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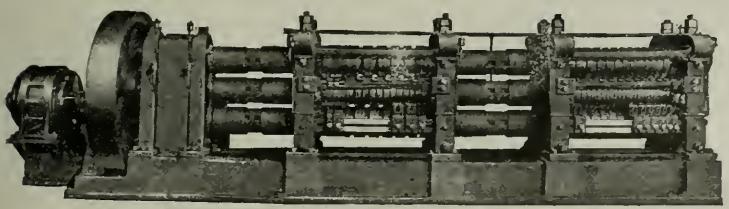
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using another nut on the same stem, the range can be increased up to 1 5/16 inches, which is sufficient for all ordinary punching. The same arrangement is followed for larger sized holes punched on the heavier machines.

Du Pont Chemical Co., Wilmington, Del. Pamphlet listing second-hand machinery and equipment which is offered for sale owing to the closing of the Du Pont war plants. The classes of machinery listed are builders', contractors', and plumbers' equipment and supplies; general manufacturing equipment; machine shop and foundry equipment; power plant equipment; hauling and transportation equipment; office equipment; welfare and hospital equipment and supplies; and miscellaneous equipment. A copy of the booklet will be sent upon request.

Wood Turret Machine Co., Brazil, Ind. Catalogue 13, describing the complete line of "Tilted Turret" screw machines, turret lathes, brass-working machines, and extra-capacity automatic chucking turret lathes. Illustrations of various types of screw machines and turret lathes are shown, as well as views showing the details of construction, and specifications are given. Several pages are devoted to improvements and special construction. Considerable space has been given to the tooling equipment and various special fixtures that can be furnished with or applied to a "Tilted Turret" machine.

Allied Machinery Co. of America, 51 Chambers St., New York City. Catalogue of metal-working machinery, showing the turning machines manufactured by the South Bend Lathe Works, of South Bend, Ind.; turret machines manufactured by the Warner & Swasey Co., Cleveland, Ohio; milling machines manufactured by Gooley & Edlund, Inc., Cortland, N. Y.; milling machines manufactured by the Chicago Machine Tool Co., Chicago, Ill.; gear-cutting machines manufactured by Gould & Eberhardt, Newark, N. J.; and brass-working machines manufactured by the Warner & Swasey Co., Cleveland, Ohio.

J. H. Williams & Co., 61 Richards St., Brooklyn, N. Y., makers of "Superior" drop-forgings and drop-forged tools, have just issued a catalogue, 160 pages, 4 by 6 inches, fully illustrating and describing their standard stock specialties. These include several lines of new tools, among which are "Agrippa" set-screw pattern turning-tool holders, "Agrippa" boring-tool posts, "Vulcan" forged-cutter tool-holders, and several new sets of drop-forged wrenches. The book contains, in addition, a description of the drop-forging process, written in a simple, non-technical style for the benefit of those not familiar with its details.

TRADE NOTES

American Shell Co., Paterson, N. J., has changed its name to the **Gillespie Motor Co.**

Poole Engineering & Machine Co., Baltimore, Md., has opened a branch office in Boston in the Old South Building, in charge of Robert W. Catlin, district manager.

John T. Moran Machine Co., 103-107 Grape St., Syracuse, N. Y., in connection with its general jobbing and tool work, is about to place on the market a special indestructible tool handle for use with wood-working tools.

J. A. Purves & Sons, 214 Temple St., Syracuse, N. Y., has moved to new quarters at W. Jefferson and Franklin Sts., where the company will have three times the present floor space. This concern manufactures tools and special machinery.

Lyon Metallic Mfg. Co., Aurora, Ill., manufacturer of steel shelving, lockers, boxes, cabinets, and general steel equipment, announces the opening of a new district sales office in Philadelphia at 519 Bulletin Bldg., with R. J. Nyce in charge.

American Machine Products Co., Detroit, Mich., is now located in its new factory at 18th and Howard Sts., which is a modern two-story brick building with ample floor space to greatly increase the production. This company manufactures milling cutters, reamers, end-mills, three-lip drills, and special tools.

Horace G. Cooke, Inc., 50 East 42nd St., New York City, has been organized for the purpose of designing and marketing for the National Marine Engine Works, Inc., a complete line of rotary compressors, gas exhausters, and pumps. Horace G. Cooke was for twenty years eastern representative of the Connersville Blower Co.

Abrasive Co., Philadelphia, Pa., announces that the use of the name "Boro-Carbone" as applying to the aluminous abrasive made by the company will be discontinued, and this product hereafter will be marketed under the registered trademark "Borolon." The silicon-carbide abrasive will continue to be trademarked "Electrolon."

Dickey Steel Co., Inc., Woolworth Bldg., New York City, has been appointed eastern sales and export representative of the Hammond Steel Co., Inc., Syracuse, N. Y., manufacturer of high-speed, alloy, and straight carbon tool steels, and a complete line of alloy steels in bars, weldless rings, die-blocks and special shapes.

Republic Tool & Mfg. Co., 1399 W. 9th St., Cleveland, Ohio, has acquired the business of the Cleveland Power Transmission Co., the Detroit Reamer & Tool Co., the Clyde E. Lowe Co., and the Diamond Stamping Works Co. A complete line of small tools and cold-rolled steel in rounds, hexagons, squares and flats will be carried.

Gale-Sawyer Co., 36 Oliver St., Boston, Mass., is making extensions and alterations to its plant at South Weymouth, Mass. The company desires to be placed on the mailing lists of machine tool manufacturers and to be furnished with catalogues and other literature applicable to the business of manufacturing cutters, reamers, and small tools.

Ingersoll-Rand Co., 11 Broadway, New York City, has established a branch office in Dallas, Tex., located in the Sam Houston Life Building. R. H. Brown, Jr., will be in charge of the new office. Mr. Brown has heretofore been connected with the company's St. Louis office and has been in intimate touch with the Texas and Oklahoma territory for many years.

New Departure Mfg. Co., Bristol, Conn., held its fourth annual field day and barbecue September 20. The usual parade, athletic sports, dinner, and concert were features of the day. This event brings together the large number of employes of the company, which increases every year, and promotes a feeling of fellowship and good will between the management and the workers.

R. S. Stokvis & Zonen, Ltd., Rotterdam, Holland, has appointed George Roemer Woods, formerly with the Allied Machinery Co., of America, manager of the New York office at 17 Battery Place, New York City. Mr. Woods sailed in October for the United States from Europe where he has been studying industrial and economic conditions, and assumed his new duties November 1.

J. Horstmann, 83 Rue St. Maur, Paris, France, announces the appointment of Charles B. Elmore as American representative of the company with offices at 47 West 42nd St., New York City. The firm requests duplicate copies of complete catalogues, price lists and dealers' discounts from firms who desire to make arrangements for selling machine tools and machine shop equipment in France.

James Ohlen & Sons Saw Mfg. Co., Columbus, Ohio, and **George H. Bishop & Co.**, Lawrenceburg, Ind., have effected a merger and consolidation of interests, which will make it possible for them to present to the trade a complete line of saws and tools adapted for every wood- and metal-cutting purpose. The Ohlen plant at Columbus and the Bishop plant at Lawrenceburg will each be immediately enlarged to meet the increased demands for the products of these companies.

Cleveland Twist Drill Co., Cleveland, Ohio, announces that it has made a four-reel motion picture entitled "The Twist Drill—Its Uses and Abuses," which is designed primarily to be shown before machinists, drill press hands, foremen's clubs, etc. The picture deals with the fundamental principles of drilling, and among the subjects treated are body clearance, lip clearance, angle of cutting edge, feed and speed, broken tangs, and many other phases of drilling practice.

Newton Machine Tool Works, Inc., Philadelphia, Pa., have just let contracts and have now under construction a new shop covering an area of 400 by 230 feet, including an erection shop, a pattern and storage shop, a forge shop, and a power plant. The erection shop is 100 by 170 feet by 45 feet high, of steel, steel sash, and brick construction, and has one square foot of overhead light for every square foot of floor space. It will be fitted with two 50-foot span overhead traveling cranes.

Allegheny Gear Works, Chateau and Page Sts., N. S., Pittsburgh, Pa., is a newly incorporated concern that will specialize in the cutting of spur, worm, and bevel gears, in large quantities. The incorporators are W. H. Thompson, E. L. White, and O. Refior. Mr. Thompson is treasurer and general manager, and Mr. White is secretary. A new fireproof brick and concrete building, 80 by 125 feet, is being erected, and plans are under way for rapid expansion. It is expected that manufacturing will start January 1.

Black & Decker Mfg. Co., 140 S. Calvert St., Baltimore, Md., will exhibit a complete line of the Black & Decker Lectrofiator electric air compressers, portable electric drills, and electric valve grinders, at the jobbers' convention, in Chicago, in November. Air compressors, electric drills, and valve grinders, sectioned so as to show their construction and operation, will be mounted on display boards, and the various sectioned models will be operated at slow speeds in order to demonstrate the actual functioning of each part.

Zobell Electric Motor Corporation, Garwood, N. J., has been incorporated in the state of New York with a capital of $250,000. The new corporation intends to manufacture both alternating-current and direct-current motors in sizes from 1 to 7½ horsepower, having many refinements not found at this time in small motors. The president of the new company is Fred G. Bell, and the treasurer, A. T. Zoebisch, both of whom were formerly connected with the E. P. Co., of Bayonne, N. J. The superintendent is F. E. Bucker, formerly superintendent of the E. P. Co.

Leland-Gifford Co., Worcester, Mass., manufacturer of sensitive drilling machines and profiling machines, has opened a sales office at 521 Chamber of Commerce Bldg., Rochester, N. Y., in charge of A. H. Anderson. The company has transferred its Chicago office from 500 Machinery Hall to 621 W. Washington Blvd., where a store and demonstrating room are maintained. C. H. James is in charge of the store, and O. H. Leidy has recently been added to the Chicago sales force. The company intends to keep a stock in the Chicago office at all times for immediate delivery.

Bearings Co. of America, Lancaster, Pa., has decided to increase the facilities of its thrust bearing factory by erecting a new building of the latest type of construction in the immediate future, adding approximately 60,000 square feet of floor space to the present facilities. With the addition of the new buildings completed last year for the increased production of universal joints, this gives the Bearings Co. of America four separate factories—one for the manufacture of thrust ball bearings; one for "Star" ball retainers; one for "Sterling" universal joints; and one for drop-forgings.

Armstrong Bros. Tool Co., 313 N. Francisco Ave., Chicago, Ill., is making extensive additions to its plant and equipment, which include an addition to the drop-forge department, a new building for the hardening and heat-treating department, and a new reinforced concrete building for the general office, finished stock and shipping department. The new buildings and equipment, together with the rearrangement of the entire plant made possible thereby, will largely increase the company's production—an increase which is urgently needed to take care of the rapidly growing business.

Goddard & Goddard Co., Detroit, Mich., has removed its business to its new factory on Hastings St., at Forest Ave. The new building will afford increased room and the equipment available will make it possible for the company to render prompter service to its customers and also to handle a larger volume of business. Owing to the increasing demand for the Goddard & Goddard type of cutters, which taxes the company's capacity to its utmost, it has been decided to discontinue the salvaging of worn tools and specialize entirely on the manufacture of the Goddard & Goddard high-speed cutters.

East Iron & Machine Co., Lima, Ohio, has bought the business of the Van Wie Pump Co., Syracuse, N. Y., including the drawings, patterns, good will, etc., of the company. The Van Wie Pump Co. was established in 1860 under the name of White, Clark & Co., and in 1905 was incorporated under the present name. Its line includes vertical and horizontal centrifugal pumps, double-suction pumps, sand pumps, hydraulic pumps, single-acting triplex pumps, and vertical steam engines. The East Iron & Machine Co. will begin manufacturing this line immediately, and will make parts and repairs for all the Van Wie products.

Production Engineering Co., 212 Centre St., New York City, has been organized to act as engineers to manufacturers. The officers of the company are John A. Honegger, president; Robert Steinman, treasurer; and H. Allen Hinchcliff, secretary. The firm will specialize in the designing and building of tools and machinery for automatic production. It is desirous of obtaining catalogues of machine tool and specialty manufacturers for use in its reference files. In addition, the company wishes to get in touch with all manufacturers of standard labor-saving devices so that it may inform its clients where such standard equipment may be obtained.

Mossberg Pressed Steel Corporation has recently been organized at Attleboro, Mass., and will specialize in the manufacture of pressed steel loom beam heads, section beam heads, adjustable loom beam heads, narrow fabric beams, jack or dresser spools, and drop wires for the textile industry, as well as special stampings. The company will endeavor to develop new ideas for the improvement of textile machinery along the lines of replacing cast-iron parts that are constantly breaking, with pressed steel. The officers of the corporation are Frank Mossberg, president; S. O. Bigney, vice-president; C. A. VanderPyl, treasurer; and A. A. Underwood, secretary and sales manager. All of the officers, except Mr. Bigney, were formerly connected with the Frank Mossberg Co.

Wyckoff Drawn Steel Co. has recently been organized at Ambridge, Pa., by A. W. Wyckoff, a former steel man and distributor of Chalmers and Reo cars for several years in the Pittsburg district. The plant will have an initial capacity of 5000 tons of drawn steel per month and facilities for immediately increasing production. It is expected that the mill will be in full operation in December, and orders are now being booked for delivery the early part of next year. Modern machinery is being installed for producing cold-drawn steel products in the shape of rounds, squares, hexagons, special shapes, screw stocks, and alloy steel. The officers are A. W. Wyckoff, president; G. R. Nutty, vice-president; and Joseph T. Somers, general manager of sales.

Bridgeford Machine Tool Works, Rochester, N. Y., and **Betts Machine Co.**, formerly of Wilmington, Del., announce the consolidation of the two companies to be known as Betts Machine Co., located at Rochester, N. Y. The Bridgeford Machine Tool Works has specialized in building heavy engine lathes and axle lathes for more than twenty years in Rochester. The Betts Machine Co. has been building heavy-duty machine tools for nearly sixty years, being organized in 1861 in Wilmington, Del., and moving to Rochester in 1918. Bridgeford lathes and Betts heavy machine tools will hereafter be built by the Betts Machine Co. at its new plant in Rochester and distributed by the Betts Machine Co. from Rochester and through its offices and representatives in New York, Chicago, Cleveland, and other large cities.

Black & Decker Mfg. Co. is erecting a new plant at Towson Heights, near Baltimore, Md., which will comprise an addition to the office building recently completed, into which the general offices have been moved. The new building will be 100 feet deep by 200 feet wide, and will add 20,000 square feet of floor space to the plant's facilities, making a total of 32,000 square feet of manufacturing floor space available. The building will be of steel and brick construction, finished in stucco to conform to the residences for employes which the company is erecting, and will be provided with a monitor roof and windows extending all the way around the sides, which will supply abundant light and ventilation. It is expected that the new factory will be completed about December 1 and will be in full operation shortly after the first of the year. It is stated that sufficient additional machine equipment will be installed to give the plant more than twice the present productive capacity. The Austin Co., Cleveland, Ohio, has charge of the construction.

VOLUME 26

MACHINERY

NUMBER 4

DECEMBER, 1919

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Principal Articles to Appear in January MACHINERY

Carburizing and Casehardening ..... *S. P. Rockwell*

The Vertical Turret Machine and its Work ..... *Fred R. Daniels*

Formulas for Formed Tools ..... *W. E. Thompson*

Valve Work on the Turret Lathe ..... *Erik Oberg*

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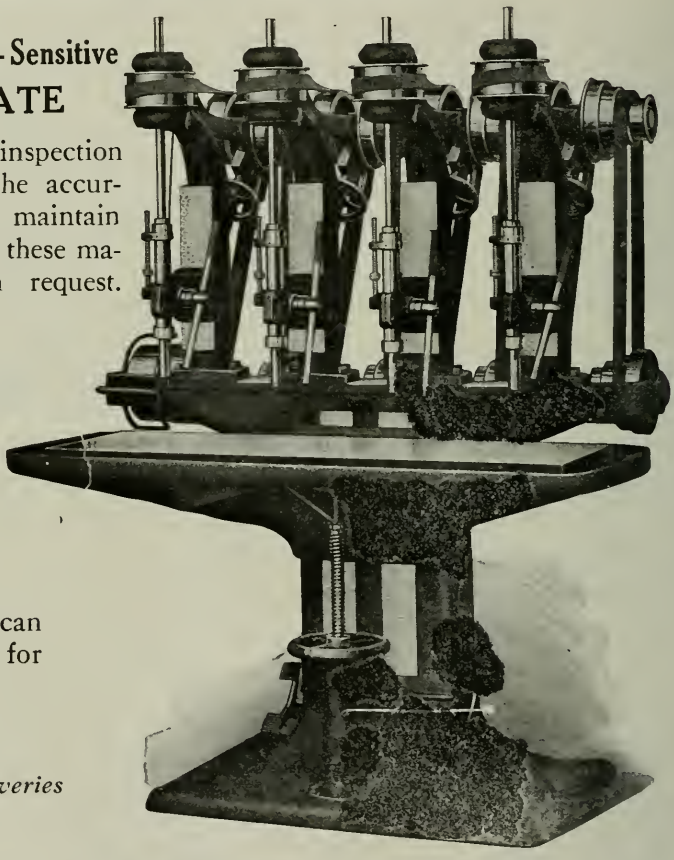
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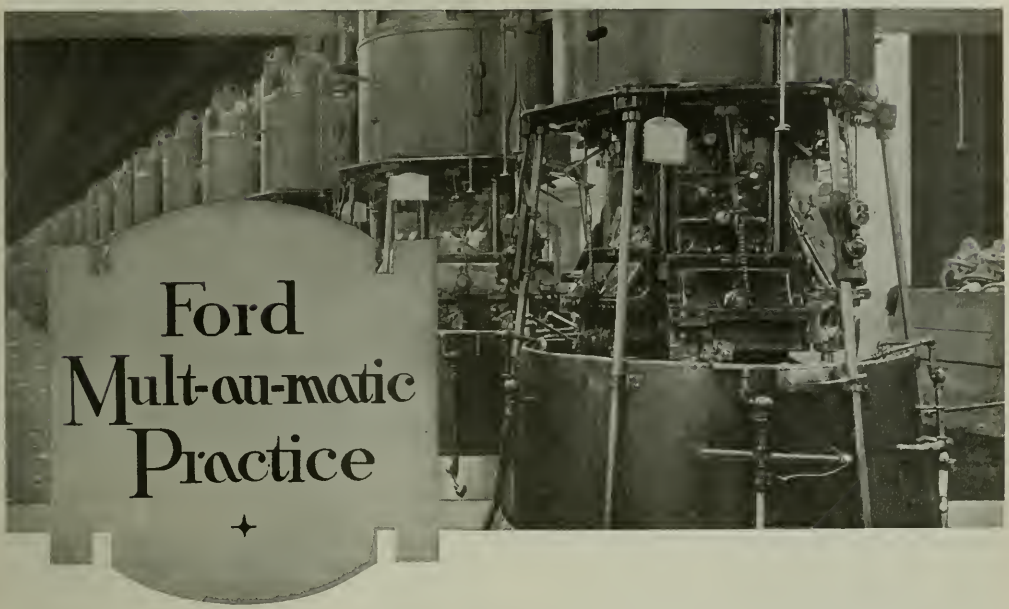
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Ford Mult-au-matic Practice

Practice of the Ford Motor Co. in Machining Automobile Parts on Bullard Mult-au-matics

By EDWARD K. HAMMOND

SINCE the introduction of mult-au-matic vertical lathes by the Bullard Machine Tool Co., of Bridgeport, Conn., these machines have found successful application in the Ford Motor Co.'s plant, where there are enormous quantities of duplicate parts on which turning, boring, drilling, reaming, facing, or threading operations must be performed. Machines of this type were introduced to the trade nearly six years ago, but as their application is most successful in those plants which have large quantities of repetition work, it may be that some readers of MACHINERY have not had an opportunity to become familiar with the characteristics of this type of machine tool; and as a clear understanding of the following article is dependent upon a general knowledge of the principles of operation, a brief description of their design will be given before entering into a discussion of their use for specific machining operations.

At the time of their introduction, the design of the Bullard mult-au-matics represented a marked departure from established practice in machine tool design. These machines are essentially multiple-spindle vertical lathes which are semi-automatic in operation; hence the name "mult-au-matic," which signifies a multiplicity of spindles and an automatic functioning of the mechanism. Machines of this type are built in six-spindle and twelve-spindle styles, according to the requirements of the work which is to be done on them, but the general method of operating both styles of machines is the same. They consist of a frame or turret in which are mounted, in equal spacing and at the same radial distance, the rotating work-holding tables and spindles—provision being made for indexing the turret or carrier with its contained spindles from station to station, so that the work may be located beneath the tools carried by successive vertical tool-slides, which are mounted on the faces of a hexagonal shaped column. Wide ranges in the speed of rotation of work are obtainable at each station, and each toolhead is, in addition, equipped with an independent feed movement. In this way, it is possible to have the desired combination of speed and feed for each table, according to the requirements of the machining operation which is to be performed on the work while located at a given station on the machine.

Factors which Improve Rates of Production

The saving of time in machining operations and the rates of production which are attained on the mult-au-matics are due to the fact that there is practically no idle time for either the machine or its operator. There is one station, known as a loading station, and five stations over which tool-carrying heads are mounted. While the operator is setting up a piece of work or removing a completed piece at the operating station, all of the successive operations which are required on the work are being simultaneously performed at the other five stations of the machine. Consequently, the total machining time is cut down to the period required to complete the longest machining operation, plus the indexing time. As the operations performed at each station are completed, the tools are automatically withdrawn from the work, and upon completion of the longest operation the work-tables are automatically indexed to bring each of the pieces into position for performing the next machining operation of the sequence. Attention has been called to the fact that turning, boring, drilling, reaming, facing, and threading operations can be performed on these machines, and none but simple tools, such as twist drills, reamers, and single-point turning and boring tools, are employed. Consequently, the expense of tooling is not an important factor. The machines are especially equipped for the specific machining operations on which they are to be employed, and in this connection, attention may be called to the fact that the tool-carrying slides over each station of

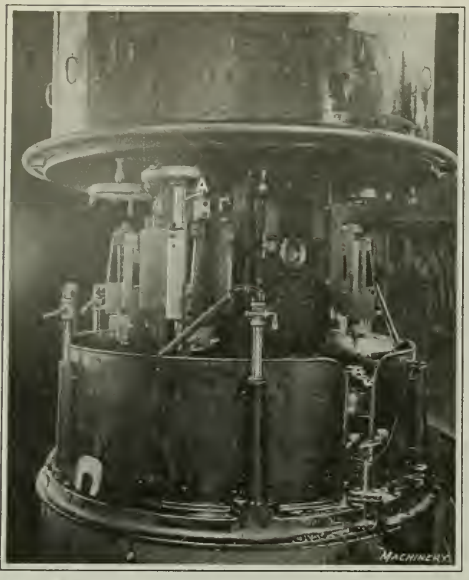


Fig. 1. Mult-au-matic equipped for machining Ford Triple Transmission Gear Blanks. Attention is called to the Drilling Spindle A provided on this Machine

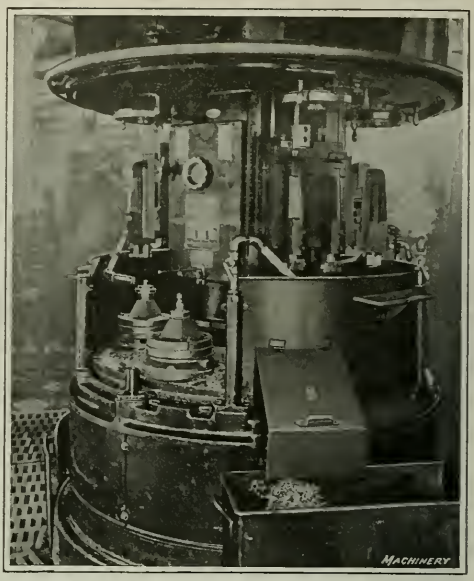


Fig. 2. Mult-au-matic on which Second Sequence of Operations is performed on Ford Triple Transmission Gear Blanks started on the Machine shown in Fig. 1

the machine are often especially designed, with the right rate of feed, etc., to meet the requirements of the work.

Variety of Work that is Handled

Reference has been made to the general classes of machining operations which are performed on these machines, and a brief consideration will make it apparent that the range of work which could be handled would be seriously restricted if some provision were not made for machining the great variety of pieces where it is necessary to either turn or bore tapered surfaces. To adapt the machines for work of this nature, the standard tool-carrying slides include a swivel base and a secondary slide which provides means for adjustment of the tool travel in either direction and at any angle within the circle. Tapered or conical surfaces, either convex or concave, may thus be readily machined.

Provision for Machining Irregular Shaped Work

By designing special tool-heads for installation at various stations on the machines, provision has been made for adapting mult-au-matics for economically producing many classes of irregular shaped work, which would otherwise be difficult to handle on a production basis. As a typical example of such specially designed tool-heads, attention is directed to the piece of work illustrated in Fig. 13, on which it is required to turn a spherical seat. It will be evident to any experienced mechanic that an attempt to use a standard machine tool for the quantity production of pieces of this form would entail a heavy manufacturing cost; but with a specially equipped mult-au-matic, the operations required on the spherical surface of this piece may be handled with little more trouble than straight cylindrical turning or boring. Similar provision can be made for machining other irregular shaped work of the same general character.

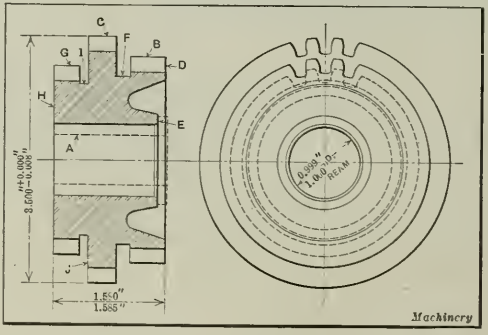


Fig. 3. Ford Triple Gear, the Blank for which was machined on Mult-au-matic shown in Figs. 1 and 2

Rotating Spindles for Drill Heads

Another important feature of the tooling of these machines is the provision of so-called drill heads, which are used in cases where it is desired to simultaneously drill a small hole at the center of a piece of work and turn a surface of considerably larger diameter on the same piece. It will be evident that if an attempt were made to rotate the work at a sufficiently high rate to afford an efficient cutting speed for the drill, the turning tool would be required to operate under such severe conditions that it would soon be destroyed; and on the other hand, reducing the speed of rotation of the work to a point where the correct cutting speed would be obtained for the turning tool, would mean that the cutting speed of the drill would be far too slow for efficient operation. Provision has been made for satisfactorily handling operations of this general character by having the turning tool mounted on the head in the usual way, while the drill is carried by a spindle supported by bearings in the head (secured to the tool-slide), with a driving shaft extending from the rear end of the spindle up to the feed works at the top of the machine. In this way, suitable gears may be employed to take power from the main drive and drive the drill spindle at the proper number of revolutions per minute for the size of hole to be drilled.

Classes of Work Done on Mult-au-matics

With a machine which has as wide a range of adaptability as the mult-au-



Fig. 4. Mult-au-matic equipped for performing First Sequence of Machining Operations on Ford Differential Gear-oases. Three-jaw Chucks hold the Work

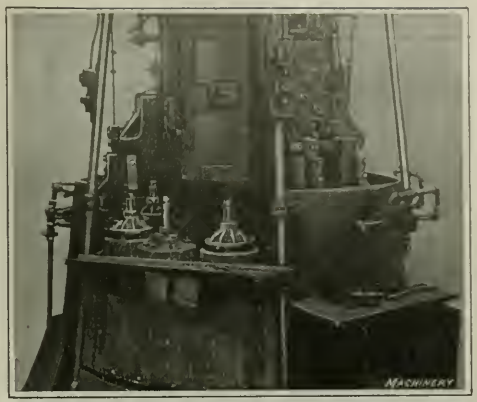


Fig. 5. Mult-au-matic equipped for performing Second Sequence of Operations on Ford Differential Gear-cases. Piloted Fixtures locate the Work from its Finished Bore

matic, it is difficult to make any general statement as to what constitutes the general classes of machining operations for the performance of which it is well suited. However a general statement may be made that the machine is adapted for handling any class of work which may be held by chuck jaws, or some other suitable means to support the piece in such a manner that it is possible to reach all surfaces on which turning, boring, facing, drilling, tapping, or threading operations have to be performed, without requiring the work to be reset. It must be borne in mind that this is a production machine, intended for use in the manufacture of duplicate parts. It is not true, however, that machines of this type can only be successfully employed in cases where there are sufficiently large quantities of the same piece to be handled to allow a machine to be kept running continuously on a single job, although such work enables the mult-au-matic to show its productive possibilities in the most favorable light, because no time is lost in changing the machine over from one job to another.

At the Ford Motor Co.'s plant, there are over 125 of these machines in operation, and when all of the machines have been delivered which are now on order, there will be a complete installation of 180 machines. Owing to the vast number and variety of pieces that are required for this firm's daily output of over 3,000 cars, it will be evident that each of the mult-au-matics can be kept constantly working on a single job, and in this way the ideal conditions of operation are attained. On the other hand, some jobbing shops which take contracts for the manufacture of moderate numbers of duplicate parts, have installed machines of this type for handling the work, and they are said to be successfully used for executing the various orders on which they are employed. Such a practice is not to be recommended, however, unless the quantity of parts on order is very large, or unless there is assurance that repeated orders will be received at regular intervals for the manufacture of a moderate quantity of work. This becomes self-evident when it is remembered that the time required for tooling-up a machine for handling a given job, if frequently taken from productive time, together with the cost of a wide variety of spe-

TABLE 1. SEQUENCE OF MACHINING OPERATIONS ON TRIPLE TRANSMISSION GEARS

Operation Number	Operation	Types of Cutting Tools Used
1	Load	
2	Drill half way through hole *A*, Fig. 3; turn outside of gears *B* and *C*	Twist drill and turning tools
3	Face surfaces *D* and *E*; cut clearance *F*	Combination facing and parting tool with cross-feed
4	Finish drilling hole *A*; finish-turn gears *B* and *C*	Twist drill and combination turning tools
5	Finish-face surfaces *D* and *E*; chamfer edges of top gears	Combination facing and chamfering tool with cross feed
6	Finish-turn outside diameters of gears *B* and *C*; bore hole *A*	Combination single-point turning and boring tools
	SEQUENCE OF OPERATIONS FOR SECOND SETTING OF WORK	
1	Load	
2	Rough-turn outside diameter of gear *G*	Single turning tool
3	Rough-face surface *H*; cut clearance *I*; face surface *J*	Combination facing and parting tool with cross-feed
4	Finish clearance *I*	Parting tool with cross-feed
5	Finish-face surfaces *H* and *J*	Simple facing tool with cross-feed
6	Finish-turn outside diameters of gears *C* and *G*; chamfer edges of gears	Combination turning and chamfering tool

Note: For the first operation, the work is held by three-jaw universal chucks which grip the outside diameter of gear G. For the second operation, a pilot enters hole A, and face E drops on a serrated plate at the bottom of the pilot, against which the work is clamped. Coolant is delivered to cutting tools at each station of the machines working on these forgings. Rate of production for first setting, 50 per hour; rate of production for second setting, 48 per hour.

TABLE 2. SEQUENCE OF MACHINING OPERATIONS ON DIFFERENTIAL GEAR-CASES

Operation Number	Operation	Types of Cutting Tools Used
1	Load	
2	Rough-bore holes *A* and *B*, Fig. 6; rough-turn face *C*; form radius in hole *D*	Combination boring, turning, and radius-forming tool
3	Rough-turn faces *E*, *F*, and *G*; chamfer corner *H*	Combination facing and chamfering tool with cross-feed from head
4	Finish surfaces rough-turned by Operation 3	Combination facing and chamfering tool with cross-feed from head
5	Ream hole *A* and finish-turn face *C*	Combination turning tool and reamer
6	Finish-bore hole *B*; finish-turn radius *D*; chamfer edges of rim *G*	Combination boring, formed-boring, and chamfering tool
	SEQUENCE OF OPERATIONS FOR SECOND SETTING OF WORK	
1	Load	
2	Rough-turn face *I* and hub *J*	Combination turning tool
3	Face surfaces *K*, *L*, and *M*	Combination facing tool
4	Semi-finish-turn hub *J* and face *I*; chamfer edge *N*	Combination turning and chamfering tool
5	Finish-face surfaces *K*, *L*, and *M*	Combination facing tool
6	Finish-turn hub *J* and face *I*	Combination turning tool

Note: The work is malleable iron, and coolant is delivered to the tools at all stations. For the first setting, the work is held by the hub in three-jaw universal chucks; and for the second setting, the work is dropped over pilots in the holes in the rim and rotated by drivers. Rate of production for first setting, 50 per hour; rate of production for second setting, 136 per hour.

TABLE 3. SEQUENCE OF MACHINING OPERATIONS ON BRAKE DRUM

Operation Number	Operation	Types of Cutting Tools Used
1	Load	
2	Rough-turn outside diameter *A*, Fig. 8, and inside diameter *B*; rough-bore hole *C*	Combination turning and boring tool
3	Rough-face surfaces *D*, *E*, *F*, and *G*	Combination facing tool with cross-feed mechanism
4	Semi-finish-turn outside diameter *A*, inside diameter *B*, and bore *C*; form radius *H*	Combination turning and boring tool, with formed tool for radius *H*
5	Finish surfaces *E*, *F*, and *G*	Combination facing tool with cross-feed mechanism
6	Finish-turn surface *A* and ream hole *C*	Combination turning tool and reamer

Note: The work is held by three-jaw chucks which grip shoulder 1. The work is cast iron and is machined dry. Rate of production, 52 per hour.

cial work-holding fixtures which might be required, would introduce such a heavy item of overhead expense that it would be impossible for the jobbing shop to bid successfully for work and include a reasonable margin of profit in its quotations.

Possibility of Running Machines on Several Different Jobs

The situation in the Ford plant and in the jobbing shop constitutes two extreme examples of the application of mult-au-matics. But for each of these extreme cases there are a large number of average shops having work that could be advantageously handled on these machines, and the general statement may be made that wherever pieces can be stocked after machining in sufficiently large quantities to keep a mult-au-matic running on a given job for a considerable period of time, it will be found that the machine will earn a satisfactory income on the investment. The time required to change the set-up of a machine from one job to another does not usually take more than one day, and it is often much less. In some cases, it may appear that an entirely disproportionate amount of time is required for setting up the machine as compared with the actual operating period, but a careful investigation will reveal the fact that this is due to the extremely high rate of production that is attained when the machine is actually placed in operation. For instance, consider the case of a job formerly done on machine tools where the rate of production was 100 pieces in twenty-eight hours. A mult-au-matic was adopted for this job, but only a small part of its time sufficed to produce the required number of pieces. It was found that twelve hours was needed to set up the machine and that only three hours was required to machine 100 pieces. But, although 80 per cent of the time was consumed in setting up and only 20 per cent in operating the machine, it will be evident from these figures that the total setting-up and production time per one hundred pieces is only fifteen hours, as compared with twenty-eight hours by the former method; that is to say, a saving of nearly 50 per cent is made. This instance, however, does not detract from the fact that the mult-au-matic is essentially a production machine, and not a job shop tool.

TABLE 4. SEQUENCE OF MACHINING OPERATIONS ON DIFFERENTIAL DRIVING GEARS

Operation Number	Operation	Types of Cutting Tools Used
1	Load	
2	First roughing cut in bore *A*, Fig. 11	Single boring tool
3	Rough-face surface *B*; rough-turn surface *C*; rough-face half way across surface *D*	Straddle tool provided with cross-feed
4	Face remainder of surface *D*; finish-face surface *B*	Straddle tool provided with cross-feed
5	Finish-face surface *D*; bevel edge *E*	Combination facing and chamfering tool
6	Finish-bore hole *A*	Boring tool carried in floating holder
	SEQUENCE OF OPERATIONS FOR SECOND SETTING OF WORK	
1	Load	
2	Rough-turn face *F*	Single turning tool with angular feed mechanism
3	Semi-finish-turn face *F*	Single turning tool with angular feed mechanism
4	Rough-turn surface *G*	Single turning tool with angular feed mechanism
5	Finish-turn surface *G*; chamfer corner *H*	Combination turning and chamfering tool with angular feed mechanism
6	Finish-turn face *F*	Turning tool with angular feed mechanism

Note: For the first setting, the work is held in a three-jaw universal scroll chuck. For the second setting, a locating plate enters bore *A* and the work is held down on this plate by clamps. For machining these steel forgings, coolant is delivered to the tools at each station of the machine. Rate of production for first setting, 50 per hour; rate of production for second setting, 84 per hour.

Application of Vertical Drilling Spindle

Three separate gears were formerly manufactured for use in producing the triple gear shown in Fig. 3. After these parts had been completed, they were riveted together into a single unit. Production costs have been substantially reduced by the substitution of a method of manufacture which enables the three parts to be produced simultaneously. Two sequences of operation are performed on separate mult-au-matics to complete the production of pieces of this kind, and the feature of the tooling of these machines in which we are particularly interested is the arrangement of a rotating drilling spindle on one of the tool-heads. This spindle is shown at *A* in Fig. 1. Little thought will be required to make it evident that if an attempt were made to rotate the work at a speed which would enable a one-inch twist drill to cut efficiently, the tool that is turning the outside of gear face *B*, Fig. 3, would be required to operate at an excessively high cutting speed. This would result in the rapid destruction of the tool. Such trouble is effectually overcome by equipping the tool-head with a rotating drilling spindle which receives power from the main drive at the top of the machine. By rotating the drill in this manner, it is possible to obtain such a combination of speeds for the rotation of the work and the drill, that both the turning tool and twist drill will be operated under conditions which enable them to produce efficiently and still avoid excessive wear of the tools.

TABLE 5. SEQUENCE OF MACHINING OPERATIONS ON UNIVERSAL JOINT HOUSINGS

Operation Number	Operation	Types of Cutting Tools Used
1	Load fixture	
2	Bore hole *A*, Fig. 13, and cut away cast flange at *B*	Combination boring and turning tool
3	Ream hole *A* and finish top *B* of open end	Floating reamer and boring tool
4	Rough-turn spherical face *C*	Turning tool carried by pivoted holder
5	Semi-finish-turn face *C*	Pivoted turning tool
6	Finish-turn spherical face *C*	Pivoted turning tool

Note: The work is malleable iron, and coolant is delivered to the tools at each station. The castings are held by the stem in three-jaw universal chucks. Rate of production, 40 per hour.

Detailed Descriptions of Typical Machining Operations

Tables 1 to 5 give a complete summary of the methods of procedure followed by the Ford Motor Co. in machining the parts shown in Figs. 3, 6, 8, 11 and 13 on mult-au-matics. These tables are self-explanatory, but in order to amplify the general description of how machines of this type operate, it will be of interest to take these three pieces and discuss the special facilities furnished for performing the operations which are required on them. Referring

first to the universal joint housing shown in Fig. 13, it will be apparent from Fig. 12, which illustrates a twelve-spindle machine equipped for handling these parts, that at each station around the hexagonal shaped column there are two tool-heads, and twelve work-holding fixtures are mounted around the turret so that two of the malleable iron castings are held at each station. Each casting is held by a three-jaw universal chuck; but to avoid the necessity of closing the jaws tightly enough to distort the hollow stem of the work, advantage is taken of two arms *C* which project out from the casting. These arms have holes drilled in them which make it possible to insert the two pins *D* on the chuck body into these holes to act as drivers.

From the preceding description it will be apparent that during the time that the sequence of operations is being performed on castings carried by the work-holding fixtures on this machine, the operator remains at the loading station shown at the front of the machine, where he is occupied after each index movement in removing two machined castings and setting up two fresh pieces in their places. There are five operations to be performed on this piece of work after loading. Too much space would be required to illustrate in detail the tooling at each station of the machine, and it was impossible to include all of the tools in a single view. However, a description will make the arrangement quite clear, as the illustration shows the tools possessing

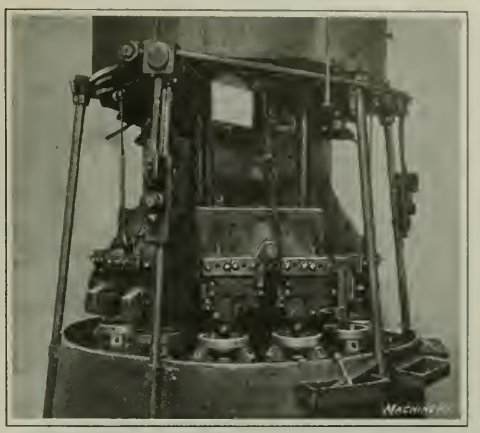


Fig. 7. A Simple Mult-au-matic Job consisting of Plain Cylindrical Boring, Turning, and Facing Operations

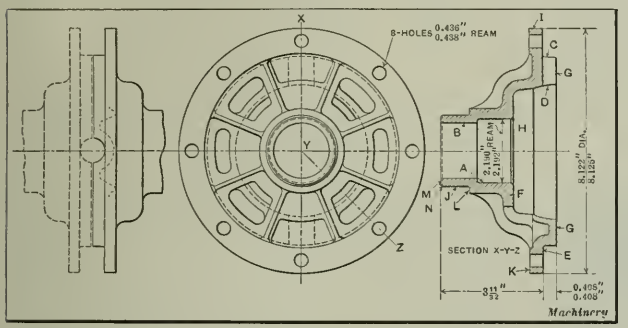


Fig. 6. Ford Differential Gear-case to be machined on Mult-au-matics shown in Figs. 4 and 5

unusual features of design. Before the malleable iron castings come to this machine, they have to be annealed, and to prevent distortion during this process, the castings are made with a web surrounding the upper opening. At the first station, the work consists of boring hole *A*, Fig. 13, and cutting away the top flange, two combination boring and turning tools being used for this purpose. At the next station hole *A* is reamed and the top opening is finished. At this station the tool-head is equipped with combination floating reamers and boring tools. At each of the three remaining stations, the operation performed is of the same general character, except that roughing, intermediate, and finishing cuts are taken for the purpose of finishing a spherical surface on the work.

A clear view of the tools used for performing the finished spherical turning operation is shown at the right-hand side of the loading station in Fig. 12. Bearing in mind that there are two tools at each station, it will be seen that there are pivoted tool-holders *A* which swing about centers of rotation *B*, the arrangement being such that the effective radius of the tool point is equal to the desired radius of curvature of the work. Secured to the tool-head, which has no vertical movement, there are two racks which mesh with pinions keyed to the back end of pivots *B*, and as the tool-head feeds down, these racks cause rotation of the pinions and thus swing the tools over the spherical surface of the work. As the work is being rotated at the same time that this feed movement of the tools is taking place, it will be apparent that the result is the turning of a perfect spherical surface on the work. After the tools have completed their cut, an eccentric mechanism moves the tool point away from the work before its return movement to the starting position is commenced. This avoids the danger of damaging the finished surface of the work by the back drag of the tool.

Machining a Piece Using Angular Cross-feed Movements

For machining differential driving gears of the form shown in Fig. 11, it is necessary to employ two machines one of which is utilized for machining all of the faces of the work which can be reached by the tools while the forging is held with its beveled face downward; and after this part of the job has been completed, the work is reset on a second machine with the beveled face upward, in order that the machining operation may be completed. Table 4 gives complete information concerning the machining of these forgings, so that it will be unnecessary to do more than explain the general arrangement of tools and tool-heads at those stations where operations are performed that involve the use of cross-feed movements for the tools. On the first

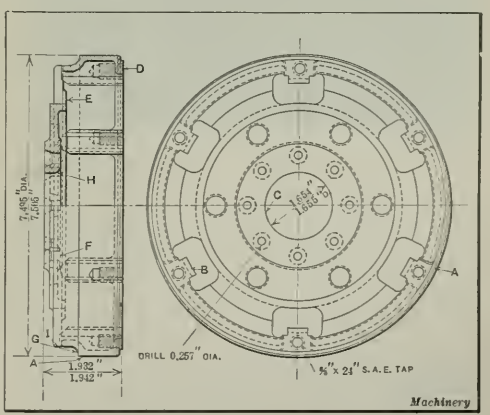


Fig. 8. Ford Brake-drum machined on Mult-au-matic shown in Fig. 7



Fig. 9. First Operation on Ford Differential Driving Gears. This Job required some Careful planning by the Tool Designers

machine, the work is mounted with the bevel face downward, as shown in Fig. 9, where it is held by three-jaw universal chucks gripping the forging from its outside. At the first station after loading has been accomplished, the inside diameter *A* is bored, after which the work is indexed to the next station, where the operation consists of facing surface *B*, rough-turning surface *C*, and facing half way across surface *D*.

In connection with this step in the process of manufac-

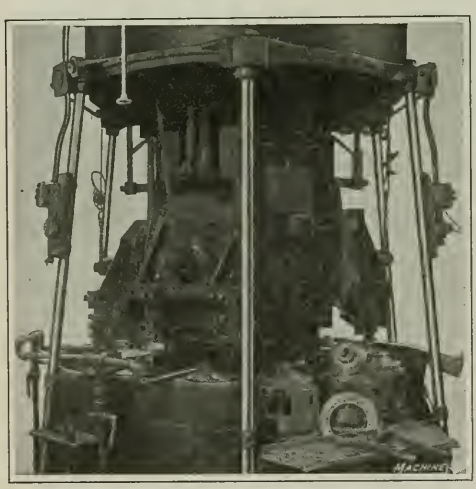


Fig. 10. Second Operation on Ford Differential Driving Gears. The Tools receive an Angular Cross-feed for Turning the Bevel Face

ture, an interesting point is the arrangement of tools for facing surfaces *C* and *D*. A straddle tool is used for this purpose in order that both faces of the work may be machined simultaneously, and the tool that works on surface *D* is mounted with its point slightly in advance of the tool working on surface *B*, so that it will have passed half way across surface *D* at the time that the tool working on surface *B* comes up against shoulder *C*. The facing of surface *D* is completed at a second operation, the idea of dividing this cut being to effect an increase in the rate of production by enabling this long operation to be performed in two steps, at the same time that other operations requiring less time are being performed at other stations on the machine. If this were not done, it would be necessary to hold up the work at other stations until the completion of this long cut over surface *D* had been finished. It will be evident that the straddle tools which face surfaces *C* and *D* must have a cross-feed movement imparted to them. This result is accomplished by a secondary or cross-moving slide, referred to above, to which feed motion is imparted through rack and pinion mechanism when the vertical movement of the tool-head, in its entirety, is brought to rest by contact with its adjustable stop. At this point, as the feed pressure is

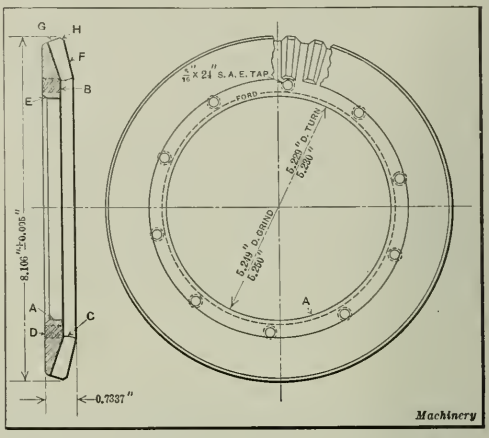


Fig. 11. Ford Differential Driving Gear machined on Mult-au-matics shown in Figs. 9 and 10

continued, a lock-pin connecting the vertical slide to the feed-rod is disengaged and instantly locks the vertical slide in its relation to the positive stop—further movement of the feed plunger actuating the cross movement through the rack and pinion mentioned.

At the completion of the cross-motion cut, the advance feed is changed to a rapid return movement and the tools are passed in a reverse direction through their original path. In this movement of the mechanism, the cross-slide returns to its initial point; the vertical slide is then released from

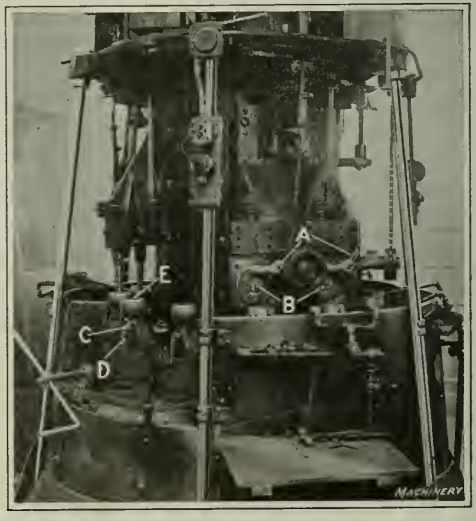


Fig. 12. Mult-au-matic Tool-heads can be designed for turning Irregular Shaped Work. This Machine is equipped for turning Spherical Shaped Surfaces

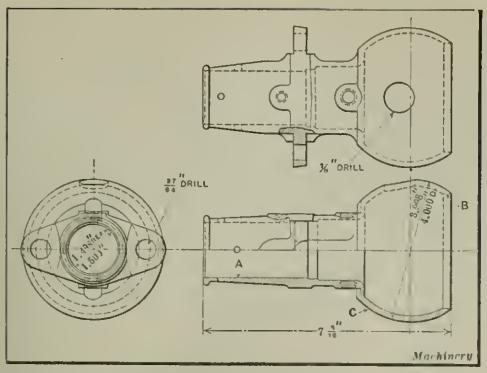


Fig. 13. Ford Universal Joint Housing which is turned, faced and bored on Mult-au-matic shown in Fig. 12

its lock in relation to the stop, the feed plunger is locked in its relation to the vertical slide, and the head in its entirety is returned to its initial position above the work and with the tools clearing it. On the machine used for performing the second sequence of operations, which is shown in Fig. 10, the operations of particular interest are the facing of bevel surfaces *F* and *G*. The mechanism which imparts a feed movement to the tools for handling work of this kind is of essentially the same design as that utilized for imparting a cross-feed movement such as that used for facing surfaces *B* and *D*. The only difference is that the cross-slide on which the toolhead feeds the tools to the work is inclined at an angle, corresponding to the required degree of taper, instead of being horizontal. Surface *F* is faced by employing an angular cross-feed movement of the tools, and surface *G* is faced by the use of an angular vertical feed movement.

Standardized Tool Equipments

It is a basic principle in operating the Bullard mult-au-matic to so plan the arrangement of tools that not only are successive operations being performed simultaneously on pieces of work held at different stations of the machine, but in many cases to also provide for the operation of two or more cutting tools on the work held at each station. This is naturally the means of greatly reducing the time required for the performance of machining operations. Another important feature of mult-au-matic tooling is that practically nothing but single-point turning, boring, and facing tools are used; as the pieces to be machined are often of quite small size, the possibility of simultaneously employing more than one tool to operate on a piece may be made difficult to accomplish through interference of tool-holders or other means which are employed for supporting the tools so that it is not an easy matter to bring them close enough together to reach the desired surfaces. With a view of overcoming these difficulties as far as possible, a large number of standard tool-holders are manufactured, representative examples of which are shown in Figs. 15 and 16.

It will be apparent that these holders are made with a variety of different offsets and insets, which provide for bringing the points of tool bits carried by different holders into close proximity to each other, although the centers of the holder shanks are far enough apart to prevent interference; also, practically all of the bits used in these holders are ground from straight bar stock, which not only saves the expense of forging special cutters, but also reduces both their first cost and the expense of maintenance. In connection with the illustrations of the tool-holders attention is called to the manner in which provision is made for the performance of straddle-facing operations, and for handling other work of a similar nature. The way in which standard tool-holders are arranged for such operations as straddle-facing will be readily understood. At the bottom of the tool-holder there is an offset section in which one of the bits is mounted; and the shank of the holder is splined to receive a collar by which the upper tool bit is supported. There is a key in the collar that fits into the spline groove in the tool-holder shank to prevent it from turning, and a set-screw in the collar enables it to be secured to the shank in any desired position, so that the proper spacing is obtained between the cutting points to provide for facing opposite sides of the work at the required distance apart.

Advantages Claimed for Mult-au-matic Machines

In running a factory under the conditions which exist today, the management is faced with two propositions which vitally affect the policy adopted when there are enough unfilled orders on the books to justify an extension of plant facilities. Conservative estimates of the present cost of

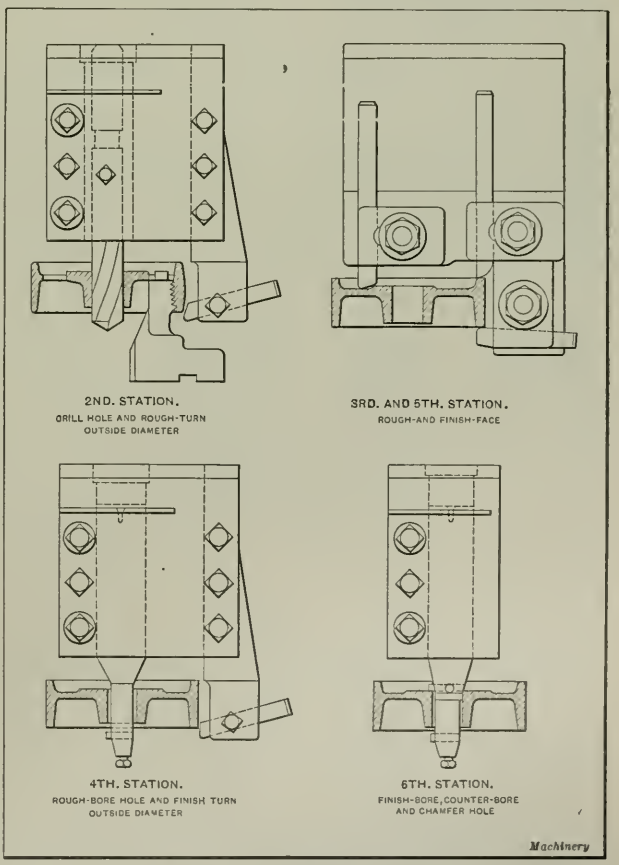


Fig. 14. Tooling of Mult-au-matic and Sequence of Operations in machining Ford Transmission Disk Drum

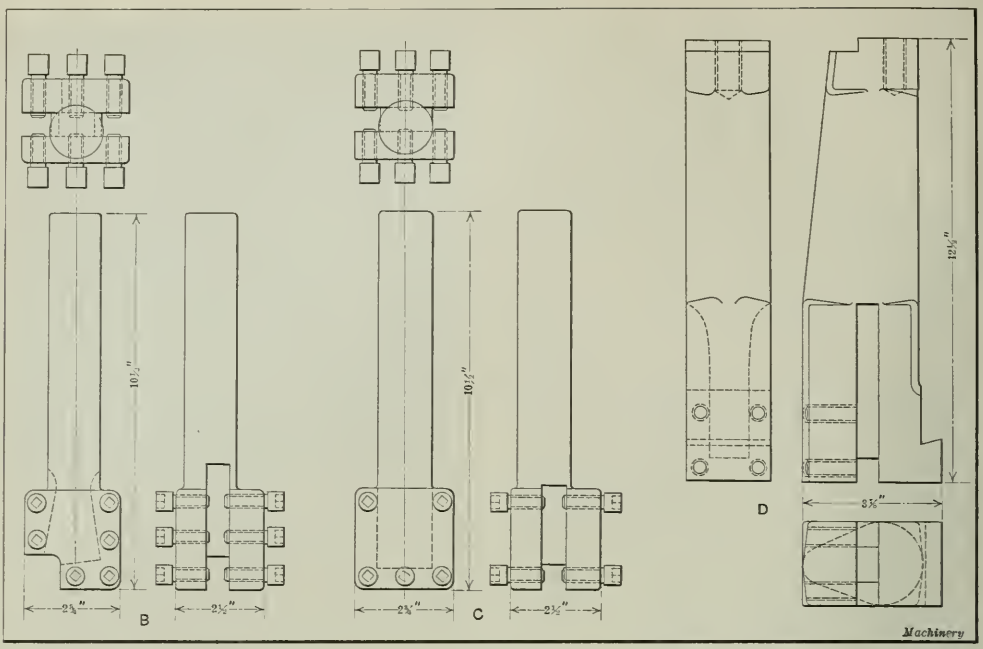


Fig. 15. (B) Combination Tool-holder made in Right- and Left-hand Styles; (C) Universal Tool-holder; (D) Facing Tool-holder made in Right-, Left-, and Combination Right- and Left-hand Styles

building construction make it necessary for those who are erecting new factories or adding to existing plant capacities to provide for writing off at least 50 per cent of the building cost during the next two or three years, in order to compensate for the depreciation in value of the property, which will result from a return of building costs to a figure approaching the normal average. This high building cost necessarily places a serious overhead burden upon work done in a factory put up under present conditions of the labor and material markets; and after the actual work of erecting a new building has been completed, the management of an industry located in many manufacturing centers is likely to experience serious difficulty in securing the necessary number of men to operate machines placed in its new factory buildings.

Not only do multiple machines of this type enable a

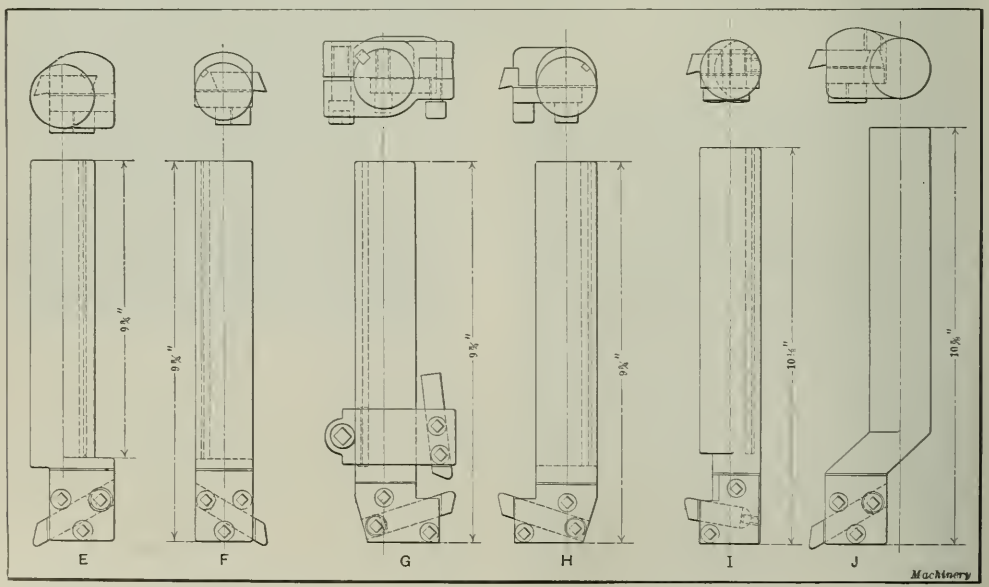


Fig. 16. Typical Examples of Standard Tool-bars, all of which are made in Right- and Left-hand Styles. (E) Inset Boring and Turning; (F) Straight Boring and Turning; (G) Right-hand Under Facing with Straddle Collar; (H) Left-hand Under Facing; (I) Outside Under Facing; (J) Offset Boring and Turning

smaller number of operators, who are assisted by the automatic control mechanism which is provided, to turn out a much greater quantity of product, but the amount of floor space required by the machine is also greatly reduced. Production obtained from a mult-au-matic is augmented by the fact that it is the equivalent of at least six machines whose operations are automatically coordinated, so that no time is lost in removing and resetting the work, or in transferring partially finished pieces from one machine to another. For the same reasons, there is a saving of power due to the elimination of a large percentage of the overhead works and

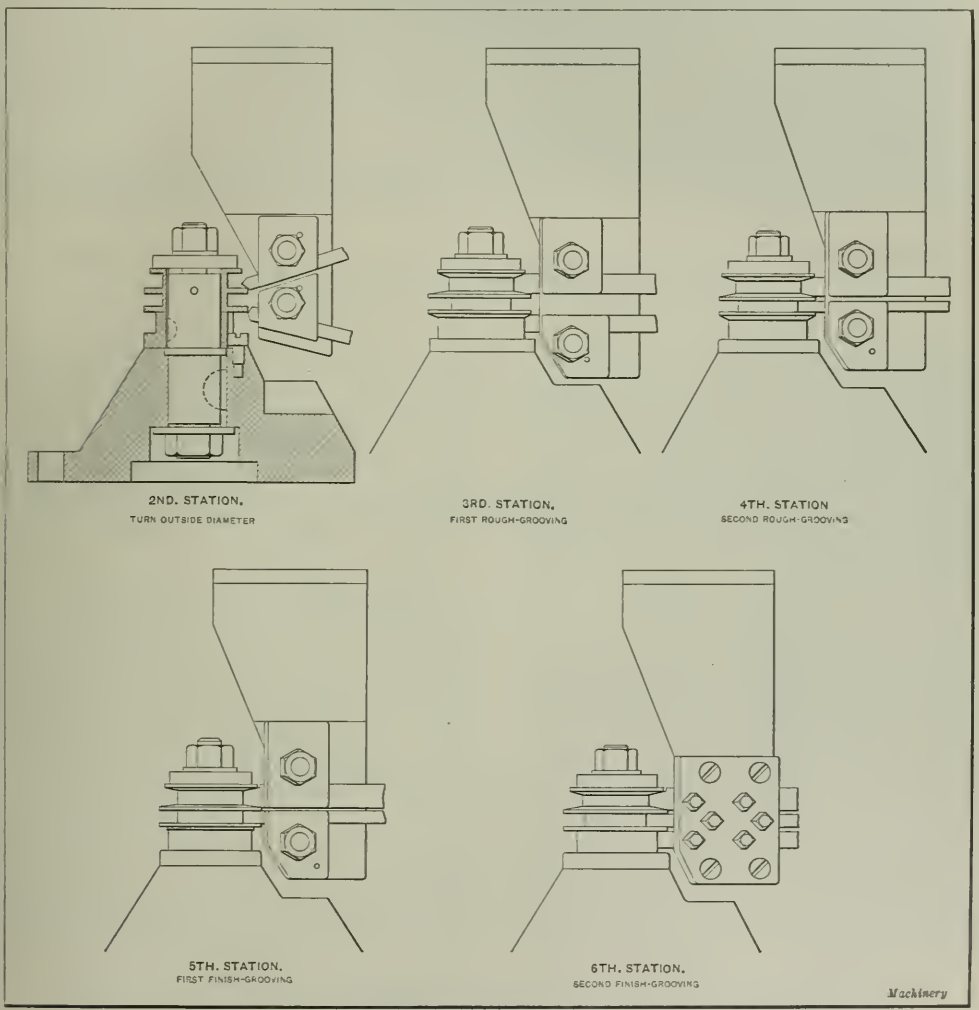


Fig. 17. Arrangement of Tools and Sequence of Operations Performed on Mult-au-matic equipped for machining Ford Clutch Shift

other auxiliary apparatus required to operate individual machines. This freedom from the presence of countershafts, belting, etc., is also the means of doing away with obstructions to adequate illumination.

As regards the actual time required to complete a sequence of machining operations, it may be mentioned that the time per piece is the same as the time required to make the longest cut on that piece, plus the indexing time. This point is of importance not only in estimating the rate of production that could be attained in machining a given piece of work, but also in its effect upon the life of cutting tools used on the machines. Of course it is desirable to increase the speed to the maximum productive capacity of the cutting tools required for taking the longest cut; but the time of operations performed at all other stations may be synchronized with the time of the longest cut, and in this way the severity of service required of tools at all other stations is substantially reduced. Hence, the problem of tool maintenance is likely to resolve itself chiefly into a question of maintaining the tools at that station of the machine where the maximum severity of service is experienced. Naturally it will be necessary to grind other tools, but at less frequent intervals.

How Overhead Charges against the Job are Reduced

Reduction of such production cost factors as floor space, labor, power, tool renewals, and maintenance charges tends to reduce the overhead which must be charged against a mult-au-matic job, as compared with other methods of pro-

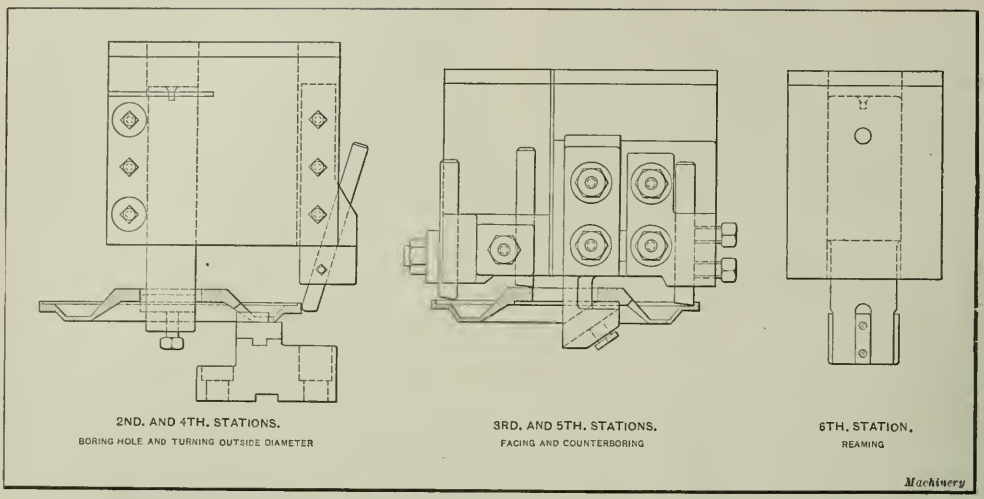


Fig. 18. Mult-au-matic equipped for machining Ford Transmission Driving Plates. Good Examples of the Simultaneous Operation of Several Tools are shown at the Third and Fifth Stations

duction. The cost of supervision is also lower because cutting down the number of workers reduces the number of men who are constantly being hired and trained for the job. In operating a machine of this type, such functions as indexing are performed at a constant speed, regardless of the rates at which the work is rotated and the tools are fed to the work. Each tool-head is independent of all other heads on the machine, and the rate of feed at each station is adjusted to meet the requirements of individual operations. An important feature of the coordinating mechanism is that it enables all movements of the machine to be performed at uniform predetermined rates which are entirely independent of the operator.

Practice of the Ford Motor Co. in Designing Tools for Mult-au-matics

Reference has been made in this article to a large assortment of standard tool equipments which are manufactured by the Bullard Machine Tool Co., for use on mult-au-matics, and it will be recalled that these tools are made with various offsets, insets, etc., to provide for handling practically any job. For plants which make a practice of avoiding the handling of tool work at their own shops wherever possible, the opportunity of obtaining these standard tools is a great convenience. But in a plant having a well equipped toolroom and experienced tool engineers to plan methods of performing machining operations, it will often be found possible to make mult-au-matic tools which possess peculiar advantages for handling special jobs. This practice works out particularly well in cases where the machines are to be run continuously on a single job, which is the method of operation in the Ford plant. Figs. 14, 17, and 18 illustrate the tools and arrangement of machining operations for manufacturing transmission disk drums, clutch shifts, and transmission driving plates. They show the sequence of operations involved in machining these parts more clearly than the photographs of machines equipped for performing the various sequences of operations which are outlined in Tables 1 to 5. These diagrams of the arrangement of tools and operations are also of exceptional interest in that they afford an opportunity of judging the relative merits of standard tool equipments manufactured by builders of the mult-au-matic machines, and standard equipments made in the user's shop to meet the special requirements of his work.

* * *

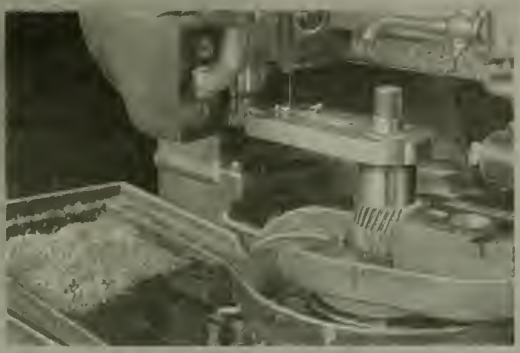
RECOMMENDED PRACTICE FOR TOLERANCES ON HOLES IN GEARS

A committee of the American Gear Manufacturers' Association at the meeting in Boston in October submitted a report which was accepted as recommended practice by the association. Holes in gears are divided into three groups or classes: Class 1 applies to precision gears, such as used in aircraft, printing machinery, etc.; Class 2 applies to gears for automobiles, machine tools, etc.; and Class 3 applies to pumps, hoisting machinery, and general jobbing gears. The recommendations cover hole diameters ranging from ½ to 12 inches. In deciding upon the tolerance and the limits for the different classes of gears dealt with, the accompanying table was worked up. It is believed that these figures, if adopted as representative of standard practice in gear-making and used by all makers of gears, will produce a standard quality. It will be noted that the tolerance of Class 2 is about twice that of Class 1 and that of Class 3 about twice that of Class 2.

LIMITS AND TOLERANCES FOR HOLES IN GEARS

Diameter, Inches	Class 1 Precision-Aircraft-Printing Machines, etc.			Class 2 Automobile, Machine Tools, etc.			Class 3 Standard Jobbing Gears		
	+ Limit "Not Go"	— Limit "Go"	Tolerance	+ Limit "Not Go"	— Limit "Go"	Tolerance	+ Limit "Not Go"	— Limit "Go"	Tolerance
0-½	0.000	0.00025	0.00025	0.00025	0.00025	0.0005	0.0005	0.0005	0.001
½-1	0.000	0.0005	0.0005	0.0005	0.0005	0.001	0.00075	0.00075	0.0015
1-2	0.000	0.00075	0.00075	0.00075	0.00075	0.0015	0.001	0.001	0.002
2-3	0.00025	0.00075	0.001	0.001	0.001	0.002	0.00125	0.00125	0.0025
3-4	0.0005	0.00075	0.00125	0.00125	0.001	0.00225	0.0015	0.0015	0.003
4-5	0.0005	0.001	0.0015	0.0013	0.0012	0.0025	0.00175	0.00175	0.0035
5-6	0.0005	0.001	0.0015	0.00175	0.00125	0.003	0.002	0.002	0.004
8-9	0.00075	0.001	0.00175	0.002	0.002	0.004	0.003	0.003	0.006
11-12	0.001	0.001	0.002	0.0025	0.0025	0.005	0.004	0.004	0.008

Cutting Triple Gears With Accurate Tooth Alignment



Methods Employed to Obtain Accurate Tooth Alignment when Cutting One-piece Triple Gears Having Spur and Helical Teeth of Different Diameters

By CLAYTON C. MARSH, Chief Tool Engineer, Allison Experimental Co., Indianapolis, Ind.

THE manufacturer is often confronted with the problem of cutting one-piece gears such as shown in Fig. 1, which have different kinds or sizes of gears on the same forging or solid blank, and which must have their teeth in alignment. There are many different kinds of gear drives requiring accurate tooth alignment of several gears on one shaft which could be produced much more rapidly and with greater accuracy in regard to tooth alignment, if the practice of cutting such gears from a solid shaft or forging were adopted in place of the usual method of cutting each kind of gear separately, assembling them on a shaft, and depending on keys to hold them in accurate alignment when in use.

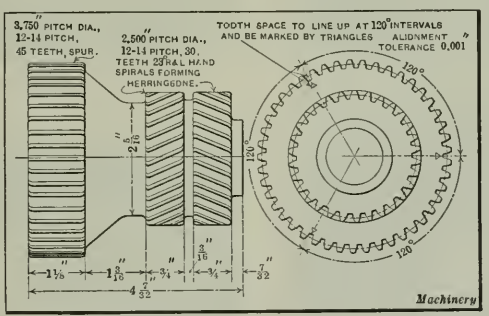


Fig. 1. Triple Gear, showing General Dimensions and Tooth Alignment Requirements

When such gears are made in one piece, the chance of their getting out of alignment by slipping on the shaft is entirely eliminated, and they will withstand severe usage such as that imposed on the gear here described and shown in Fig. 1. Among gears of this type that could be cut in one piece might be mentioned automobile transmission gears, machine tool feed gears, and many kinds of gears used in power transmission. This problem has presented itself more often in the production of spiral and herringbone gears than spur gears, although modern spur gear design often demands this construction, especially automobile transmission gearing.

Various manufacturers have used different methods for obtaining tooth alignment with more or less accurate results, but few have attained high production combined with accuracy. To obtain successful operation and smooth running qualities in herringbone gearing, with minimum friction, it is, of course, necessary that the right- and left-hand spiral tooth angles be exactly opposite and in as nearly perfect alignment as possible. One of the common methods of aligning herringbone gears is to cut each spiral as a separate gear, later mounting these on a hub and bringing them into alignment by turning one gear around until the teeth line up, then using either dowel-pins and bolts, or keys, to hold them in position. Cutting a keyway in some definite relation to a tooth does not appear to be a difficult problem, but very slight errors in the location of the keyway are multiplied at the pitch diameter of the

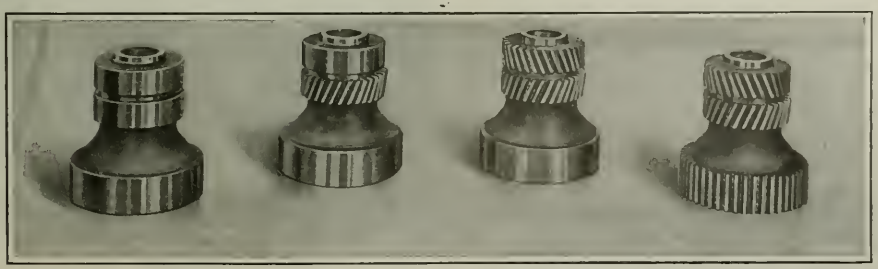


Fig. 2. Blank, and Finished Gear after Each Successive Operation

gears; thus gears made in this way quite often show undue wear caused by incorrect meshing.

When developing a method of producing gears having spur teeth in some fixed alignment with spiral teeth, or when it is required that two or more sets of spur teeth in one-piece gears have their various teeth in alignment with each other, it should be remembered that in rapid production, work set-ups must be made quickly and that the chance for error in setting up must be eliminated in so far as possible. The fixtures to be used must also be capable of repeating the same operation with a degree of accuracy commensurate with the tolerance of tooth alignment of the work.

and spiral gears combined with bevel tooth gears could be cut in alignment. These fixtures need not be either elaborate or expensive; the only requirements are that the limit of possible error in them be a little less than the tolerance of the work.

Construction of Fixtures, and Method Employed in Cutting Spiral and Spur Gear Teeth

In Fig. 1 is shown a one-piece gear having a right- and left-hand set of spiral teeth forming a herringbone gear, and also a set of spur teeth. In this case, the two spirals forming the herringbone are of the same pitch diameter, while the spur teeth are cut on a larger pitch diameter.

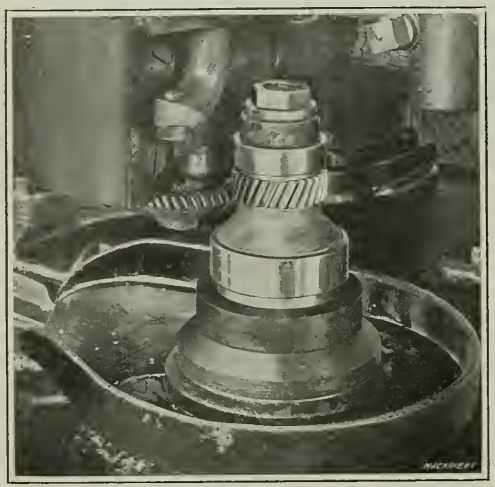


Fig. 3. First Operation—Cutting Right-hand Spiral Gear on Gear Shaper, using Pull Stroke

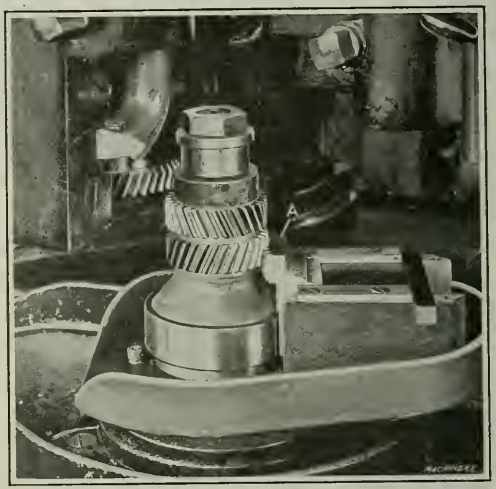


Fig. 4. Second Operation—Cutting Left-hand Spiral Gear on Gear Shaper, using Push Stroke

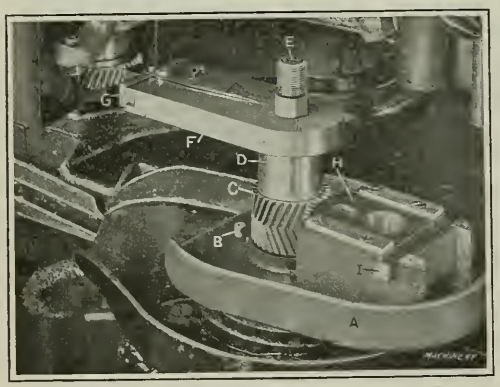


Fig. 5. Method of aligning Cutter for Second Operation

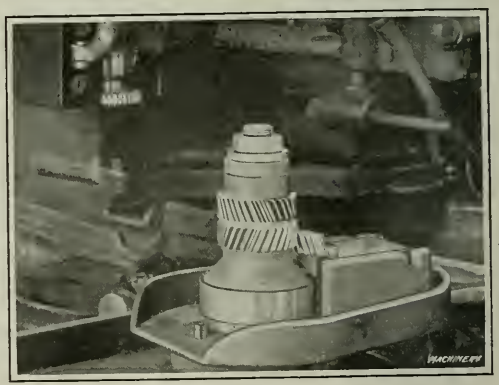


Fig. 6. Work after the Second Operation is Completed

The gear shown in Fig. 1 was designed for and used in a planetary reduction set on the "Liberty Twelve" motor and is subject to heavy load, considerable thrust, and fairly high speed. The requirements called for interchangeable hardened gears with a tooth alignment tolerance of 0.001 inch. After some study of these requirements the tooth alignment was found to be less difficult to maintain than it was first supposed to be. By considering each cutting operation separately, the following method was adopted, and the fixtures here described designed and put in use. By a modification in design of these fixtures, not only spiral, herringbone, and spur teeth could be aligned, but also spur

The machine employed to cut this particular gear was the Fellows gear shaper, as shown in Figs. 3 to 9. In order to obtain correct alignment, it was necessary to provide some means of locating the different cutters on the ram in their proper tooth position for cutting the teeth at the large and at the small end of the gear blank. To do this, it was necessary to have some kind of locating fixture which would be adaptable for more than one pitch diameter and form of teeth. The indicating device shown in Fig. 11, used with a sliding segment in the U-shaped casting, is the device finally developed for this purpose.

In Fig. 2 are shown the blanks after each successive

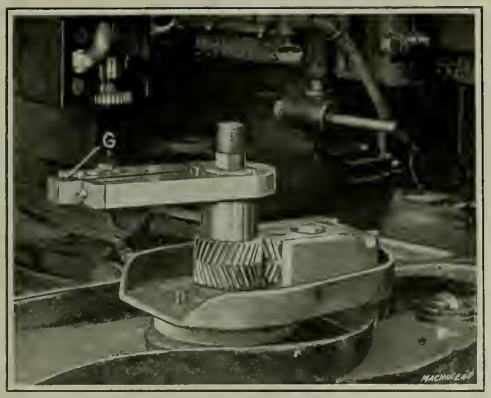


Fig. 7. Aligning Fixture placed on Arbor preparatory to aligning Spur Gear Cutter

operation. At the extreme left is shown the turned blank, uncut. The next view to the right shows the blank after cutting the first spiral or lower half of the herringbone gear. The next view shows the second cut or upper half of the herringbone gear completed, while the last view shows the finished gear after the spur gear teeth have been cut.

The first cut is made without regard to the radial position of the teeth, the blank being held as shown in Fig. 3, which enables the pull stroke to be used. An arbor having the necessary raising plates is used to bring the work into position in relation to the cutter. The first operation consists of making the complete cut to depth. This requires from three to five cuts, depending upon the material, the last cut before the work is removed being but a few thousandths inch in order to produce a smooth finish.

It is now necessary to place the spiral cutter on the ram for the second operation, which is that of cutting the opposite spiral. This cutter must be set so that the alignment between the two spirals will be in accordance with the tolerance allowed on the work. The fixture used to locate the cutter is shown in Fig. 5. The casting *A* which holds the fixture fits over the work-arbor and rotates with it. It is locked to the spindle of the machine by means of a dowel-pin *B*. This pin passes through the casting into the work-table. The casting *A* is made in the form of a pan similar to the apron-pan on the machine, in order to allow the cutting compound to carry the chips into the large pan.

The fixture having the indicator hand is used to multiply the error in setting the cutter. The herringbone gear *C* shown on the indicating fixture is composed of two ordinary spiral gears. These gears were cut on the same machine and by the same cutter that are used later to cut the spiral teeth on the work shown in Fig. 1. They were made from one solid blank which was cut apart after the teeth were formed. After the two spiral gears were aligned by the use of a sine bar, and small pins laid between the teeth, they were locked in position on the sleeve *D* by means of a dowel-pin. The sleeve is turned to fit the bored holes in the spiral gears forming the herringbone. The indicator plate *F* was bored to fit a turned down portion of this sleeve at the opposite end. The end of the plate nearest the cutter was then slotted to fit the tongue in the locating segment *G* that engages the cutter. These sliding segments have approximately five full teeth which is a sufficient number to give full contact with the cutter teeth at the cutting face, the diameter of the top or cutting face determining this. This segment is held in place by shouldered screws that pass through slotted holes, allowing it to slide back and forth the required distance and thus actuating the indicator hand. The action of this slide moves the indicator hand to both sides of a center line intersecting the work-arbor and the pivot of the indicator hand, the latter being pivoted to the main indicator plate in a ratio great enough to multiply the error at least ten times. The indicator hand is slotted

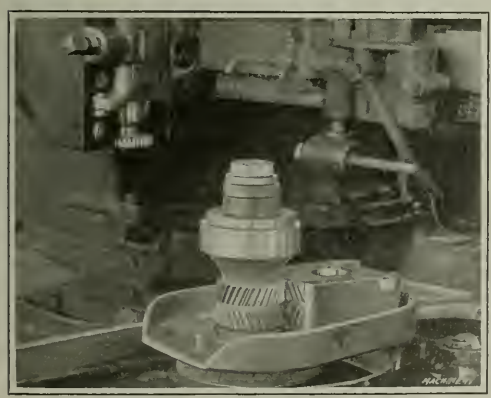


Fig. 8. Work set up in Position for Third Operation—Cutting the Spur Gear Teeth

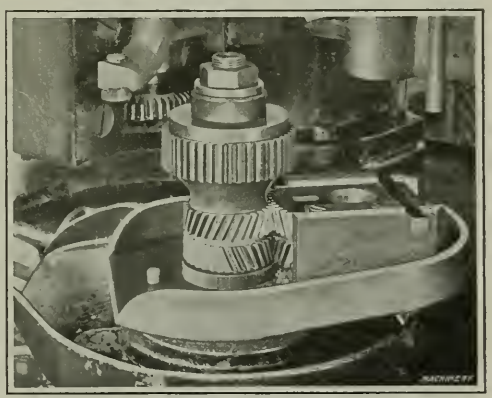


Fig. 9. Third Operation—Cutting Spur Gear Teeth using Push Stroke

to receive the small pin in the center of the sliding segment. The sliding segment is a section cut from a gear having finished teeth cut by the same cutter that is used for the work so that it will engage the cutter itself to the proper tooth depth, thus locating on the pitch line. The bearing surfaces of the tongue in the slide, and the groove in the plate, must be ground and finished smoothly on the sides only, the bottom of the slot allowing a clearance for the end of the tongue, while the sides serve only to keep the segment in line with the plate.

In Fig. 11, the tongue of the sliding segment that engages the cutter can be seen. A space is seen in the slot in the plate in which the tongue fits, the corners of the slot being relieved as well as the corners at the bottom of the tongue in the slide so that the bearing surface is only on the sides of the slot against the tongue and on the ends of the plate against the back of the slide. Three sliding segments, *G*, Fig. 5, are necessary—one for locating the cutter used in cutting the spur gear teeth, one for locating the cutter for the left-hand spiral, and one for locating the cutter for the right-hand spiral gear. The slotted holes in the segment through which the screws pass allow the segment to slide freely. A spring is provided on the indicator hand to obviate lost motion in the slot which engages the slide pin.

In making the indicating fixture, the hand is aligned

with the sliding segment and the plate is then doweled to the sleeve, locking both plate and sleeve in a permanent position. The sleeve is shouldered so that the plate rests against this support. The indicator graduations on the plate are made by bringing the hand to a central position which is determined by measuring from either side of the finished plate. The graduations in either direction from the center can be made in accordance with the ratio of the short and long ends of the indicator hand. The indicating fixture is slipped on the arbor, the large herringbone segment *H* in the cutting fixture meshing with the herringbone gear on the indicating fixture.

The large segment *H* was cut from two segments of a driving gear which were aligned in the same manner as were the two spirals forming the herringbone gear on the indicating fixture. The sliding segment used in the casting should have enough teeth to give full contact according to diameter. This segment slides in a machined groove in the cutting fixture casting and is held by two small plates at the top which are fastened by screws. This allows the segment to slide back and forth, and when correctly meshed with the small herringbone gear *C* it is locked by a hardened square key *I* which holds it in a rigid position. It is only necessary for the locking key to bear on the forward side of the slot in the segment, as it will readily be seen that the key cannot move backward when it is in place. The elongated hole shown in sliding segment *H* is merely for reducing weight, and the large hole in the center of the segment is used as the arbor hole when turning as well as when cutting.

Setting Spiral Cutter for Second Operation

For the second operation, the nut which locks the cutter on the ram is first loosened and the cutter rotated until the indicating hand is brought into a central position as shown in Fig. 5. The nut is then tightened, permanently locking the cutter on the ram. The ram is next moved back, and the sliding segment *H* is also moved back, after removing the square key *I*. The apron of the machine is then opened, and the indicating fixture removed from the arbor. After this, the large segment *H* is removed and replaced by the segment shown at *A*, Fig. 4, which meshes with the lower spiral. The work is then placed over the arbor.

The first operation of cutting the lower half of the herringbone gear having been completed, the meshing segment *A* of the cutting fixture, Fig. 4, is moved forward, and the locking key placed in position, thus locking the work in the correct position relative to the cutter on the ram. The locking nut on the work-arbor is then tightened and the apron closed. After this, the ram is moved forward, the first cut set for depth, and the cutting proceeds in the same manner as the cutting of the first spiral, except that the push stroke is used. It must be borne in mind that segment *A* must have the same alignment of teeth as segment *H*, Fig. 5. The sliding segment *A* must revolve with the work, and the engaging segment of this fixture must be low enough to clear the cutter. In Fig. 6 is shown the machine and work

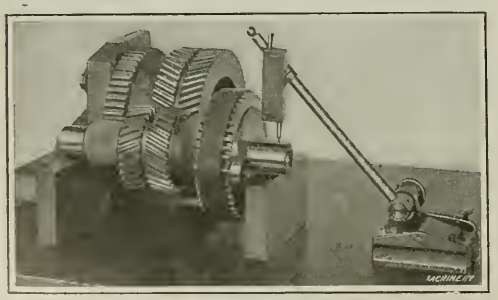


Fig. 10. Method of inspecting Gear for Tooth Alignment

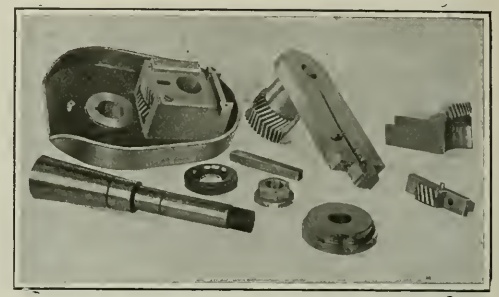


Fig. 11. Work-arbor with Cutting and Aligning Fixtures

after the second operation has been completed. In this illustration the work is ready to be removed.

Cutting Spur Teeth

The next operation is cutting the spur teeth, which must also be in some definite radial alignment with the herringbone gear teeth. Leaving the apron in the machine open after removing the work, the sliding segment in the cutting fixture is changed, the double or herringbone segment *H*, Fig. 5, again being inserted. It is then necessary to change the cutter-engaging segment in the indicating fixture to one having spur teeth as shown at *G*, Fig. 7. The spur cutter is then placed loosely on the ram, the lock-nut not being tightened. The apron of the machine is next closed so that the aligning fixture is in the position shown by the heading illustration, the spur cutter for the third operation being in place and the apron of the machine closed and locked. The nut of the ram is tightened as in the previous operation, locking the cutter in the correct position for cutting the spur teeth. The ram is then moved backward, away from the fixture, the apron of the machine opened, and the indicating fixture removed. The work is next placed on the arbor in position for cutting the spur teeth, being located by the sliding herringbone segment in the cutting fixture, and locked with the square key as shown in Fig. 8. The apron is then closed, the ram moved forward, and set for the first cut, the fixture, of course, rotating with the work as in the previous operation. The necessary number of cuts are next taken with the work held as shown in Fig. 9.

Inspection for Tooth Alignment

In testing the finished gears, it is necessary to have a master herringbone gear drive, which must be a copy of the gear drive used in the assembled unit, and which must be in correct alignment. This is made by using a master of three sections brought into alignment in the same manner as the small herringbone on the indicating fixture, and permanently keyed, or doweled. This master gear has an end ground square with the longitudinal section of the teeth, and is mounted on an angle-plate which is also square with and bolted to a surface plate on which the inspection is made. The arbor which is used in the master gear must have an end of the same diameter as the arbor used in the work. A pair of ground parallels is used to support the work-arbor on which the work is mounted, so that the height of the arbor in the master gear and in the work is exactly the same from the face of the surface plate.

A small gage-pin having a shank ground to a diameter that will engage the teeth at the pitch line is held in a tooth space by means of a rubber band placed around the gear to be inspected. This gage has one end ground concentric with the shank which protrudes from the end of the gear as shown in Fig. 10. The diameter of the large end is also exactly the same as the two arbors used in the master gear and in the work. The work is moved forward on the parallels until it meshes with the master gear, the former having

been placed in such a position that the large end of the gage-pin comes in a parallel plane with the arbors in the master gear and work. A height gage is then used and set so that the plunger rests on top of the work-arbor. Sliding the gage over the large end of the gage-pin and over the end of the arbor in the master gear should show any error in alignment which may exist. The gage-pin can be removed and placed in any position (using the right combination according to the difference in the number of teeth between the diameters) so that in any one of these positions the three arbors should be the same height from the surface plate within the required tolerance. The pitch diameters can be measured by means of pins or wires similar to those used in measuring the pitch diameter of screw threads. This fixture does not insure correct depth of cut; that must be governed by the operator.

* * *

PLANS FOR INDUSTRIAL CENSUS COMPLETED

Special effort is being put forth to make the manufactures section of the approaching fourteenth decennial census the most complete and comprehensive inventory of the nation's manufacturing establishments ever taken. The schedules which will be used in tabulating the information about the country's industrial resources have already been prepared and printed. These schedules will be mailed to every manufacturing establishment in the United States during the month of December, so that factory owners and managers can familiarize themselves in advance with the questions to be answered when the records of the past year's business have been compiled. The questions relate to the calendar year 1919.

In 1914, when the last manufactures census was taken, about 275,000 manufacturing establishments were listed by the Census Bureau. This time more than 300,000 establishments will be sent schedules. In addition to this it is expected that about 50,000 mines and quarries will be reported. The inquiries relating to manufactures, as specified by the act of Congress providing for the census, include the name and location of each manufacturing establishment; character of organization, whether individual, corporate or other form; character of business or kind of goods manufactured; amount of capital actually invested; number of proprietors, firm members, co-partners and officers, together with the amount of their salaries; number of employes and amount of their wages; quantity and cost of materials used in each establishment; quantity and value of products; principal miscellaneous expenses; time in operation during the year; character and quantity of power used; and character and number of machines employed.

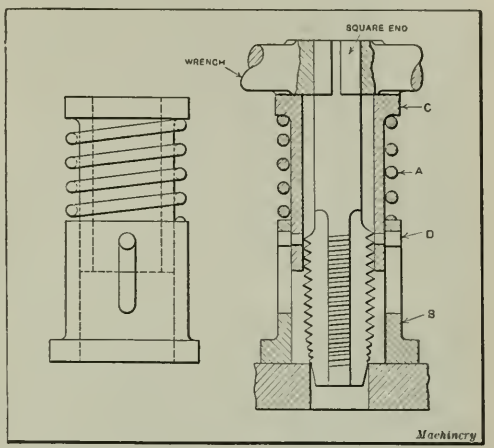
The questions as outlined above will be covered by the general schedule which every establishment will receive. In addition to this a supplemental schedule will be sent to the sixty-eight principal industries as classified by the Census Bureau. This supplemental schedule will allow detailed statistics of output to be set forth under the heading "products manufactured." Census Bureau officials emphasize the fact that all information gathered by the census is strictly confidential, made so by Act of Congress, and is for general statistical purposes only.

* * *

A novel method of grinding surfacer and jointer knives is employed in the carpentry and machine departments of the Danbury Trade School, Danbury, Conn. A beveled block of cast iron is clamped to the planer table. This block is the same length as that of the knives which are clamped to the block with the edges up. An electric grinder is fastened to the toolpost and grinds the knives lengthwise as the bed of the machine travels back and forth. The grinder is carefully guarded so that no emery is allowed to enter the bearings of the planer. The device is said to work very satisfactorily.

HAND TAPPING FIXTURE

The purpose for which the fixture here illustrated was designed is to hold taps at right angles to the work when tapping operations are being performed by hand. This is accomplished through the force exerted by the compression spring *A* against sleeve *B* during the tapping operation, thus holding the sleeve at right angles to the work. This force becomes greater as bushing *C* is drawn into the sleeve when the tap is being fed into the work. On account of bushing *C* being a sliding fit in sleeve *B* and the tap being a running fit in the bushing, these parts are also held at right angles to the work. Bushing *C* is kept from turning in sleeve *B* by the pins *D*, which are driven into the bushing. These pins operate in slots in the sleeve which govern the travel of the bushing. The tap should extend far enough beyond the sleeve to permit it to be inserted into the drilled



Device for holding Taps at Right Angles to the Work

hole so that it will commence cutting the threads when the wrench is revolved. The square end of the tap is held in the wrench by means of a set-screw. C. B. A.

* * *

MOVING PICTURES TO FURTHER TRADE

It has been suggested that South American trade could be considerably furthered by the use of moving pictures. In this way, American manufacturers could show Latin-American buyers how their goods are made, how they are packed, and how they are used. By the aid of moving pictures prospective customers could be taken on a trip through a plant thousands of miles away, and could be even introduced to the heads of the business in the United States by a picture taken in the office of the executive. It is stated that 300,000 feet of industrial film is going to South America every month, but of this amount only 50,000 feet comes from the United States while 250,000 is of foreign origin, being sent mainly from England and Japan to aid the merchants of those countries to get a hold on the South American trade. It is also stated that German industrial organizations are preparing a great number of industrial moving pictures with which the South American market will be flooded at the proper time in an effort to win back good will and business in that market. Efforts are made in the United States to induce our manufacturers to take suitable action along similar lines.

* * *

An association has been formed in England, with Premier Lloyd George as president, to organize at London, in 1921, an exhibition of the industries, inventions, products, and raw materials of the British Empire.

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NEW AND USED EQUIPMENT

After the signing of the armistice, apprehension was naturally felt by American machine tool builders over the possible effect of the sale of a great amount of second-hand machinery by the government, as well as by manufacturers of munitions and war supplies. But the expectation that the government would promptly place large quantities of slightly used machinery upon the market, at greatly reduced prices, did not materialize. If such machines, in considerable number, had been available for immediate delivery some satisfactory transactions would undoubtedly have been made. But unfortunately for those who expected to fill their machine tool requirements from this extraordinary source, numerous delays occurred, and many who waited for the bargains had to wait too long. The books of many such firms would show that failure to realize profits on new business, undeveloped because of the delays in making plant extensions, more than offset any possible advantages in price between second-hand machines obtainable for delivery at an indeterminate date and new machines which could have been set up and put to work without loss of time. The new machines would have paid. It was an after-war experience, without precedent, and if it teaches any lesson at all, it is that our manufacturers, as well as our people generally, go ahead faster and surer when their enterprises are free of government red-tape.

In regard to second-hand equipment, generally speaking, it is probably true that current sales of used machines, tools and appliances do not materially affect the sale of new equipment. On the whole, the second-hand market creates or locates its own clientele, and often aids the builder of new machinery in making the buyer better acquainted with later and more efficient designs, through the sale of used tools which replace still older and less productive equipment in his shop. Some people never buy used equipment, while a very considerable number seldom buy anything else. There is a logical and legitimate market for each class.

* * *

BUILDING A PLANT TO SUIT THE PRODUCT

Unfortunately, a great many machine shops and manufacturing plants are planned by architects rather than by mechanical engineers, with the result that the plant, when completed—while it may be perfect from the architect's point of view and be properly provided with adequate means for lighting, heating, ventilation, and sanitary arrangements—lacks that adaptation to efficient production which should be an item of at least equal consideration with all the other factors.

There are a few notable examples throughout the country where machine shops and manufacturing plants in general have been laid out by mechanical engineers with the view of providing for the proper location of the machinery and the best facilities for transporting materials from one part of the shop to another; and then the architect has been called in merely to provide a roof over and walls around the pre-arranged machinery, and to devise proper lighting, heating, and ventilation systems.

Owing to the complex requirements in the design of manufacturing plants, men who are mechanical engineers and architects in combination have begun to devote themselves exclusively to plant construction. Manufacturers contemplating the building of new plants, or additions to old ones, should not overlook the importance of having the plans made by men who thoroughly understand the mechanical problems involved. The old method of merely deciding upon the addition of so many thousand square feet of additional floor space—and then turning the matter over to an architect—has decreased the efficiency of many a plant by an appreciable percentage. The mechanical engineer should first determine how the machinery and other equipment of the plant ought to be arranged in order to provide for the greatest efficiency in the manufacturing processes; then the task of the architect is a comparatively simple one, and consists chiefly of providing a suitable enclosure for the machinery, which has already been installed, on paper, in its proper place.

* * *

TRAINING OF INDUSTRIAL WORKERS

One of the hopeful signs in the industries today is the increasing tendency toward proper training of men and women for industrial work, so that they may be able to perform their given task more efficiently than formerly. In the past, in the machine industries, very little special training was given to any of the employes, unless they were apprentices. They were expected to find out for themselves how the machining of a certain piece of work should be performed. They were not always properly instructed in the use of the machines that they operated, and, on the whole, no care was taken to insure maximum production. If a man failed to make good, he was merely dismissed, and another hired in his place. The second man often had no better qualifications than the first, and without proper training both were costly to their employers.

The larger plants in the country have now undertaken to hire their help with considerable care, so that the applicant's ability and inclinations are likely to fit in with the work for which he is hired. In addition, special training departments are installed in which newly hired help is properly instructed in the best methods for performing the work to be done. It has been estimated that out of a total of 10,000,000 workers in all the industries, only 3,000,000 are properly qualified by virtue of previous training or apprenticeship to perform the operations comprising their work with any approach to maximum efficiency.

In plants where training departments have been installed, it has generally been found that the productive capacity of the specially trained employes greatly exceeds that of the untrained worker; in fact, new employes, properly trained, have excelled men of longer experience in the trade, who have received no special instruction and who have, therefore, largely worked out their own methods.

The Importance of Engineering Science

By NIKOLA TRBOJEVICH

IT seems unnecessary to say that there has been no time in the history of mankind when the rate of scientific progress, and particularly that of the applied sciences, such as engineering, has been so high as at present. One year, now, when expressed in terms of actual and tangible achievements, means more than did ten years, fifty years ago, and perhaps a century, a thousand years ago. Think of the wonderful results achieved during the past year—the crossing of the Atlantic, both by airplanes and dirigibles; the wonderful developments in the wireless telephone and telegraphy, the telephone amplifier and scores of other things, perhaps less well known, but equally as important. It would be an error, however, to judge the progress of technical science merely by the number of these outstanding or spectacular inventions and applications. It is the condition and the vitality of the great economic body of the world that is of principal interest. This vitality is the soil from which all the inventions have sprung.

We are living in an age in which the development of important inventions and the new applications of scientific principles indicate the beginning of a new era in the life of humanity and a period of enormous expansion in all fields of human endeavor. Mankind is saturated with latent energy seeking an outlet. There is a universal desire everywhere to *act* and to *accomplish* things. The engineers are greatly responsible for this feverish state of mind of the whole world. It was they who taught the people how to get the most out of their labor. They have showed, for instance, how it was possible to assemble a complete chassis of an automobile from hundreds of component parts in slightly more than one hour and a half of one man's time, and how to make it possible for a single operator to spin more yards of cotton thread in a day by the use of automatic machinery, than a thousand workers could spin in a week, by hand work alone.

The adaptation of scientific principles in different trades to the production of goods is the primary field of the engineering science. The application of such principles tends usually either to increase the production or to improve the quality of the product, or both. The engineer's duty is to devise the material means by which to satisfy the demands for greater production or higher quality.

The student of modern history and sociology soon becomes aware of the fact that engineering, being the foundation of material welfare, is the most important of all sciences. Essentially, it is the science of producing wealth. Most of its results are achieved by some labor-saving device, because the rate of production can only be increased in two ways: either by working harder and longer, or by increasing the efficiency of manufacture by adopting suitable machinery, etc.

The progress of humanity may be compared with the motion of a ratchet wheel. It can only go forward; the methods of production are constantly improving, and the intrinsic price of goods as expressed in labor necessary for its production is decreasing. The term "intrinsic price" does not mean the price in dollars and cents, but the amount of labor which is consumed in the manufacture of the article. The increase of production, coupled with the decline of the intrinsic price, tends to raise the standard of living of all classes.

It is the nature of the human race to take any advancement or improvement of its living conditions as a matter of course, but to deeply resent any lowering of them, irrespective of the cause. Every widespread lowering of standards results in dissatisfaction. The latest developments in some parts of Europe, for instance, are the result of a lowering of the living standard, due to war. Here is where the engineering science actually becomes humanity's greatest asset, affecting the course of our whole economic life. The intrinsic price of goods must be lowered in order to create a surplus, and this can be done by engineering coupled with the willingness of workers to work. So long as the engineers are able to improve on their methods and increase the efficiency of processes, there will be a reservoir of energy to draw upon in order to satisfy the steadily increasing demands for a higher standard of living, provided the processes are properly utilized by men at work. The world is in a sort of dynamic equilibrium, and our safety lies in the velocity of our progress.

Now, the question is, how to make progress in engineering? The answer is, by cooperation and by specialization. Genuine progress is only possible by combining a highly developed cooperation with specialization. The specialist will originate a new method, a new device, and the community will give body to the new idea by adopting it, or giving it a fair trial, at least.

In the field of engineering, the amount of knowledge we already possess is so vast as to make it physically impossible for any one individual to become an expert, in the true sense of the word, in more than a comparatively small domain of that immense field. The capacity of the human brain to absorb details is limited. The only way of producing results is to use one's mental capacity, concentrated upon the essential points of a chosen field and leave the rest for the experts in other fields. We cannot increase our individual productive ability above a certain extent, due to our obvious limitations which are of physical and physiological character, but we can increase our efficiency for producing valuable results by coordinating ourselves with others.

The engineering science even in its present state of development, and much more in its truly unlimited future possibilities, is the greatest treasure humanity possesses. Any condition which does not favor the fullest possible development of the sciences in general, and in particular of the engineering science, carries in itself the germs of ultimate self-destruction. The dual principle of specialization and cooperation lies at the bottom of all our progress. Our future development will be exclusively determined by the degree of application of that principle.

* * *

WARTIME CHANGES IN WAGES

The National Industrial Conference Board, 15 Beacon St., Boston, Mass., has issued a bulletin giving a review of the changes in wage rates from September, 1914, to March, 1919. The following is a summary of the report: Average wages of men in eight leading industries, including the metal industry, as measured by average hourly earnings, increased all the way from 74 to 112 per cent during the period from September, 1914, to March, 1919. Increases in weekly earnings of men ranged from 62 to 110 per cent. Percentage increases in earnings of female workers were similar in the respective industries. The increases shown were in most cases greater than the corresponding percentage increase in cost of living, which was placed by a previous report of the National Industrial Conference Board at 61.3 per cent for the period July, 1914, to March, 1919.

American Machine Tools in Spain

By RAMON CASALS, Barcelona, Spain

While Spain is not an industrial country of the first rank, there are nevertheless a number of machine industries in the country, and a considerable quantity of machine tools have been imported in the past, mainly from Germany. The author of the present article, Ramón Casals, a Spanish engineer, who has had a varied engineering experience in the mechanical field in Spain, France, and the United States, and who is now contemplating the selling of American machine tools in Spain, believes that, after the war, there will be a great industrial development in Spain, and that there is a possibility of replacing the German machine tools with the American-made product, provided American machine tool manufacturers are interested in this field.

WHILE Spain does not offer the opportunity for the sale of machine tools that some of the more industrial European nations do, the country, nevertheless, has a number of machine shops for the manufacture of quite a varied product, and there is a fair field for the introduction of American machine tools. Previous to the war, most of the machine tools used in Spain were obtained from Germany, mainly because the Germans sold cheaper grades of machines and offered easier terms to their customers. The Spanish machine shops are nowhere nearly as highly developed as those of England, France, and Germany, and the machine tools most commonly used are lathes, planers, and drilling machines. The methods employed are quite old-fashioned. A great deal of work that is done in the United States by the aid of machine tools is done in Spain by filing or by chipping, the chisel being used in many plants, for example, for the cutting of keyways and for similar work. There is, however, a market for a standard line of machine tools, and if the more highly developed specialized machine tools could be properly demonstrated in Spain by American demonstrators, who thoroughly knew their business, it is likely that they could also be introduced. There is, further, a field for the American type of bench vise, the vises used in Spanish machine shops being of a very old-fashioned type. There is also a great market for files and small tools.

Review of Spanish Industries Using Machine Tools

While none of the industries in Spain is large in the American sense of the word, there are, nevertheless, factories manufacturing a varied line of machinery and products in the making of which machine tools are used, including automobiles, electrical machinery, aviation motors, locomotives, steam engines, railway cars, refrigerating machinery, flour mill machinery, agricultural machinery, pumps, mining machinery, textile machinery, and appliances and devices used on board ships, together with woodworking machinery, scales, and ordnance. The best known automobile plant is "La Hispano Suiza S. A."; but there is also the plant of "A. Elizalde," building an automobile well known in Spain. These were the only two factories for automobile building in Spain at the beginning of the war, but now there are not less than seven automobile factories, all located in Barcelona.

Quite a large plant for the building of locomotives and steam engines is located in Barcelona, as well as works for the building of pumping machinery. In one section of Spain, there is a large textile industry and all the textile mills have their own repair shops for which machine tools are required. The railroad repair shops, of course, are also prospective customers for machine tools. There are several shops devoted to gear-cutting, and gear-cutting machinery should have a fair market in Spain. There are also some screw products companies making use of automatic screw machines, but apart from these shops, automatic screw machines, grinding machines, milling machines, highly developed turret lathes, boring mills, and other machine tools, not in the simple lathe, planer and drilling machine class, are not generally in demand. These classes of machines can be sold only if they are properly introduced and their advantages thoroughly demonstrated to the buyer. The shipbuilding industries have been considerably augmented during the war, there being in Spain, at the present time, seventeen shipyards, the most important ones being the "Astilleros del Ferrol," at Coruna; "Astilleros de la Carraca," at Cadix; "Astilleros Cardona," at Barcelona; and "Astilleros Escalduna S. A.," at Bilbao, where ships up to large tonnage are constructed.

In the ordnance field, there are from thirty to thirty-five factories making firearms, guns, and other ordnance of this class, the most important ones being the "Fabrica de Artilleria de Truvia," at Asturias; "Fabrica de Armas," at Oviedo and at Sevilla; "Garate, Anitua y Ca," at Eibar (Guipuzcua); "Beristain y Ca.." at Eibar; and "La Industrial Orbea," at Eibar.

There are also several important firms making locomotives and railway cars, among these being the "Material para Ferrocarriles y Construcciones," at Barcelona, and "Maquinista Terrestre y Maritima," at Barcelona, where from 1500 to 2500 workmen are employed.

Old-fashioned Methods must be Changed

Too much emphasis cannot be laid upon the fact that the old-fashioned methods used in Spanish shops make it difficult to sell the most highly developed types of American machine tools. Neither the superintendents nor the foremen, not to speak of the workmen, understand the operation of the newer types of machine tools, and the owners of the plants do not appreciate the value of these tools, nor the increased production possible when these machines are properly operated. Ordinarily, if such machines were sold to Spanish shops, they would not be profitable to the buyer because the ordinary Spanish workman would not operate the machine to its best advantage, on account of never having received the proper instruction in the use of these machines. American demonstrators, thoroughly familiar with the use of the machines, who can go into the shops and train the men and show them how greater production can be obtained are, therefore, necessary, if these types of machines are to become commonly used in Spain.

Past Imports of Machine Tools into Spain

The imports of metal-working machinery into Spain from the United States in 1913 amounted to $109,624, which, of course, represents a comparatively small amount. However, there has been a steady increase since 1909, when the value of the imports was only $23,000. On the other hand, the imports from Germany in 1913 amounted to from $480,000 to $500,000, which shows what a big proportion of the trade Germany obtained. During the war, conditions were abnormal, but in 1917 the imports of metal-working machinery into Spain from the United States rose to nearly $1,700,000, and in 1918 the imports were $1,250,000. During the month of May, this year, the total imports of metal-working machinery into Spain from the United States amounted to about $93,000. Of this amount, however, only about $32,000

represented machine tools. It is not possible to state the amount of machine tools represented by the figures for metal-working machinery in past years, because separate statistics of machine tools were not prepared until 1918. In that year, over $350,000 worth of machine tools were imported. The difference between this figure and $1,250,000 is represented by other kinds of metal-working machinery.

Competition that American Machine Tools Must Meet

The figures given relating to the past German imports of machine tools into Spain indicate the competition that may be expected from Germany when that country again begins to become a factor in international trade. England will also doubtless attempt to get some of the Spanish trade, but as England has had very little of this trade in the past, it will be more difficult for the English to introduce their machines in Spain than it will be for the American machine tool manufacturer.

The native competition is not likely to be important. There are, at the present time, about a dozen firms in Spain who make machine tools, but only six or seven of these make machine tools exclusively, or have separate departments devoted to this line. The machines manufactured are largely designed along American or German lines. The machine tools built are of simple types and include only lathes, planers, milling machines, shapers, drilling machines, and turret lathes. All of the shops making machine tools are quite small. It is evident, therefore, that the native competition need not be considered as of great importance.

The most important factors to be taken into consideration are price, delivery, and terms. American machine tool manufacturers can sell their product at a higher price than German machine tools, because they are acknowledged to be of better quality. Delivery, however, must be prompt and the terms must be made to suit the customers' needs, the same as those that are offered by other European competitors. American machine tool manufacturers cannot expect always to be paid in cash upon the delivery of their machines on board ship in New York harbor. If they persist in requiring this, they will seriously curtail their European trade and will work to the advantage of the German machine tool builders, who will be able to sell an inferior quality of machines in the Spanish shops, because of the long credit terms that German machine tool builders have been in the habit of giving their customers.

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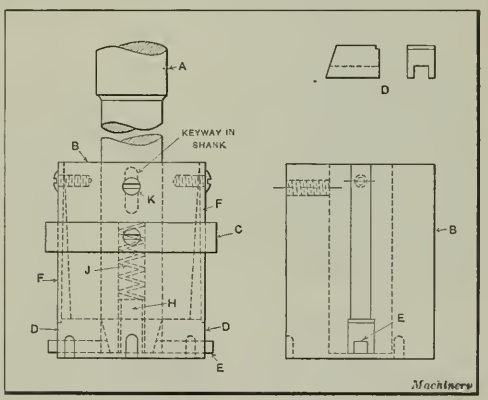
The most refractory metals are used in connection with the manufacture of filament electric lamps. Of these metals tungsten is the most refractory and is the one now in use in lamps. Tantalum, molybdenum and osmium are also very refractory. Tungsten is produced in the form of powder by the reduction of its oxide. This powder can be molded into rods, crucibles and other forms, and sintered by heating to 1800 to 2000 degrees C. The material produced in this way is very porous. Compact ductile tungsten, suitable for the drawing of wire for lamp filaments, is made by hammering the porous material, with suitable heat-treatment. Metals of the platinum group are all refractory. Platinum is used for crucibles, thermocouples, resistance thermometers, electric heaters, and other purposes. Electric furnaces with platinum heaters may be used at temperatures up to about 1500 degrees C., though it is commonly not advisable to approach very close to this limit. Laboratory furnaces with iridium heaters have been used in a few instances, but they are very expensive. They give temperatures up to about 2000 degrees C. The advantage of platinum and iridium heaters over the cheaper graphite heaters is that they can be used in contact with air, while graphite heaters would burn in air and must be used in a vacuum or in a non-oxidizing gas. Graphite produces reduction or contamination in many materials which it may be desired to heat. Some base metals, especially alloys containing chromium and nickel, are used for electric heaters at moderate temperatures.

RECESSING TOOL FOR DRILLING MACHINES

By WILLIAM KELLER

The recessing tool shown in the accompanying illustration was designed to be used on drilling machines for cutting an internal recess to provide a working clearance when tapping holes. The shank *A* of the tool has a standard Morse taper at one end and is tapered off sharply at the opposite end. The straight part of the shank is a sliding fit in the body *B* and is held therein and kept from turning by means of a screw *K* which engages a keyway in the shank. The lower end of the shank is bored out to receive the coil spring *J* and the plunger *H*. It will be noticed that the hole in the body does not pass clear through, and also that a rectangular hole is broached through the body near the bottom, intersecting the shank hole. In this rectangular hole, the two cutter-holders *D* (a detail of which is shown in the upper right-hand corner of the illustration) are a sliding fit. Two slots are milled diametrically opposite each other in the body, directly above the rectangular holes, in which two flat springs *F* are fastened by means of machine screws. These springs engage shoulders cut in the cutter-holders *D*. The adjusting collar *C* fits the body of the tool, and may be fastened to it so as to determine the location of the recess.

The operation of the tool is as follows: In its normal position, that is, when the tool is not at work, the body will be forced down by spring *J* working against plunger *H* as



Internal Recessing Tool for Use on Drilling Machines

far as the screw *K* will allow it to. This brings the lower end of the shank almost to the top of the rectangular slot in which tool-holders *D* are assembled, allowing the springs *F* to slide these holders toward the center of the body, and consequently forcing the tools below the surface. This allows the body to act as a pilot and enter the hole to be recessed until the collar *C* rests on the top surface of the work. The continued downward movement of the shank brings its tapered end in contact with the tool-holders, forcing them radially outward and cutting the recess at this point. While the recess is being cut to the required depth, the coil spring *J* becomes contracted and the force thus exerted on plunger *H* will hold the body in place at the completion of the operation until the spindle has been raised sufficiently to allow the springs *F* to withdraw the cutters from the recess. The continued upward movement of the drilling machine spindle will cause the screw *K* to be engaged in the lower end of the keyway in shank *A*, so that the body *B* will be withdrawn from the hole. The tools bits *E* are made of high-speed steel and are forced into the holders *D* and peened, so as to be held in place, and the ends ground at an angle to fit the end of the shank.

Special Pattern Work

Use of Stopping-off Pieces—Core and Strickle Work—Skeleton Pattern Work—Match-Plate Work—Loam Molding

By JOSEPH A. SHELLY

THERE is more or less specialization in the different branches of the patternmaking trade. This specialization has developed from the efforts that are constantly being made to produce castings with a minimum amount of pattern work or with greater rapidity. The adapting of stock patterns to special jobs is practiced to such an extent in steam-pump and engine shops that it is almost a trade in itself. This work is done largely through the use of stopping-off pieces, and results in a saving in pattern work as well as in the subsequent cost of storing another pattern. Skeleton core-boxes and patterns are also largely used in this work. Shops handling very light work specialize on the follow-board type of pattern, while many patternmakers work a lifetime without having occasion to build a pattern in that way. The use of gated patterns to secure multiple production of small parts is well known, but a knowledge of the use of match-boards is not so common. Loam molding is extensively used in certain lines of work and not at all in others. Many odd jobs have to be produced quickly, and the means for doing them must be inexpensive. Very often the devices used for this purpose are makeshifts that cannot take the place of a properly made pattern, but answer very well for one or two castings.

The fitting of patterns to molding machines is another form of specialization. Generally speaking, there are two types of molding machines: one is called a stripping-plate and the other a vibrator-plate machine. The stripping-plate machine requires a special metal pattern which is mounted on a bolster plate that draws it through the opening in the stripping plate. This opening is made an exact fit for the pattern so that there will not be any danger of breaking the corners of the mold when the pattern is drawn. The patterns are usually mounted so that the cope and drag are made at the same time. Ordinary wood or metal patterns are used on the vibrator machine; these are mounted on a plate that is rapidly vibrated by means of compressed air while the pattern is being freed by drawing away the flask and the plate. The flasks are filled either by hand or by sand fed from a bin through a chute that gives enough fall to partly ram the flask, and the sand is evenly compressed by means of a squeezing device. Many so-called molding machines are not molding machines at all but simply sand rammers or squeezers.

Stopping-off is the process of reducing the size of a mold made by a pattern that is too long or too wide for the required casting, the pattern in other respects being right. This stopping-off is effected by the use of cores or of stopping-off pieces; the latter are sections of a pattern with one side conforming to the form desired. They are placed in the mold to make it the proper size and to form the part adjacent to the section that is to be filled in or stopped off. The stopping-off piece is located by contact with some other portion of the mold or by a heavily scribed line on the cope face of the pattern that is transferred to the sand face; thin strips fastened to the face or side, or a core-print may be used for this purpose.

Cylindrical bodies are stopped off by the use of a half section of pattern made to fit in the mold as at *A*, Fig. 1. The piece is located by means of lines laid off on the joint indicating the length, or by two strips tacked on the body of the cylinder each side of the parting to indicate the length. If a large cylinder is to be stopped off and the stopping-off piece will not stand upright, a batten will have to be fastened across the end to rest on the mold parting and serve as a support.

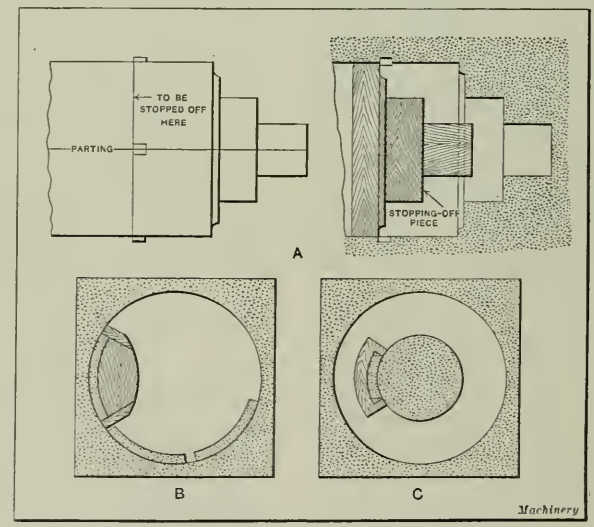


Fig. 1. Examples illustrating Use of Stopping-off Pieces

To stop off a square plate, a narrow piece of pattern is made to lie in the mold to form the new end or side. The stopping-off piece is located by measurements or by blocks fastened to the pattern, corresponding with similar blocks fastened to the stopping-off piece; the blocks on the pattern act as prints and those on the stopping-off piece fit into these prints.

A round plate is stopped off to a smaller diameter by means of a piece made to fill in the mold by ramming up sand segments as illustrated at *B*, Fig. 1. The opposite edge of the piece is sawed to conform to the smaller diameter and used in filling in the spaces between the segments of sand caused by the end pieces on the stopping-off piece. An opening in a ring may be enlarged by the same method, as shown at *C*. The same results could be obtained by the use of segment cores, but the stopping-off method is quicker and gives a better casting.

Square columns are stopped off by fastening blocks or core-prints on the column as at *A*, Fig. 2. Instead of the blocks being fastened, they are sometimes located by strips secured to the pattern. The advantage of this method is that the column can be arranged to stop off to a number of different lengths before being sent into the foundry. These square column patterns are made without end core-prints,

as the core is made of green sand rammed up into the mold. The column or "block," as it is called, is made to the outside dimensions of the column and long enough to form the greatest length required. Two pieces, the width of the sides and of a thickness corresponding to the casting thickness, are made to lie against the sides of the mold after the block is drawn, and the green sand core is rammed between them. These columns have rectangular openings in the back formed by dry sand cores set in the bottom of the mold, and on these are laid flat cake cores on which the green sand core is rammed. These side pieces should be made of quarter-sawed dry pine to prevent warping and twisting, and should be provided with lifting straps to pull them out of the sand.

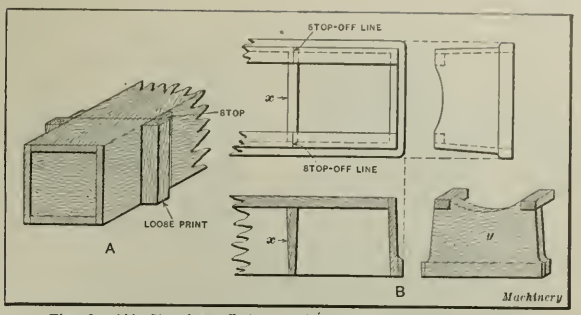


Fig. 2. (A) Stopping off Square Column. (B) Stopping off Bed

Beds are made either to leave their own cores or to have the inside removed by dry sand cores. On bed work, these cores must often be set by measurements, as the print only makes a bed for the core to stand on. The section of a bed shown at *B*, Fig. 2, is made to leave its own core, and is to be stopped off where indicated. With this type of pattern, the inside or core is lifted out to draw the pattern which is molded downward in the floor. A piece *x*, used to stop off the inside or core, is fastened in place with screws, and the stopping-off piece *y* is made in the form of an end with two short sections of flange fastened to it.

Fig. 3 shows a section of a cored bed that is to be stopped off on the depth. To do this, two stopping-off pieces are made to lie in each side of the mold. These are used to strickle a bed upon which are laid the pieces that form the new flanges; after this the space between the flanges is strickled off to form a bed for the core which has also been strickled down to suit. The section through the mold indicates the original line of mold at *e*; the first line strickled to is shown at *b*, and the last line at *c*. The end was stopped off with a new end, as in the first example referred to, except that the pieces of flange were not required. The internal flange on the end was formed by a piece placed in the core-box. The examples shown illustrate clearly the methods used in stopping-off in pattern work, and the adding of further illustrations would not involve any new principles.

Pieces for Enlarging Rings or Plates

Rings and circular plates may be enlarged by supplying the molder with a segment to lay against the outside of the pattern for ramming up the mold to the increased size. Plates may be increased in thickness by supplying the molder with three or four strips representing the added thickness to put under the pattern after he has molded and drawn it. The pattern is replaced in the mold with the strips under it and a new parting made; the required thickness is thus obtained. This method is applied to pulley rims, linings and similar patterns and is called "drawing up."

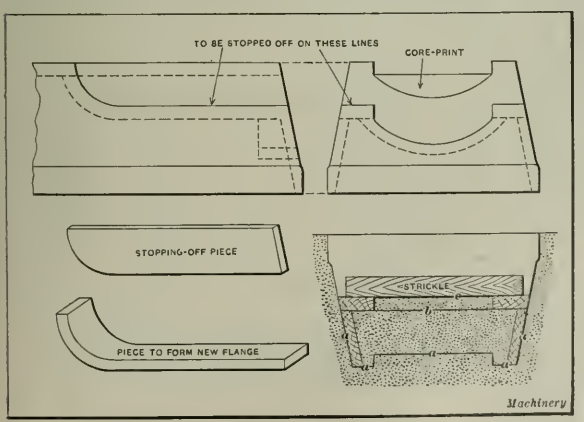


Fig. 3. Bed to be stopped off along the Line indicated

Frames for Enlarging Cores

Portions of cores may be enlarged by means of skeletons or frames placed over the part to be built up, as shown by the core *A*, Fig. 4, part of which is to be increased in diameter. The addition is rammed inside of the frame and strickled off. This could also be done by making a dry sand core to paste to the larger core, but there would probably be trouble in fitting it, as such a core is likely to warp in the drying.

Molds Made with Cores

Molds are frequently made in whole or in part by the use of cores. Hinge lugs and the trunnions on the ends of boxes, are formed in this way; the core is rammed up with the pattern or located by means of prints. An example of a simple mold made with cores is shown at *B*, Fig. 4. All the cores but the central one were made in the box *C*, the end cores being formed by fillers that fitted into each end of the box. Flanges that lie deep down in a mold are always hard to pick in when made loose, and these are best made by the use of a core as at *A*, Fig. 5. The core is made to slip over the projecting piece of pattern and is rammed up with it.

Part Patterns for Plates and Pans

Another subject that must receive consideration is that of part patterns as applied to patterns for plates and pans. Patterns for large plates and pans, instead of being made solid, are framed with the center part open and the thickness strickled out as at *D*, Fig. 4, which shows a section of a mold with the pattern in place. This is done to avoid turning the mold over when it is made in a flask and to facilitate "bedding in" when it is molded in the foundry floor, as it is impossible for the molder to ram the under side of a piece of great area. Portions of beds and baseplates are often framed to mold in this way, and the bottom thickness is strickled in boxes and pots where the pattern is coped off without turning the mold over.

Patterns Made on Follow-boards

Patterns are made on follow-boards when they are very fragile, or they are fitted to follow-boards after they are made, to withstand the foundry ramming. A great many stove and furnace patterns are made on follow-boards, and these are often masters for casting metal patterns. The follow-board is usually made first to conform to the inside or cope side of the pattern as at *B*, Fig. 5, which shows the follow-board on which the light hopper

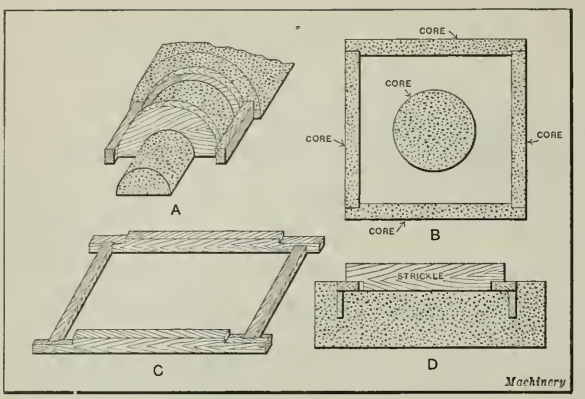


Fig. 4. Examples of Core and Strickle Work

pattern *C* is to be built. The round corners of hard wood are fitted first and they are made to extend beyond the corner radius each way, so that a rabbet, as at *D*, may be cut to receive the rabbeted ends of the sides. The different pieces forming the hopper are glued together and fastened to the follow-board by thin narrow pieces of wood nailed from the outside. A layer of newspaper should be placed between the pattern and the follow-board to prevent any glue that may run through from sticking. The follow-board should be sandpapered and varnished, and instead of newspaper being used, it is sometimes coated with paraffin; but newspaper is preferable for a fair-sized job, as it provides allowance for the varnish and shrinkage.

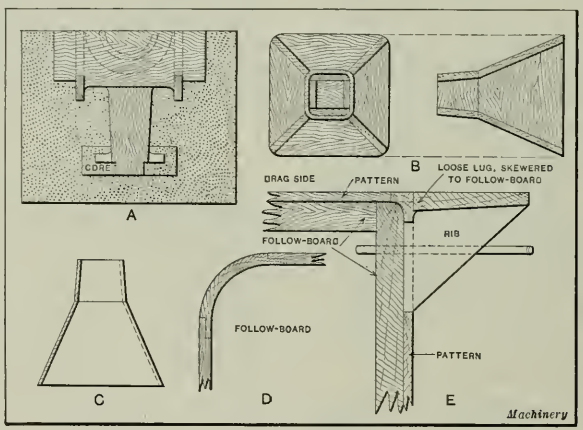


Fig. 5. (A) Core used for forming Flange. (B, C, D, and E) Follow-board Work

Projecting pieces on the outside of a follow-board pattern may be fastened to the follow-board in some cases, so as to add to the strength of the pattern. The rectangular tank pattern partly shown in section at *E*, Fig. 5, had projecting lugs that were always breaking, so the pattern was cut away and the lugs fastened to the follow-board with skewers. The purpose of the follow-board, in some cases, is not only to support the pattern, but also to make the molder's parting. Follow-boards for making partings are very often made in the foundry of plaster-of-paris or litharge. Another variation of the follow-board idea is used in making patterns of boxes that are open top and bottom and have openings through the sides; these openings are made to leave their own cores, the sides being skewered to the follow-board which is lifted out after the outside is rammed and the cope lifted.

Plaster Core-boxes

Master patterns of plaster for casting core-boxes in which small cores are made in multiple are easily constructed by first making duplicates of the cores in wood and fastening them to a board, as shown in Fig. 6. These core duplicates are given several coats of varnish. A frame is afterward fitted around them and filled with plaster; a strickle is used to form the back, the frame acting as a guide for it. Before pouring the plaster, the form should be well greased with vaseline or lard to keep it from sticking; the frame, however, is not greased as it is part of the pattern. To mix the plaster, a sufficient quantity of water is placed in a can, and the plaster added until the mixture is of the consistency of thick cream. If the box is of some peculiar shape that is going to be difficult to duplicate in wood, one pattern could be made and used to form a plaster mold for casting duplicates in plaster.

Plaster core-boxes for odd-shaped pieces can be made by first forming a plaster mold of the piece. A layer of modeling clay equal to the required thickness of the casting is then placed in the plaster mold. This clay can be rolled to an even thickness by using a biscuit roller and two strips of the thickness required. The clay is fitted over the inside of both halves of the mold, and two half-section plaster castings of the core are made and used for forming the core-box. The same plan can be followed in making duplicate plaster-of-paris patterns by first making a mold in plaster from the original and casting as many patterns as are desired. In fitting wooden frames around pieces to be molded in plaster, some means should be taken to keep the plaster from coming loose from the frame; this may be done by boring holes part way through the sides from the inside or by bradding strips to them or even driving a few nails and permitting the heads to protrude.

Skeleton Pattern Work

Skeleton patterns are either frames used for forming the outside of the mold (with dry sand cores to form the interior) or complete framework models designed to form both the exterior and the interior of the casting. In making patterns of this type having a top and a bottom flange, it is usual to notch the ribs into the inside of the bottom flange and into the outside of the top, and fasten them with screws as shown at *C*, Fig. 8. Unless the flanges are round, it is better to make them with splined joints so that they can be band-sawed both inside and out.

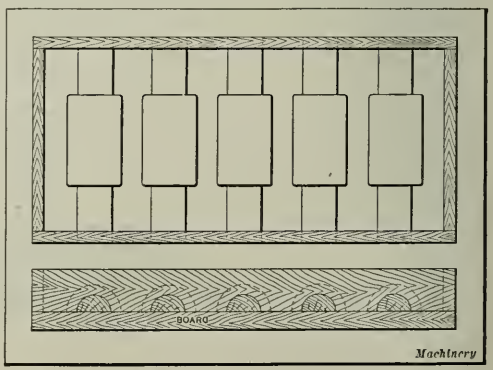


Fig. 6. Multiple Pattern in which Plaster Core-box is made

The crooked pipe *A*, Fig. 7, is a good example of the first type of skeleton pattern mentioned, and it is applicable to elbows, bends, and different forms of pipe work. It is made by doweling two pieces of one-inch stock together and laying out and sawing it to the proper outline. The edges should be rounded to conform to the circle, and the flanges and core-prints fitted. The pieces for forming the prints and body are half round less the thickness of the foundation pieces; they should be made of one-inch stock and, on the bends, the center line of each piece should be radial with the center of the bend radius. One strickle, or "strike," as it is sometimes called (see view *B*), completes the pattern. This strickle is the same diameter as the body of the pattern and is used to strike off or smooth up the clay or loam that is used to fill the spaces between the ribs. This forms a complete pattern which is molded in the usual way.

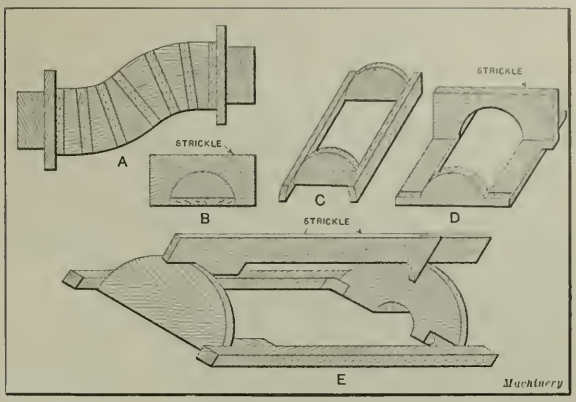


Fig. 7. Examples of Skeleton Pattern Work

Skeleton Core-boxes

Skeleton core-boxes are frames used to confine the core sand which is formed by means of strickles guided in their course by heads fastened to the frame, over which they are worked back and forth; the strickles may also be drawn lengthwise of the frame with the side for a guide. The strickle for the skeleton box *C*, Fig. 7, is a straightedge which slides over the heads. This box is made with the two side pieces screwed to the heads so that it may be changed to different lengths by unfastening one head and moving it to a new position. The core is formed in the box *D* by drawing the strickle lengthwise; this view also illustrates another form of construction in which the heads are prolonged at each side and are screwed to the side pieces. This does not lend itself very well to alterations, but provides a broad space for the strickle to slide on.

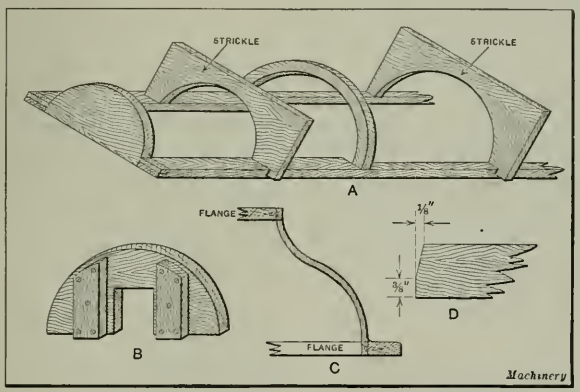


Fig. 8. Details of Skeleton Core-box and Pattern Work

The same types of boxes may be used for forming two or more diameters as illustrated at *E*, which shows a box that is strickled smaller at one end and has the strickle arranged to form a round corner at the other end where the small part of the core is formed by a half-round box made on the head. When more than one diameter is to be formed by drawing the strickle along the frame, it will be necessary to fasten a half ring at the junction of the different diameters as shown at *A*, Fig. 8. It will be noted in this illustration that the side pieces are fastened to the heads by means of a half-lapped joint. This type of box is best when the core is long. In making skeleton boxes, the heads and sides should be stout enough to withstand the ramming as well as rough handling. In some shops it is the practice to use core arbors that run through the end of the box; this necessitates cutting an opening through the head which should be reinforced with battens as at *B*.

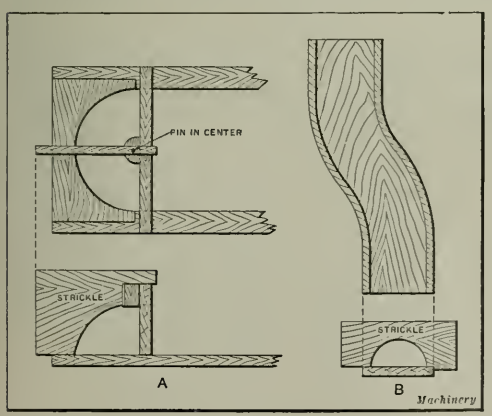


Fig. 9. Examples of the Use of the Strickle

The use of skeletons is not confined to the forming of cores with straight or curved parallel sides, as a large variety of outlines may be secured by using frames and strickles of the proper outline. Hemispherical ends may be formed on the ends of straight cores by arranging a sweep to revolve on a central pin as at *A*, Fig. 9. In making skeletons for pipe bends, it must be borne in mind that the core must reverse or be right and left; therefore, the frame forming the outline must be made complete with the edges square. It is a good plan to make the frame with corner lap joints and fasten the heads with dowels and screws so that they may be changed from side to side. Straight skeleton boxes over 16 inches in diameter should have a third frame piece connecting the heads at the top in the center to add stiffness.

Core-plates

Core-plates are plates of wood or iron that are made to conform to the outline of the pattern, and the core is formed on them by a strickle that is guided by the edge of the plate in the same manner as when using a skeleton core-box. In

making cores in the box, however, the core is made on a metal plate and the box is lifted away from it; but when the core is swept up on a plate, it goes into the oven without being removed, so that if the plate is of wood it must be substantial enough to withstand the heat. In making a wooden core-plate for the pipe illustrated at *A*, Fig. 7, the pattern is laid on a piece of suitable board and the outline marked; the prints are made the same size as the body of the pipe. The core-plate and strickle for this pipe are shown at *B*, Fig. 9. If the core is to be right and left, no battens can be placed on the plate, as a core must be made on each side of it. It is the practice in some shops to place half-round heads on the ends of core-plates and these are often necessary, particularly in forming branches at right or other angles to the body of the core. In making patterns for iron plates, a double amount of shrinkage must be allowed. These are usually made of 1/2-inch stock and are battened to hold them straight. All the strickles should be beveled on the working edge as at *D*, Fig. 8.

Match-plate Work

An important subject is that of match-plates. To expedite the molding of small patterns, they are often mounted on plates with the cope side of the pattern on one side of the plate and the drag on the other. The slide-valve casting *A*, Fig. 10, illustrates this method. The pattern for this casting is mounted on one side of the board and the steam recess is carved out of the other side as at *B*; it will be noted that the flask pins are fitted through the match-board so that it will always be in the same place in relation to the flask. A number of patterns are usually mounted on the plate, and this work must be accurately done to secure good results. The gate and runners are usually made on the cope so that the molder does not have to touch the mold when it is finished. An example of turned work mounted on a match-plate is shown at *C*. The core-print, in this case, is elongated to fit a hole bored in the plate, and the cope part of the pattern slips over it, thus insuring that the cope and drag will come in line.

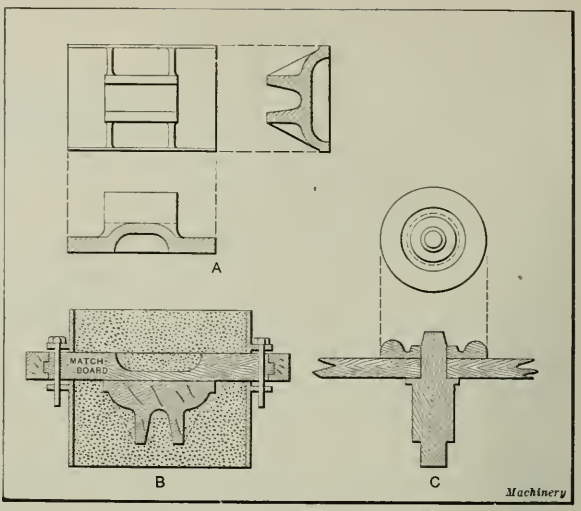


Fig. 10. Examples of Match-plate Work

Chills

Chills are pieces of metal placed in a mold to harden certain surfaces by having the molten metal come into contact with the chill. Chills may be used as part of the mold or in the same capacity as a core. A popular example of chilled work is a car-wheel rim in which that part of the mold that forms the rim is of metal. The patternmaker's job, in this case, is to fit the pattern to the chill as they are rammed up together; if a round hole is to be chilled, core-prints are fitted to the pattern and the chill is made with considerable taper so that it may be driven out. It is sometimes desirable to make sections of pipe to bolt together without finishing the flanges; and to do this, metal ends are used in the mold, not to chill the casting but to form a finished flange. In this case, the flanges are made long to form core-prints for the metal ends, the face sides of which are grooved with concentric V-grooves to give the packing a hold. The core is carried on an arbor that fits openings turned in the end pieces which are also drilled with holes through which the bolt hole cores are pushed.

Gated Patterns

Gated patterns are small patterns fastened to the runners and gate pin to form a multiple pattern which can be used to mold a number of pieces at one time. The patternmaker is sometimes required to make wood patterns on a gate, but more often he furnishes but a single pattern from which the molder casts the required number of patterns and then proceeds to mold and cast them on a gate. This gated metal pattern is then sent back to the shop to be filed smooth and have drawn iron holes drilled and tapped in it.

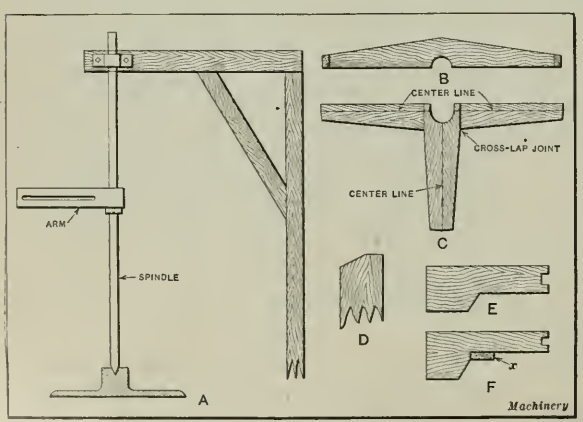


Fig. 11. Equipment Used for Loam-molding

Splitting Hubs and Pulley Rims

Pulley and flywheel rims and hubs, as well as bosses on levers, are frequently cored part way through so that they may be broken after machining. This is done so that they can be placed on a shaft after it is installed, or to provide for a compression joint to avoid using keys or set-screws. If the core required is thick in proportion to its length and width, a dry sand core may be used for this purpose, but often the piece to be removed is very thin, and instead of a sand core a piece of iron plate is used. A core-print should be provided and the splitting plate coated with something to prevent sticking. It is often coated with glue over which core sand is sprinkled so as to cover it, and it is then coated with some form of facing.

Pattern Work for Loam-molding

In making molds in loam, the molder may use a pattern or any of the devices that are applied in

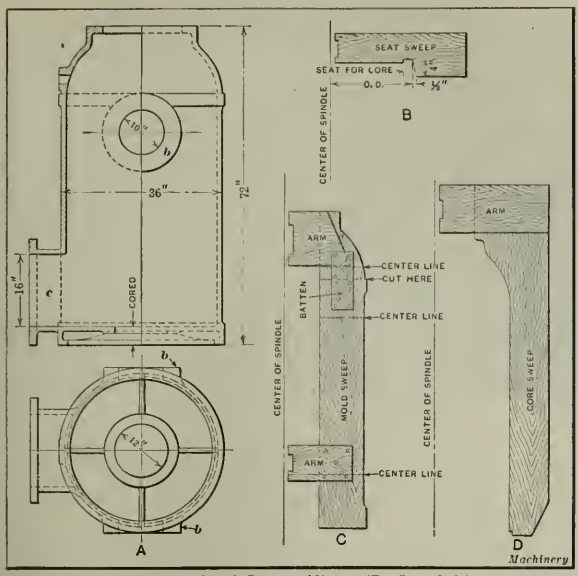


Fig. 12. (A) Example of Loam-molding. (B, C, and D) Use of Sweeps

forming molds in green or dry sand; but loam work lends itself more readily to cylindrical bodies that may be formed by the use of sweeps revolved around a central spindle. The cylinder may have branches, bosses, or other projections, and patterns are made for these as though they were to be fitted to a cylindrical body that had been built up and turned. The foundry rigging used for sweep work is shown at *A*, Fig. 11. It consists of a vertical spindle which is supported by a plate at the bottom and a pillow-block at the top. The spindle may be a piece of shafting but more often it is a tube closed at one end, and it is usual to have two or three sizes on hand. To hold the sweeps, an arm is fitted to the spindle; this arm has a slot in it for bolting the sweeps in place and it is kept in its proper position by a collar and set-screw. The side of the arm to which the sweep is bolted is in a vertical plane intersecting the spindle center. Instead of the hole in the arm being made to slip over the spindle, it is more convenient to make it slotted and have it fastened to the spindle with a gib and key, as it is more easily removed.

A loam mold is built on an iron base or foundation plate provided with three or four lugs and sometimes with other projections to carry portions that extend beyond the main body of the mold. A top plate with lugs corresponding to those on the bottom is used to fasten the mold together after it is finished. Loop clamps are slipped over these lugs and fastened by driving wedges through the loop at the top.

The jet condenser body shown at *A*, Fig. 12, is a good example of a loam job, and will give a fair idea of what the patternmaker is required to furnish for this type of work. Patterns were made for the projecting bosses *b* and the flanged nozzle *c*; these were provided with core-prints, and boxes were made in the same manner as if the job were to be molded in green or dry sand. The recess in the bottom was formed also by a core for which a box was made. To draw the flanged nozzle through the side of the mold, a cake covering core was provided to fit over the core-print. A full-size lay-out was made, showing the thickness of metal, finish, centers of hubs and bosses, and the seat parting at the bottom corner of the mold.

In starting a loam job, the first thing to ascertain is the size of the spindle to be used and then to make, from a piece of 1/2 or 5/8-inch stock, what is known as a "gage-stick" *B*, Fig. 11, on which is indicated the inside and outside diameter of the job. This is used to set the sweeps to, and the semicircular notch in the center should fit the spindle.

Seat Sweep

The seat sweep *B*, Fig. 12, was made first to sweep the parting at the bottom of the mold for the condenser shown at *A*. As the bottom recess was to be removed with a core, a projection to sweep a seat for the core was placed on this seat sweep. The taper and depth of seat are usually regulated by some shop standard; in this case, the depth was 4 inches and the taper 1/8 inch per inch.

If the mold were for a cylinder with a flange at the bottom, the seat sweep in this case would have to be cut away beyond the taper to the top of the flange, and a piece *x* fastened to it to form a mold for the flange as at *F*, Fig. 11. This piece is fastened with screws and is removed to sweep the sand pattern which is formed in the mold made with the piece in place; this is done to avoid an under-cutting finger that would have to be placed on the mold sweep to form the flange.

The Body and Core Sweeps

The body or mold sweep *C*, Fig. 12, for the condenser shown at *A*, was made of 1 1/4-inch dressed stock and had two arms that were halved into it to make it flush on the face; the arms are sometimes abutted against the sweep and fastened with battens, which is a good plan if they are to be taken apart in the molding. The inner ends of the arms were notched to fit over the hubs on the arm clamps to abut them against the spindle. On the face of the sweep the centers of the nozzle and bosses were plainly scribed and this sweep was cut where indicated so that it could be removed from the mold, the two pieces being held together by a batten that doweled and screwed into place. The core sweep *D* did not differ essentially from the body sweep except that it had but one arm and was centered to sweep the inside or core.

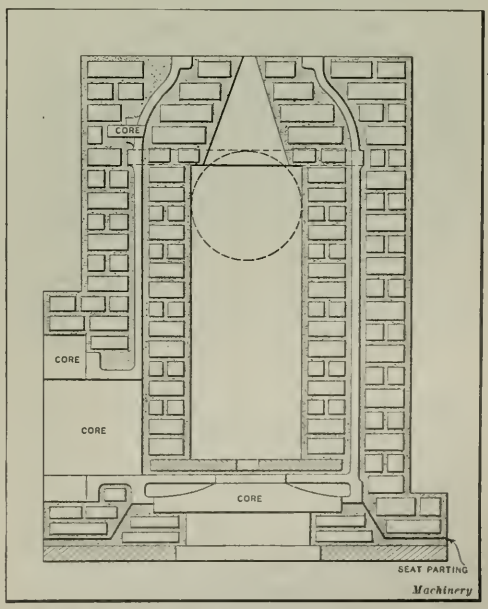


Fig. 13. Sectional View of Mold for Condenser Casting shown at A, Fig. 12

Beveling Sweep Boards

The sweep edges were beveled as at *D*, Fig. 11, so as to force the loam against the brickwork. The molder usually holds the sweep and draws it toward him with his left hand while he applies the loam with his right, the beveled edge of the board being toward him. The proper edge to bevel may be determined in this way.

Centering Gage

The center lines on the sweep (see view *C*, Fig. 12) located the centers for the nozzle and bosses in a vertical direction, and to locate them circumferentially a centering gage *C*, Fig. 11, was made of light stock; this gage fitted around the spindle, and the centers were transferred from it to the mold. When work of this kind is being done the mold is swept first and lifted off the seat to permit sweeping the core. All loose pieces used in loam work should have well defined center lines, and these lines should be carried entirely around the piece. A section of the condenser mold, Fig. 13, shows the different parts formed by the sweeps and the patterns.

Loam Patterns and Cores

Loam patterns are sometimes formed by means of a spindle and sweep or by frames and strickles. The usual procedure when operating with the spindle and sweep is to sweep up the core first and dry it. The outside of the pattern is then swept up by applying sand to the core to form the thickness of metal. This sand pattern is used to mold with, and the sand formerly applied to obtain the thickness is removed so that the core is ready for use. Loam cores are formed by boards pressing the loam against a barrel which is wound with straw rope and revolves in a horizontal position. The patternmaker is concerned only with the boards that must be shaped and beveled on the edges to give form to the core.

The patternmaker does not have to concern himself about partings in loam molds to the same extent that he does when a pattern is made for green or dry sand work. The principles of molding should be observed, but owing to the construction of a loam mold, the molder determines the location of the parting.

Using Old Castings as Patterns

When breakdowns occur there is not always time to make a new pattern to take the place of the broken part, so the old casting must be patched up and used for a pattern. When there are holes in bosses and hubs, these may be plugged, and this will enable the patternmaker to attach thin material by brads to allow for finishing the casting. When there is no chance to fasten the "finish," the molder should be provided with a piece of the proper size and thickness to cover the surface and should add on the required amount. Paper and cardboard are frequently wound around cylinders and fastened with shellac or tied in two or three places with a piece of string. Narrow wooden strips may also be used in this way. Under-cutting bosses can be utilized by fitting pieces under them to form tailprints; a piece is then made to set into the mold while the tail is stopped off.

* * *

Cadmium solders may be used for soldering tin plate, terne-plate, brass and copper, according to an investigation recently made by the Bureau of Standards. Four different compositions of cadmium solders have been tried: (1) Lead, 90 per cent; cadmium, 10 per cent; (2) lead, 80 per cent; cadmium, 10 per cent; tin, 10 per cent; (3) lead, 85 per cent; cadmium, 10 per cent; tin, 5 per cent; (4) lead, 75 per cent; cadmium, 10 per cent; tin, 15 per cent. The manufacture and use of the alloy first mentioned is rather difficult, because it oxidizes easily in the molten condition. The best composition is said to be that containing 80 per cent of lead and 10 per cent each of cadmium and tin.

TEACHING SHOP PRACTICE BY MOTION PICTURES

One of the best motion pictures produced in the shop practice field has recently been shown to mechanical audiences under the auspices of the Cleveland Twist Drill Co., Cleveland, Ohio, which company has staged a four-reel motion picture on the use and abuse of twist drills. This picture illustrates in a striking manner what can be accomplished in the machine shop field along the lines of teaching shop practice. Briefly described, the picture is a text-book on the construction and the proper use of twist drills, the latter lesson being best brought home to the audience by pointing out the various abuses to which twist drills are frequently subjected in the shop, and by emphasizing the methods that should be employed in order to obtain the best results and the highest efficiency from twist drills.

In the early part of the picture, the correct definitions of the various terms used in connection with twist drills are clearly given and instructively illustrated. Such terms as "body clearance," "lip clearance," "web," "web increase," etc., are explained in a manner that will create a lasting impression, and later the results obtained in drilling by the use of drills having correct and incorrect clearance, point angle, length of lips etc., are shown. The various abuses to which the workman frequently subjects twist drills are then taken up, and every point is made unusually clear by showing the whole procedure step by step. The staging of the picture is cleverly done, giving a humorous touch here and there, so as to prevent the instructive part from becoming too dry or the interest to lag. Well selected captions, giving further emphasis to the points brought out by the picture are interspersed at frequent intervals, and aid materially in creating that lasting impression and in producing that educational value that the picture is intended to possess.

An unusual and commendable feature of the film is that it does not give the impression of having been produced for advertising effect, but purely for general educational purposes along correct shop practice lines. Except for the name of the company that produced the film, and an outside view of the Cleveland Twist Drill Co.'s plant there is no reference to that company or its products. It is a distinct step toward the ideal shop educational picture, and the producers are entitled to credit for their work.

The picture, however, opens up a trend of thought as to the possibilities of the motion picture in the industrial field for training and educational purposes. The eye catches an idea more easily and quickly than the ear and except for the great cost of producing a film, such as the one described, there could be no better means for effectively instructing workmen or students in regard to mechanical principles. The engineering and trade schools of the country should have—as part of their standard equipment—a series of motion picture films of mechanical practice, carefully produced by men who really understand all the underlying mechanical principles, and not by a motion picture expert only. If this were done, much time could be saved in the instruction of young men, and they would get a clearer idea of the work in the industries.

The industries themselves also will find a great value in the use of the motion picture to instruct operators properly in the use of machines and tools. It is to be hoped that the users of twist drills, for example, will take full advantage of the film mentioned which will be sent to manufacturers and dealers—free of charge—by the Cleveland Twist Drill Co., in order that it may be exhibited to those interested By the use of a portable picture machine, the film can be shown anywhere—in an office, a show room, or in the shop. When films of this kind become commonly used to instruct workmen in the proper use of machines and tools, it is reasonable to expect that the cost of broken and damaged machines or tools will materially decrease.

Organizing a Trade School Along Business Lines

by Dean B. Cobb



IN order to obtain the advantage of cooperative effort among boys, which is difficult to do unless the interest of the boys is definitely enlisted, a plan has been adopted by the drafting department of the Boardman Trade School at New Haven, Conn., whereby the whole drafting class is arranged as a commercial organization. The greatest problem of an instructor is that of securing and holding the boys' attention. Many methods have been worked out which have proved successful in some instances, but the same methods do not always succeed in different schools, either on account of different departmental organizations or because of the differences in the teaching force.

The method to be described has been in successful operation for the past year. The scheme of the system is outlined in Fig. 1 which shows an organization diagram of the drafting-room of the Boardman Trade School, which is arranged on the same plan as employed in industrial organizations. The chief draftsman, assistant chief draftsman, and the squad chiefs are students. The organization is headed by the instructor who supervises in general everything going on in the department. Next in line is the chief draftsman who reports to the instructor and who has an assistant. Next to the chief draftsman in authority are the squad chiefs, who are in charge of two or three boys. In addition there is what is known as an assistant squad chief.

The students are divided into two classes or divisions, A and B. The chief draftsman must be a class A boy; so must also the assistant chief draftsman and the squad chiefs. The only executive position that is open to a class B boy is that of assistant squad chief.

The Duties of the Officials

The chief draftsman is responsible for the condition and discipline of the drafting-room when the instructor is busy, and he assumes complete charge of the room during the absence of the instructor. He checks drawings and tracings before they are handed to the instructor. From this it is evident that the chief draftsman acts as an authority in the room and that his decisions can be overruled by no one except the instructor. An early development of executive ability is thus obtained, enabling the boy to promote those activities which are necessary in an executive position. The duties of the assistant chief draftsman are to assist the chief draftsman in all his work and help him when necessary. One of the special duties of the assistant chief is that of checking all time sheets and seeing that the time is properly entered. He also checks all the work that is done personally by the other squad chiefs. Another one of his duties is that of taking complete charge of all magazines that come into the room. Articles in these magazines are marked for different boys to read.

The duties of a squad chief consist of maintaining discipline in his squad, and of checking all tracings and drawings made by his squad boys before being passed to the chief draftsman. He is to assist his squad boys in every way possible, and in case a very important question arises he submits it to the chief draftsman for settlement. If the chief is in doubt, the question is then submitted to the instructor for a final decision. By this method the squad chiefs begin to develop responsibility. The supervisional duties of the assistant squad chief are but few. One of them is that of maintaining order in the room during the absence of all the officials above him, which in a sense, develops responsibility in the younger boys. Other duties of the assistant squad chief are to assume the authority of the squad chief during his absence, and to assist the instructor during any tests that are being taken by the B class. Thus it will be seen that each of the officials has his distinct duties to perform and they are such as to develop responsibility and executive ability in the boys.

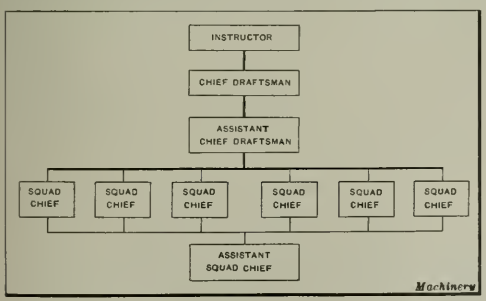


Fig. 1. Organization Diagram of the Drafting-room Class at the Boardman Trade School

TIME CARD

Name_____

Job_____

Date Started_____ Date Finished_____

Drawing		Tracing	
Time Allowed	Actual Time	Time Allowed	Actual Time

Credits_____ Demerits_____ Checked by_____

Percentage_____ Approved by_____

Fig. 2. Time Card on which is marked the Credits, Demerits and Percentage of the Student

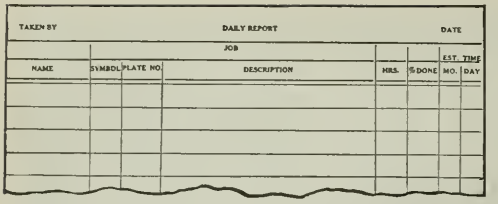


Fig. 3. Report Sheet on which Daily Progress of Each Student is Recorded

The Checking System

In order to ascertain thoroughly just how much each boy knows, a checking system has been installed, based upon the following points. The colored pencil system is used to enable the instructor to give proper credit to the boys. This system may be explained by taking as an example a drawing made by a squad boy and following this drawing from the time it leaves the squad boy uncorrected, until it has been corrected and returned to him. It goes first to his squad chief, who may find, say, ten mistakes, which he corrects with a blue pencil. The drawing then passes to the chief draftsman who may find three more mistakes, which are marked with a green pencil. It is next passed to the instructor who, in the final checking, may discover two errors, which he marks in red. He also makes other notations as he sees fit, such as the number of credits or demerits, lines too light, etc., after which he marks the necessary credits and demerits on the time card, shown in Fig. 2. The drawing is then passed back to the chief draftsman who notes the corrections, and he, in turn, passes it to the squad chief who finally passes it to the squad boy. By this means each boy who has checked this drawing becomes acquainted with all the mistakes that have been made. All drawings before being handed in to the instructor must be checked by two members of the drawing-room organization, that is, one member outside the chief draftsman must check the drawing. This practice causes the work to be properly checked before being handed in to the instructor.

System of Recording Time, and the Other Marks

When a drawing is handed out to any member of the drawing-room, a time card such as shown in Fig. 2 is given to the boy; this contains spaces for the following information: name, name of job, date started, date finished, time allowed, and actual time spent in making the drawing. At the bottom of the time card are spaces for entering the number of credits and demerits and the percentage attained, as well as for entering the name or initials of the person by whom the drawing was checked and approved. When a squad chief gives a boy a job, he allows him so many hours to do the drawing. When the job is finished, the actual number of hours is properly entered on this card, which accompanies the drawing all the way through to the instructor,

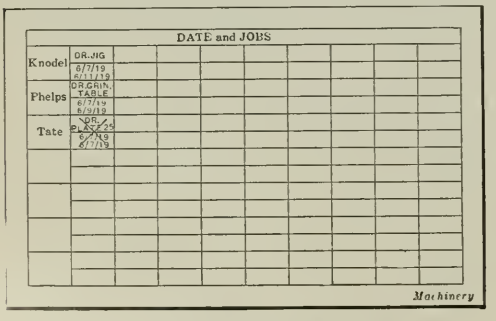


Fig. 4. Ruled Form on which the Progress of Each Student is shown by a Record of All Drawings made

who marks thereon the necessary credits or demerits and the percentage. This enables the instructor to check up all work thoroughly without spending unnecessary time looking up the different jobs. From this time card, the number of credits or demerits are recorded in a book. This book contains the date of the entry and also shows whether the drawing was made by the student or simply traced or checked by him. If it was drawn or traced, it shows the hours allowed and the actual number of hours on the job. The number of credits or demerits allowed and the percentage received are also entered in the book. In case the job consists merely of checking, the name of the person who made the drawing and of the checker are shown in separate columns.

Another time card, shown in Fig. 3, is called the daily record and is filled out each night by the clerk of the room. He records this information on a recording sheet, Fig. 4, which shows at a glance the work each boy is doing. On this sheet the name of the job is entered, the date it is

TABLE GIVING VALUES USED IN MARKING DRAWING FOR CREDITS AND DEMERITS

Assembly	Perfect	5 Credits
"	1-3 Mistakes	3 "
"	4-6 "	1 "
"	7-10 "	1 Demerit
"	11-15 "	3 "
"	16-20 "	5 "
"	21 and above "	15 "
"	Poor printing	1 "
"	Dirty paper	2 "

DETAILS

Number of Parts 1-20 Inclusive		Above 20 Parts	
Perfect	5 Credits	Perfect	10 Credits
1-3 Mistakes	3 "	1-8 Mistakes	5 "
4-8 "	1 "	9-15 "	3 "
9-15 "	3 Demerits	16-20 "	3 Demerits
16-20 "	5 "	21-25 "	5 "
21 and above "	15 "	Over 25 "	10 "
Poor printing.	1 "	Poor printing.	1 "
Dirty paper...	2 "	Dirty paper...	2 "

TRACING

Perfect	3 Credits		
1-3 Mistakes	1 "		
4-5 "	2 Demerits		
6-10 "	5 "		
Over 10 "	10 "		
Finding Mistakes after drawing is checked		1-3	5 Credits
		4 and above	10 "

started, the time that it is expected to be finished and the date it is actually finished. If the job is finished on the date expected, it is crossed out; if not, the actual date is filled in. The accompanying table gives the values used in marking the drawing for credits and demerits. Illustrating this by using the previously mentioned example, we find the following marks: The squad chief found ten mistakes, the chief draftsman found three and the instructor found two, making a total of fifteen for the squad boy. According to the schedule, if the number of detail parts is from one to twenty, inclusive, he is given three demerits. The squad chief in checking overlooked only five mistakes, thus entitling him to one credit; the chief draftsman who overlooked only two mistakes gets three credits. By posting the number of credits and demerits each month and the percentage, the comparison will show which student is doing the best work in the room.

General Remarks

In order that the boys may feel that they have something to say in conducting the organization, an official meeting is held every Saturday morning, and is attended by the chief draftsman, assistant chief draftsman, squad chiefs, and assistant squad chiefs. The instructor is also present, acting as supervisor. The chief draftsman presides, and all

subjects that pertain to the organization are brought up at this time and thoroughly discussed. During one of these meetings it was proposed that a "Suggestion Box" be put into use. The proposition was adopted and has proved to be of much value. All suggestions that are received in this box are brought into the squad chief meeting and acted upon. For a good suggestion, credit marks are allowed by the squad chiefs, the number depending upon the suggestion, subject to the approval of the instructor. The minutes of these meetings are posted on a bulletin board for the benefit of the whole room. This bulletin enables the entire room to understand how its management is being conducted. For the benefit of the boy's welfare, a squad chief social is held in one of the boys' homes each month. This event tends to promote a better understanding between the instructor and the boys, as well as among the boys themselves.

In conclusion, a few advantages resulting from the employment of this scheme may be mentioned, among which are the development of responsibility in a boy; the acquirement of an understanding of business organizations; and the faculty of thinking independently, which is developed by the checking system, as it brings up many questions that would not otherwise have been thought of. The system also permits the instructor to place his boys advantageously as the occasion arises. The incentive to become a squad chief is also an advantage, in that it encourages better work and greater endeavor.

* * *

USE OF CARDBOARD TEMPLETS FOR TESTING SPECIAL GEARS

By W. MANGOLD

When designing special gears, it is considered advisable to test the tooth outlines by some means before cutting the gears. This may be accomplished by making templets of the teeth from heavy smooth cardboard which can be obtained in large sheets. A portion of each gear is accurately drawn on the cardboard with a hard lead pencil, after which it is cut out, the center of the gear being on the same sheet. In the case of a gear having large teeth, a full size lay-out may suffice, but in most cases the teeth should be drawn to as large a scale as convenient. When the sheet is too small to include the center of the gear, another strip of cardboard may be pasted to it so as to permit the center to be on the same sheet. Probably the quickest and best method of cutting out the tooth outlines of gears is to take a beam compass, having needle points in each leg, and go carefully over the outlines of the teeth with a needle point. By doing this a number of times, a smooth accurate cut is made through the cardboard without injury to the hardened needle point. A bow divider may be used to cut the lines of small arcs or fillets. After the templets have been made, any error in the design of the mating gears may be detected by locating the centers of the templets a distance apart equal to the center distance of the gears; then holding the templets in place by pins through the centers; and finally turning the templets to and fro with the teeth in mesh.

* * *

ANNUAL MEETING OF S. A. E.

The annual meeting of the Society of Automotive Engineers will be held in New York City, January 6 to 8, 1920, at the Engineering Societies' Building, 29 W. 39th St., New York City. During the same week, the passenger automobile show will be held. The meeting of the Automotive Engineers will include four professional sessions with two evenings of entertainment. On January 6, there will be a Standards Committee meeting, and in the morning and afternoon of January 7 and 8, there will be professional sessions.

RECOMMENDED PRACTICE FOR BEVEL GEARING

At its meeting in Boston, in October, the American Gear Manufacturers' Association adopted as recommended practice the following rules with regard to the design of bevel gearing. The accompanying table, adapted from MACHINERY'S ENCYCLOPEDIA, was accepted as giving the proper size of shafts for bevel gears according to horsepower. The sizes given should be regarded as the smallest limits, and the designers of gear drives should use larger sizes when convenient in order to be on the safe side. The importance of making the overhang of bevel gears on the bearings as short as possible was emphasized.

Length of Face

The maximum length of face of bevel gears should not be over one-third of the cone distance for gears up to 3 inches pitch diameter and not over one-quarter of the cone distance for gears from 3 to 20 inches pitch diameter, assuming that the pitch in every case will be in proper proportion to the size of the gears. A safe rule is to make the face from one and one-half to two and one-half times the circular pitch.

HORSEPOWER TRANSMITTED BY SHAFTING MADE OF MEDIUM STEEL

Diam. of Shaft	Number of Revolutions per Minute				
	100	150	200	250	300
1½	5	7	10	12	14
1⅝	6	9	12	15	18
1¾	8	11	15	18	22
1⅞	9	14	19	23	28
2	11	17	23	28	34
2⅛	14	21	27	34	42
2¼	16	24	33	41	48
2⅜	19	29	38	48	58
2½	22	33	45	55	66
2¾	30	44	59	74	89
3	39	58	77	96	116
3¼	49	74	98	123	148
3½	61	93	123	153	184
3¾	75	113	151	188	226
4	91	137	183	228	274

Length of Bearing

The minimum length of bearing along the face is to be at least one-half the length of the face when the gears are held in correct alignment. Gear users should test the strength of the gear housings as follows: Block the driven gear shaft and then apply a lever to the shaft of the driving gear and measure the displacement of both gears when a dead load is applied through the lever. This measurement can be made by inserting feelers or shims on the driving side of both ends of the teeth before and after the load is applied.

Shape of Teeth for Bevel Gears

Bevel gears with generated involute teeth of standard addendum, having a pressure angle of 14½ degrees may be used according to the following rule:

Ratio	Number of Teeth
1 to 1	14 and over
1½ to 1	18 and over
2 to 1	19 and over
3 to 1 and over	21 and over

The recommended practice rules as given are confined mainly to gears up to 20 inches pitch diameter as distinguished from larger gears. They also apply to average machine design as distinguished from gears for automobiles.

The adoption of the recommended practice for bevel gearing by the Gear Manufacturers' Association is one of the steps along the path of the standardization work that the society has made one of its chief aims.

Machine Tool Trade in Sweden

By G. A. LINDSTEDT, Director of A. B. Galco, Ltd., Stockholm, Sweden

THE industrial conditions in Sweden at the present time are far from satisfactory. Sweden is dependent upon export business, and the most important export markets in the past were in the East—toward Russia. This market has been cut off by conditions too well known to be mentioned. When the Russian situation made business there impossible, the Swedish industries began to develop export trade to Norway, Denmark, Holland, and Spain, but the demand in these countries was not sufficient to keep the industries fully employed. As a result, all the Swedish industries have been working on stock for a long time, and the financial conditions, as a whole, are greatly strained. Most of the Swedish industries are now working with only from 50 to 60 per cent of the force employed during the war.

With most of their working capital tied up in stock, the industries are unable to expand in a normal manner, and the general opinion which seems to prevail in the United States, that Swedish industries are still flush with the great war profits made, is erroneous. A great many of the concerns in Sweden had to rely upon outside sources for their raw materials, and these were contracted for at prices much higher than those prevailing at the present time. In this way, much money is tied up in raw materials that can now be bought for one third the price originally paid.

Another reason for the strained financial conditions is that, during the war, there was a great deal of buying done by Swedish concerns of raw materials and foodstuffs from all countries of the world. These goods generally had to be paid for in cash before leaving the foreign port, and were then held up by the British Government as a war measure, as Great Britain feared that the goods were intended for Germany. Much material that had been paid for was thus held in England until it could be proved that goods were intended for home consumption in Sweden, or for export to neutral countries. These processes of adjustment are still going on, and have tied up an enormous amount of capital in goods that have either never been received or were received after the prices had been so materially reduced that a loss was inevitable.

The Germans owe large sums of money to the various manufacturing industries in Sweden, but these sums will not be paid for a long time to come, because the allied governments, as the result of the peace treaty, naturally require that Germany should first pay the indemnity to the belligerents before making any adjustments with neutral countries.

These conditions indicate that, at the present time, any trade with Sweden must be based upon liberal credits. The lack of cash wherewith to make immediate payments does not mean that the well-known importing concerns in Sweden are unsound financially. On the contrary, it may be said that credit may be given without risk to any of these houses. A three months' credit, however, to a foreign concern, is of no particular value, because it often takes more than three months for machines to reach their destination. A foreign dealer, if he is to benefit by the cooperation on the part of the manufacturer of machine tools in the United States, must be given long credits, because he, in turn, must give credit to the manufacturer who buys the machines from him. The prevailing conditions necessitate longer credits than do the conditions in normal times.

Practically no American machine tools were imported into Sweden during the war. The factories were much enlarged, however, and were filled with machine tools made in Sweden, which, in most cases, cannot be compared with the American tools, either in regard to accuracy or to productive capacity. Hence, there is a certain demand for high-class machine tools in Sweden, but as the factories have no orders, and from 50 to 60 per cent of their machine tools stand idle, it is evident that at present they will not buy more machinery, nor will they be able to do so for some time to come. Furthermore, the effect of the exchange rates—the low rate of German exchange and the high rate of dollar exchange—makes itself definitely felt. Several Swedish manufacturers are making preparations for further enlargement of their works by taking advantage of the present low rate of German exchange. The machine tools thus bought are not needed at the present time, but are bought merely because of their cheap price when paid for with Swedish crowns exchanged into German marks. Many Swedish firms already have German marks in Germany and are simply seizing the opportunity of disposing of them by taking products in exchange, as they cannot get money out of Germany in any other way without a serious loss, due to the low value of the German mark.

German competition is so keen at the present time that it is impossible to sell American machine tools with the exception of certain highly specialized types to which the Germans offer no competition. It is only a question of time, however, before even these machines will be copied by the Germans, making competition still more difficult. Six months ago, it was not believed that the German competition would be serious, and it would not be, were it not for the present low value of the German mark. The Germans are able to demand twice as much for the machines for export as compared with those that they sell at home, and yet, when the machines are paid for by foreign money, the price is low. The following examples will give an idea of present prices of German machine tools sold in Sweden.

Vertical milling machine from a high-grade maker: Net weight, 9000 pounds; single pulley, all-gear drive; all power feed; longitudinal feed, 50 inches; horizontal feed, 18 inches; vertical feed, 14 inches; equipped with rotary table. Price, Marks 29,960—equivalent to approximately $1200 at present exchange rates.

Horizontal boring, drilling and milling machine: 5 1/4-inch spindle diameter; 70 inches longitudinal feed of table; 55 inches horizontal feed of the table; longitudinal travel of the spindle, 47 1/2 inches; all modern construction and a close copy of a well-known American make; net weight, 45,000 pounds. Price, Marks 85,100, or approximately $3500.

Vertical boring mill: Single pulley, all-gear drive; 54 inches maximum turning diameter; similar to one of the best known American machines; net weight, 22,000 pounds. Price, Marks 62,700, or approximately $2500.

Universal grinding machine: 8-inch swing; 20-inch grinding length; similar to one of the best known American machines; net weight, 2300 pounds. Price, Marks 11,300, or approximately $450.

Planer: 7 by 7 by 12 feet; modern construction, American type; net weight, 38,000 pounds. Price, Marks 74,650, or approximately $3000.

The Germans have so thoroughly canvassed the Swedish market that they are capturing every order. It is difficult to suggest anything that can be done to change the situation at present, but the foregoing remarks merely are a record of the facts for the information of American manufacturers.

Labor Conditions in Sweden

As regards labor conditions, there is, in Sweden, as everywhere else, a considerable amount of labor unrest. Strikes are prevalent everywhere, but although there is a radical element of Bolshevik tendencies, the conservative workmen constitute the majority, and it is only a question of time when proper adjustments will be made that will prove satisfactory both to employer and to employe. One of the most important leaders of the Swedish Socialist party has issued an appeal to the Swedish workmen, stating that further demands on manufacturers for higher wages must cease, because the manufacturers cannot, under existing conditions, increase wages. Greater production only will bring higher wages, and the workmen are requested to lend their energies in this direction. Wages in Sweden are very high as compared with pre-war conditions. A good toolmaker in Sweden receives from 16 to 20 crowns per day (at present exchanges rates, from $4 to $5 a day), and bricklayers or carpenters get from 35 to 40 crowns a day (at present exchange, from $9 to $10 a day).

Prospective Russian Market

The business with Russia is absolutely unsettled. It does not seem possible that Russia can begin to buy for a couple of years to come, because everything in Russia is completely disorganized. However, even this statement is a mere guess, because nobody knows anything definite about the conditions in Russia. Possibly a stabilized government could place Russia on her feet very rapidly. Sweden has sent cargoes of products to Russian ports in the Black Sea, but this business has been founded on an exchange basis; that is, exchanging the goods on the Swedish ships for hemp, linen, etc., loaded on the ships in the Russian port.

* * *

DRIVER FOR GRINDERS AND LATHES

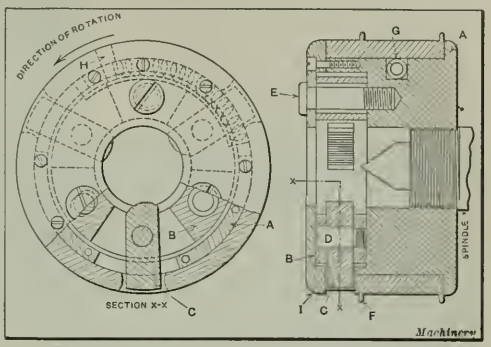
By T. L. STALKER

The driver or chuck which is here illustrated was designed for revolving work held between the centers of a lathe or grinding machine. The special feature of this device is that it permits the insertion and withdrawal of the work while the machine is in operation. The construction of the appliance is clearly shown in the illustration. The steel body *A* is threaded to fit the spindle of the machine, and is counterbored so as to provide space for the floating ring *B*. This ring has three slots in which the hardened steel jaws *C* are held by the pivot pins *D*. The ring is held in the chuck body by means of plate *I*, pins *E* and fillister-head machine screws. The flanged sleeve *F*, which is a running fit on body *A*, has three slots along the edge adjacent to plate *I*, which receive the outer ends of jaws *C*. An expansion spring *G* is contained in a recess in body *A*, one end of which bears against pin *H*, which is a drive fit in sleeve *F*. When the device is assembled on the machine, a plain leather brake, that is connected to a foot-pedal, is arranged to bear between the flanges on sleeve *F*.

When in operation, the jaws are opened for the insertion of the work by exerting pressure on sleeve *F* by means of the brake. This retards the motion of the sleeve and causes pin *H* to compress spring *G*. As the outer ends of jaws *C* are held in slots in sleeve *F*, this action causes the jaws to pivot on pins *D*, thus opening the jaws sufficiently to permit the work to be inserted. When the brake pressure is released, spring *G*, acting upon pin *H*, forces the sleeve forward, thus pushing against the outer ends of the jaws in a counter-clockwise direction, causing the jaws to pivot on pins *D* and bear against the work. The grip of the jaws on the work is automatically tightened when the cutting tool is brought in contact with the work, by reason of the toothed construction of the end of the jaws.

It will be noted that two of the holes in ring *B* through which pins *E* pass are circular, while the third one is elongated, the distance across the width of this hole being less than the diameter of the circular holes. When the work is in the chuck, the device is driven by the pin that passes through the elongated hole, there being sufficient clearance around the other pins so that they do not touch the ring. This clearance allows the ring to adjust itself when the work is not entirely concentric with the spindle centers. Holes are provided around one edge of the flanged sleeve to permit the use of a spanner wrench in case the work should become wedged so hard between the jaws that the chuck could not be opened by means of the brake.

The correct strength of spring *G* must be determined for different sizes of chucks, because if the spring is too strong it will be impossible to open the chuck jaws while the machine is in motion, and if the spring is too weak, the jaws will not be closed properly. The curvature of the gripping end of the jaws depends upon the size of the chuck. In



Chuck for driving Work held between the Centers of a Lathe or Grinding Machine

cases where the chuck is very sensitive, it is frequently necessary to equip the brake with a device that will lessen the friction on sleeve *F* when pressure is released on the brake.

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NEW BEARING METAL

A development in bearing metal which is the outgrowth of the scarcity of tin during the war was of great value to the Government during the period of hostilities. It is an electrically hardened lead with a very small percentage of other ingredients added which had never before been used in bearing metals. The Bureau of Standards made a series of tests on this new bearing metal and issued a report showing that the tensile strength of the metal is 13,000 pounds, the elastic limit 11,525 pounds and that it is capable of enduring a running test at a pressure of 1000 pounds per square inch at a speed of 400 revolutions per minute. The final temperature was only 150 degrees F. The report stated that this metal possesses all the requisites of a good bearing metal, that is, hardness, compressive strength, low friction, and heat resistance, as well as low cost.

* * *

REMOVING BUSHING FROM BLIND HOLE

A novel method of removing a bushing from a blind hole is mentioned by one of our contemporaries. There was not space enough at the bottom of the hole to obtain a grip with a hook of sufficient strength to pull out the bushing. After several other methods had been tried without success, a rod was made that fitted quite accurately into the bushing. The hole was then filled with heavy oil, the rod inserted, and driven in with a hammer against the pressure of the oil, the fluid pressure of which transferred the force of the hammer blows to the inner end of the bushing, forcing it out with very little difficulty.

Machining Impeller Pump Cylinders

Methods Employed for Facing Flanges, Drilling and Tapping Flange Holes, and Boring Cylinder

At the plant of S. F. Bowser & Co., Inc., in Fort Wayne, Ind., the factory is required to machine impeller pump cylinders of the form shown in Fig. 1. There are a number of interesting operations connected with the manufacture of these parts, but in this article a description will merely be presented of the methods that are employed for facing the flanges, drilling and tapping the flange holes, and boring the cylinder. The cylinder boring operation is the most interesting of the three, because of the peculiar shape of the cylinder. All of these operations, except tapping the flange holes, are performed on a battery of high-duty drilling machines built by Baker Bros., of Toledo, Ohio, which are set up in line and equipped in such a way that work may be passed along from machine to machine, for the performance of a sequence of operations which would ordinarily be regarded as typical turret lathe jobs. The flange holes are tapped by a machine built by the Garvin Machine Co., New York. This tapping machine is equipped with individual motor drive and mounted on a skid, so that it may be pulled into place on an elevating truck which deposits the machine beside the battery of drilling machines, for the period during which the tapping operations have to be performed.

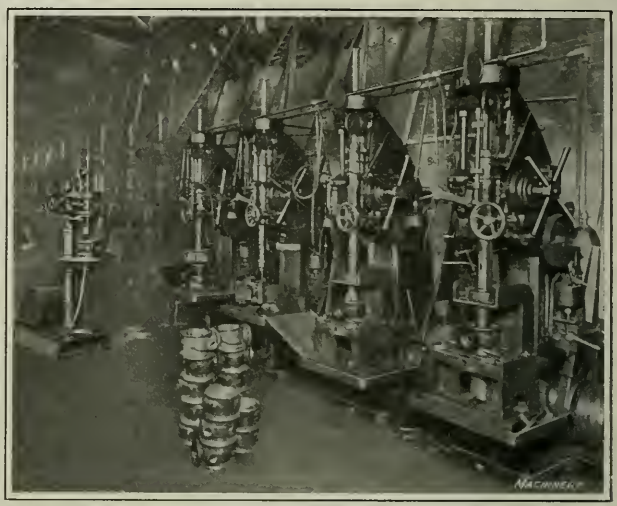


Fig. 2. Battery of High-duty Drilling Machines for drilling and boring Cylinder Castings, and Portable Tapping Machine for tapping Holes in Flanges

It will be apparent from the form of the pump cylinders, as shown in Fig. 1, that after the flanges have been faced on the left-hand drilling machine shown in Fig. 2, there are holes to be drilled in the flanges at both ends of the cylinder. In order to facilitate the performance of these drilling operations as far as possible, the jig used for this purpose was so designed that after the work has been set up, all of the holes may be drilled without the necessity of resetting. This result is accomplished by having bushings arranged in both the top and bottom plates of the jig, with provision for turning the entire jig over after one set of holes has been drilled, in order to locate the work for drilling holes in the opposite flange.

Fig. 3 shows the jig set up for drilling, and from Fig. 4 a better idea will be obtained of the construction of this tool. The holes to be drilled are located on the circumference of a circle, and at both the top and bottom of the jig there are three feet A, which are made in the form of segments of circles. The entire jig rests on a baseplate that is secured to the drilling machine table, and on this plate there is a circular track which engages the feet A. With such an arrangement, it is merely necessary to drill one hole, and after the machine spindle has been withdrawn, to push the jig around by hand until the next bushing has been brought into position under the drill. This procedure is repeated until all of the holes have been drilled. Then the jig is turned over so that the three feet A, at its opposite side, rest on the circular track, after which the same sequence of movements is repeated to drill the holes in the opposite flange.

Standing on the machine table in Fig. 3, there will be seen two quick-change collet chucks. There are 1/2-inch tapped holes and No. 0 holes to be drilled, and to save time in changing tools, these quick-change collets are utilized. The method of setting up the pump cylinder casting in this jig is quite simple. To put a casting into the jig, the top plate must first be removed. It will be seen that there are three pins B which enter holes in the top jig plate C to assure accurate location of this plate, after which nut D is tightened in order to clamp the plate down onto the work held in the jig. The location of the work in the jig is obtained from the flat faces of flanges that surround the intake and discharge openings. After the drilling operations have been performed in this jig, the work is transferred to the portable tapping machine for tapping the ½-inch holes, which operation does not involve any unusual procedure requiring description.

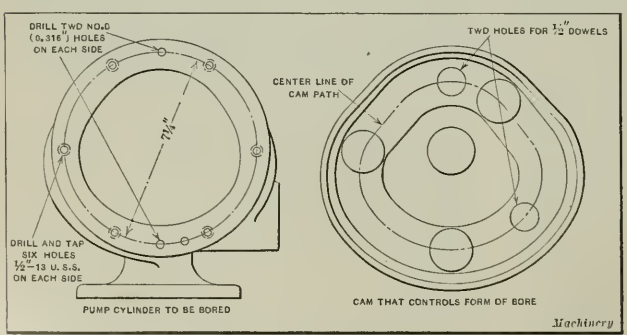


Fig. 1. Pump Cylinder to be bored, and Cam on Boring Tool that controls Form of Bore

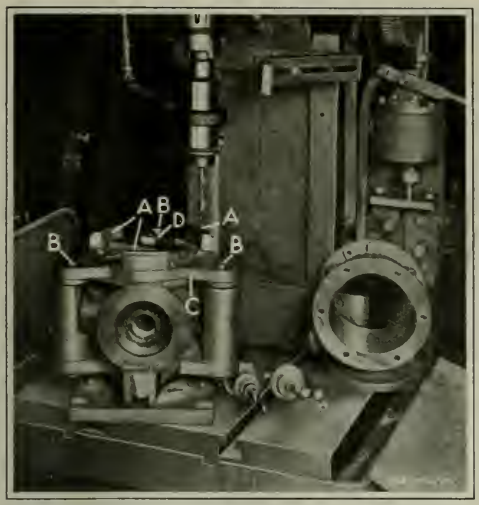


Fig. 3. Close View of Jig used for drilling All Flange Holes in Cylinder Casting at a Single Setting of the Work

Machining the Eccentric Cylinder Bore

It will be apparent from Fig. 1 that the bore of the pump cylinder is not of the usual circular form, as a result of which the problem of devising a method of machining was more difficult to solve than if it had merely been necessary to provide for machining a cylindrical bore. Fig. 5 shows a close view of the tool provided on a Baker high-duty drilling machine for the performance of this cylinder boring operation. Two machines are equipped for this job. Before starting to describe the mechanism of this boring tool, it will doubtless be helpful to make a general statement as to the method by which the work is done. The boring tool is mounted on a cross-slide that is free to move transversely, so that the path followed by the tool point may be governed by a cam of the same contour and size as the cylinder bore. As the tool rotates, its radius from the center of rotation is constantly changing, and is controlled by the cam, so that the tool point bores the cylinder to the desired shape.

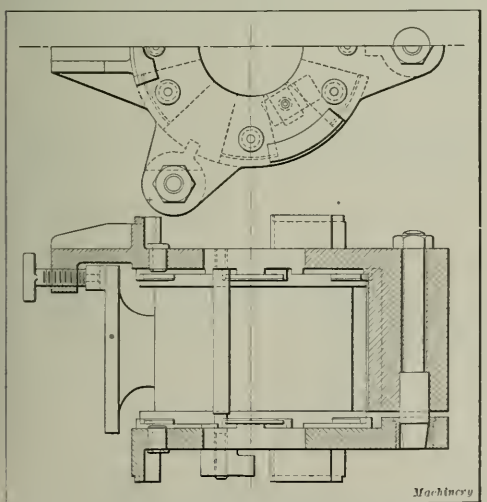


Fig. 4. Sectional and Plan View of Drilling Jig shown in Fig. 3

Having made a general statement as to the method of procedure in handling this boring operation, we are ready to enter into a detailed description. This tool is designed in such a way that the lower portion may be dropped out of the position which it occupies inside the pump cylinder, in order to allow the work to be lifted off the machine. A fresh casting is then put into position, and the lower part *A* of the boring tool is raised into place inside the work, in order that pilot *B* may enter a bushed hole in the upper tool member *C* to assure accurate alignment. The rear end of the cross-slide on which the boring tool is mounted carries a cam roller *D* that enters the cam groove *E*. Very little thought will make it apparent that aside from its vertical movement, the lower tool member *A* is held stationary, while the upper tool member *C* is secured to the drilling machine spindle so that it rotates. This rotary movement results in carrying cam roller *D* around in the stationary cam groove *E*, this groove being carefully machined to conform in both shape and size to the contour of the pump cylinder. As the cam roller is secured to the rear end of the slide on which the boring tool is carried, it will be apparent that the radius of the boring tool point from the

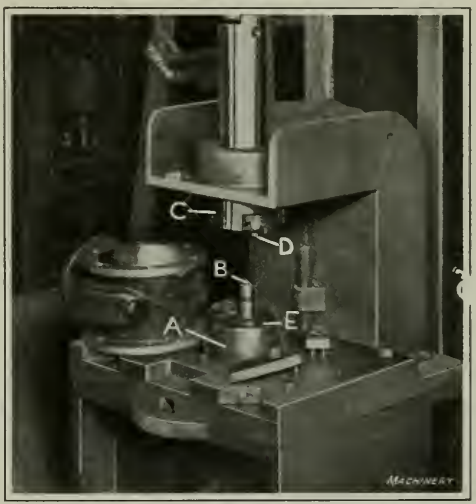


Fig. 5. Close View of Tool used for boring the Cylinder. The Cam that controls Form of Bore is shown in Fig. 1

center of rotation is constantly changing, in order to make this tool bore the cylinder to the required form. In addition to its rotary movement, the upper tool member *C* is fed downward by the drilling machine spindle, so that the boring tool is traversed from end to end of the cylinder to complete the boring operation.

The eccentric cylinder bore is finished in two cuts without taking the piece out of the fixture. This result is accomplished by changing the tool steel bits carried by the upper tool member *C*, which was so constructed that it only requires about fifteen seconds to make the change. By having two machines employed on the boring operation, which are semi-automatic in their operation, one man and a helper are able to operate four machines employed for facing, drilling, and boring these parts, and also to tap the holes on the Garvin tapping machine. E. K. H.

* * *

In a paper published in the Bulletin of the American Institute of Mining and Metallurgical Engineers, it is stated that in making acceptance tests of moderately hard steels, better results are obtained if the test pieces are allowed a day's rest between the time they are machined and the time they are tested.

Component Drawings for Interchangeable Manufacture

Second of Two Articles on Methods of Dimensioning Drawings and Indicating Tolerances

By EARLE BUCKINGHAM, Engineer, Pratt & Whitney Co., Hartford, Conn.

THE previous article on this subject, published in the November number of MACHINERY, stated the general laws of dimensioning, and gave examples showing their correct and incorrect application. The dimensioning of composite surfaces and compound tolerances were also discussed.

Dimensioning Force Fits

The dimensioning of a taper key and its seat offers a very instructive example. In this case, we have a drive fit so that instead of clearances we must concern ourselves with the establishment of the proper interferences. Fig. 19 illustrates such a key and its seat. The functional conditions to be maintained demand that we have always an interference of at least 0.002 inch and never have a greater interference than 0.008 inch. The illustration shows clearance at those points at which no bearing is required. Often, however, we find drawings for such functional conditions specifying fits on all surfaces. Such conditions add nothing to the strength or effectiveness of the construction but entail unnecessary refinement in the manufacture of the detailed parts with a correspondingly increased cost. Fig. 20 illustrates the details of such a condition dimensioned in a very common manner. This method of dimensioning is wrong. The key in this sketch violates the first, second, third, and fifth laws of dimensioning; the slide violates the second, third and fifth laws; while the dimensioning on the seat violates the first, second, third, and fifth laws. With the dimensions given as they are, it is impossible to specify tolerances that will insure the required functional conditions unless we reduce each tolerance to a fraction of a thousandth. The dimensions and the tolerances as they stand permit, in some cases, the key to be tight in the slide and loose in the seat of the slide. In other cases, the reverse is true. Parts made to the basic dimensions will have a fit on all surfaces.

Fig. 21 shows these parts dimensioned in accordance with the laws of dimensioning. It will be noted that with parts made to the basic dimensions, the key will be driven home to its head, with an interference on the bearing surfaces specified of 0.002 inch. The direction of the tolerances on every dimension affecting these bearing surfaces is such that this interference is increased as the sizes of the parts vary from the basic dimensions. Under maximum metal conditions, the bottom of the key will be flush with the bottom of the slide with an interference of 0.008 inch on the functional surfaces. It should be noted that by giving the dimensions in this manner, the required conditions are always maintained, while the manufacturing tolerances are greatly increased. Both slots are made with parallel sides to facilitate machining. Fig. 21 offers a good example of the application of the fifth law of dimensioning. This illustration should be carefully studied and compared with Fig. 20. Note, in particular, the ease of checking the functional conditions in Fig. 21 as contrasted with the difficulty and confusion which arises if we attempt to determine the possible combinations permitted in Fig. 20. Note also how the relative extent of the tolerances specified in Fig. 21 calls attention to the essential functional surfaces. These same relative conditions exist between any drawings that are dimensioned without careful study as compared with those which are rationally and logically dimensioned. No attempt has been made in this example to express any dimensions other than those which affect the taper key and its seat. The example given in Fig. 14 on page 262 of the November number shows the proper dimensioning of the dovetail slide.

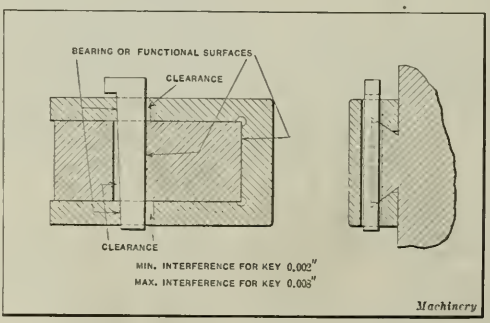


Fig. 19. Functional Requirements for a Taper Key

Dimensioning of Profile Surfaces

The dimensioning of contours with tolerances introduces still another problem. To give tolerances on the various dimensions which establish the basic contour inevitably introduces compound tolerances. On the other hand, it is often impossible to resolve such composite surfaces into elementary ones for the purposes of dimensioning and checking, because their dimensions and relative locations are inseparable. Fig. 22 illustrates one satisfactory solution of this problem. The basic dimensions of the profile are given without tolerances. A dotted line is drawn parallel to the basic contour which indicates the direction of the tolerance. A dimension is given between the full (or basic) outline and this dotted line which specifies the extent of the tolerances. This method of dimensioning gives definite information which can be used directly in the manufacturing departments.

Dimensioning of Holes

The dimensioning of the location of holes with tolerances is a most difficult problem. These dimensions are usually given to the centers of the holes and define neither male nor female surfaces. They must be used in conjunction with the diameters of the holes, thus establishing a composite surface condition. The introduction of tolerances on these dimensions of location immediately will produce compound tolerances.

We might dimension them as shown in Fig. 23 by giving one dimension to the inside edges of the holes (which is a male dimension), another to the outside edges of the holes (a female dimension), and eliminate the dimension for diameter. This would

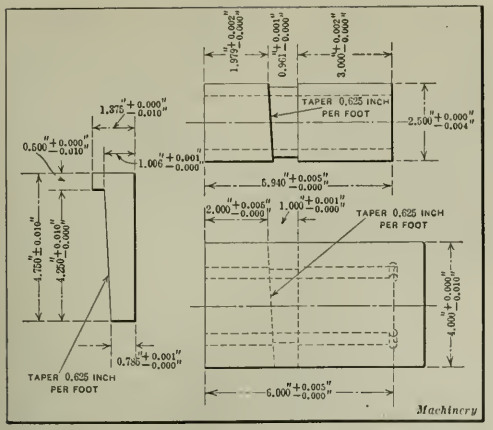


Fig. 20. Incorrect Dimensioning and Design of Details shown in Fig. 19

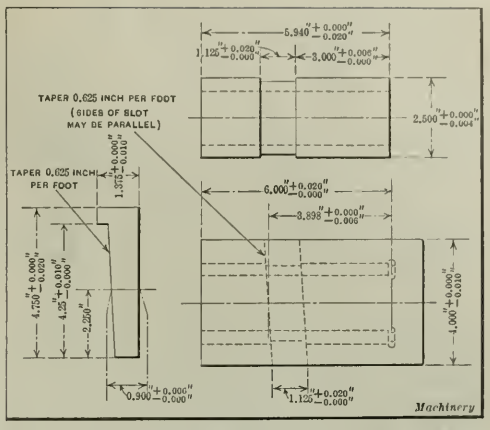


Fig. 21. Correct Dimensioning and Design of Details shown in Fig. 19

give us a better opportunity of applying the five laws of dimensioning in a similar manner to that employed for elementary surfaces. However, this would prove unsatisfactory in practice because it does not give directly the information which is of most value in the shop—namely, the diameters of the holes and the center distances.

No rules can safely be given for dimensioning the location of holes in which the permissible variations are distinctly expressed, unless the required functional conditions are duly considered. The following examples give possible solutions of a few of these problems. If these solutions are accepted, the corresponding interpretations, expressed in terms of inspection gage requirements, must also be accepted. For the first example, we will take the base for a bracket and its pad on a frame illustrated in Fig. 24. We will assume that the position of this bracket on the frame is important and must be held as closely as manufacturing conditions will permit. We will assume also that the jigs from which these holes are drilled locate the parts on the finished surfaces from which the dimensions are given.

Causes of Variation in Manufacture

Variations of locations in manufacture develop from three main causes: First, from a fixed error in the jig; second, from a difference in size between the drill and its bushing in the jig; and third, from improper location of the parts in the jigs. Variations occurring because of the first cause will affect the locations of the holes both in relation to each other and to their locating surfaces. Variations because of the second cause will have similar effects to those developing from the first cause. Variations because of the third cause will affect only the location of all holes as a unit from the locating surfaces. Thus, with these problems, there are always composite variations to contend with. The surfaces involved are always composite, and a condition of compound tolerances is always present.

If precision, rather than absolute accuracy, is the main consideration, and if these locations in the two jigs check with each other, the variations due to the first cause may be disregarded, provided that the gages which check these locations are made to agree with the jigs.

The variations due to the second cause may be reduced to comparatively small amounts by closely maintaining the relative diameters of the drills and their bushings. This naturally involves a somewhat increased maintenance cost of the equipment. The extent of the variations due to the third cause depends upon the design of the jigs and the care exercised by the operator. In general, the third cause is responsible for the largest amount of variation.

The locations in Fig. 24 are given without tolerances, yet the drawing should not be interpreted to mean that no variations are permissible. The minimum clearance between the studs and the holes is 0.004 inch. This clearance is provided to allow for the variations in their locations. Therefore, this clearance should be considered in testing the locations of these holes.

The inspection gage for testing these locations would be a functional gage which invades this minimum clearance. There are two conditions to be considered here which affect the amount of the minimum clearance that may be used on the gage. If the studs used are loose, individual pieces which pass through both parts and are bolted or riveted at assembly, the functional gage may utilize the entire minimum clearance. On the other hand, if the studs are first driven or riveted into one member, these functional gages could invade the minimum clearance not over fifty per cent. In either case, it is possible to make a single gage which will check both parts.

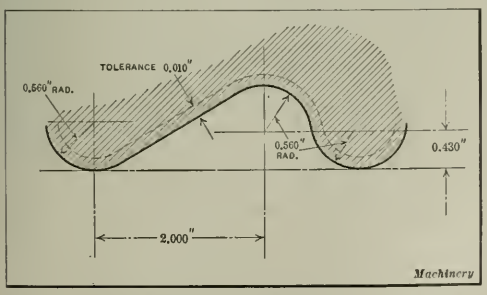


Fig. 22. Sketch showing Satisfactory Method of specifying Tolerance on Contours

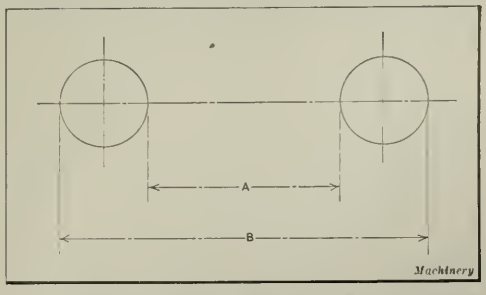


Fig. 23. Diagram illustrating Conditions met with in measuring Holes

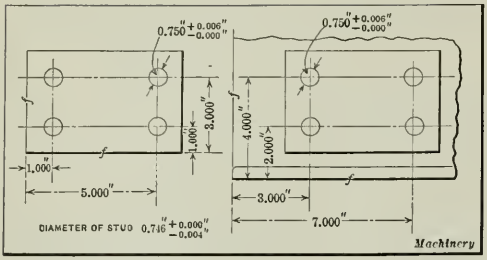


Fig. 24. Methods of Dimensioning the Location of Holes

We will first consider the functional gage to check the first of the above conditions. This gage would consist of a plate with four pins, as shown in Fig. 25. It checks both the locations of the four holes relative to each other and the location of the group from the edges of the part. The locations of the pins are identical with the corresponding basic dimensions given on the component drawings. The diameter of the pins is 0.746 inch (basic diameter of hole minus minimum clearance). The gage must always enter all four holes on the part. When the gage is held against the upper edge of the holes, the lower edge of the gage must not project below the lower edge of the component. When held against the lower edge of the holes, the lower edge of the gage must not be above the lower edge of the part. This checks the vertical position of the holes. The horizontal locations are checked in a similar manner. The diameters of the holes are checked as elementary surfaces with limit plug gages made to the specified limits.

Thus, although both the drawings and the gages are made to flat dimensions, a tolerance on all positions of the holes has been established. If their relative locations were perfect, under maximum metal conditions of the various holes, a variation of 0.002 inch either way would be permitted on their location from the edges of the parts. If the various holes were made to the maximum limits, this variation could be 0.005 inch either way. On the other hand, if the position of these holes as a unit were perfect in regard to the edges of the components, a variation of 0.004 inch would be permitted on their relative locations under maximum metal conditions, with a correspondingly increasing tolerance as the parts approach minimum metal conditions. This would amount to 0.010 inch at the extreme minimum metal condition. Inasmuch as variations will develop in both types of locations, all that is not consumed by one is available for the other.

We will now consider the functional gage to check the condition where the studs are rigidly fastened to one of the parts. A gage for this purpose would be similar to the one shown in Fig. 25 except that it would contain four holes instead of four pins. Such a gage is shown in Fig. 26. Four plugs would be used with this gage for testing the locations of the holes in one piece, while the holes in the gage would go over the studs fastened to the companion part. The diameter of the holes in this gage and also of

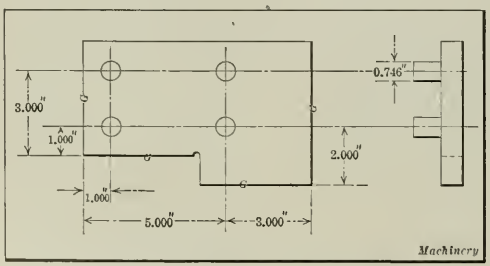


Fig. 25. Functional Gage for Part shown in Fig. 24

the plugs is 0.748 inch (basic diameter of hole minus one-half minimum clearance or basic diameter of stud plus one-half minimum clearance). This gage would be used in exactly the same manner as the first. The permissible variations under maximum metal conditions of the holes and studs would be but one-half that permitted in the first case. As these holes and studs approach minimum metal conditions, the permissible variations in location would increase in the same manner and extent as in the first case.

In Fig. 24, the locating dimensions are given from common locating surfaces in each direction. They could be given as shown in Fig. 27. As long as no tolerances are expressed, the method most convenient for the shop is best.

Expressed Tolerances on Location of Holes

If expressed tolerances for locations of holes are insisted upon, it is impossible to avoid compound tolerances. Then an arbitrary method of interpretations must be promulgated to prevent continual argument and misunderstanding. Fig. 28 illustrates two methods of indicating such tolerances. We assume that the functional conditions are identical with those previously discussed in the first case of Fig. 24. This is one example where the mean size is the proper basic dimension, and tolerances apply equally plus and minus.

In order to establish the sizes of inspection gages we must consider the tolerances, instead of minimum clearances. Re-

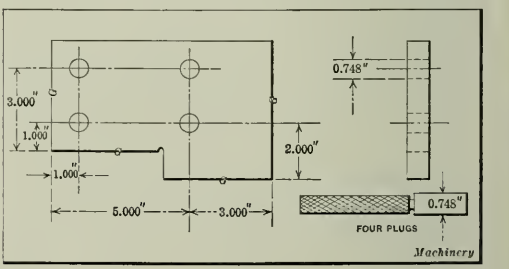


Fig. 26. Another Type of Functional Gage for Part shown in Fig. 24

ferring to Fig. 23, an inspection gage to check the relative locations of the holes must be made to the maximum dimension A and the minimum dimension B. In the horizontal direction, the maximum limit of A is equal to the maximum center distance (4.004 inches) minus the minimum diameter of the hole (0.750 inch) which amounts to 3.254 inches. The minimum limit of B in the same direction is equal to the minimum center distance (3.996 inches) plus the minimum diameter of the hole (0.750 inch) which is equal to 4.746 inches. The difference between A maximum and B minimum gives double the diameter of the pins on the inspection gage, which amounts to 1.492 inches. The diameter of these pins is therefore 0.746 inch, and the inspection gage for the relative location of the holes is identical with the one shown in Fig. 25.

In like manner, we must consider the location of these holes from the edge of the components. Call, for simplicity in notation, the dimension from the lower edge of the piece (in Fig. 28) to the upper edge of the circumference of the lower left-hand hole, C. Call the distance from the lower edge of the piece to the bottom edge of the hole D. On the gage, evidently, C must be minimum, while D must be maximum. The minimum dimension of C is equal to 0.998 inch plus half the minimum diameter of the hole (0.375 inch) which amounts to 1.373 inches. The maximum dimension D is equal to 1.002 inches minus half the minimum diameter of the hole, which equals 0.627 inch. The diameter of the pins in the gage is equal to the difference between C and D, which equals 0.746 inch. Therefore, the gage shown in Fig. 25 applies both to Fig. 24 and Fig. 28. Or, to put it in other words, Fig. 24 and Fig. 28 express the same information.

Therefore, in those cases where no tolerances are given for center distance (and this applies equally to locations of holes or grooves or slots, etc.), the minimum clearance must be analyzed, and utilized accordingly to determine the inspection gage requirements, and a suitable minimum clearance must be provided to allow for the inevitable variation in these dimensions. On the other hand, where tolerances are specified on such dimensions, these must be analyzed and applied accordingly, to establish the inspection gage dimensions, and the minimum clearance between the holes and studs must be sufficient to prevent interferences. In either case, the basic dimensions should be identical, and the inspection gages would also be identical. For conditions such as discussed above, experience will teach that the safest plan is to eliminate the tolerances from the component drawings.

The above interpretations of drawings are arbitrary to a certain extent. It would be possible to demonstrate that under certain combinations of conditions, the exact letter of the component drawings would be violated. This is inevitable in this connection. As stated before, if these solutions are accepted, the corresponding interpretations must also be accepted.

Tolerances for "Group" Locations

We will now consider the same parts, but with different functional conditions. Naturally, the holes in the companion parts must line up sufficiently to enable the studs to pass through. Therefore, the importance of the location of these

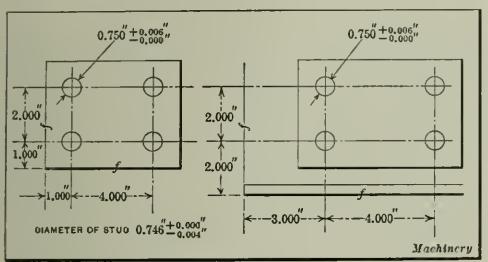


Fig. 27. Method of Dimensioning Location of Holes without Tolerances

holes in relation to each other is constant. We will assume, however, that in this case the position of the bracket on the frame is unimportant. The only method of indicating this condition that will be consistent with the general practice of dimensioning discussed heretofore will be to express a tolerance. This is done in Fig. 29. No tolerances are shown in this sketch on the dimensions controlling the relative locations of the holes to each other.

The interpretation of this drawing is that a variation of 0.040 inch, plus and minus, over and above that allowed by the minimum clearance between studs and holes is permitted on the location of the holes as a group. The inspection gage for testing this is shown in Fig. 30. This gage differs from that shown in Fig. 25 only in the addition of the steps on the edges which check the additional tolerance. It is used as follows: When the gage is held against the upper edges of the holes, the minimum lower step of the gage must not extend below the lower edge of the part. When the gage is held against the lower edge of the holes, the lower maximum step must not be above the lower edge of the part. The horizontal locations are checked in a similar manner. If the functional conditions permit a liberal variation in one direction (say, horizontal) but not in the other direction (vertical), a combination of the methods of dimensioning and checking meets the situation.

Conditions arise where the locations of holes must be established and checked from other points than a flat surface. This often requires quite elaborate fixture gages. A

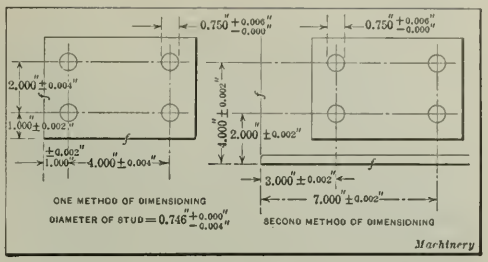


Fig. 28. Two Methods of Dimensioning with Tolerance which maintain Identical Conditions

full understanding of the preceding principles and a careful study of the particular conditions will point the way to a consistent solution of the problem. The present space is not sufficient to go into the subject in greater detail. Simple examples have been purposely selected to indicate and illustrate the general principles involved.

The preceding examples involve maintaining the relative position of several holes with each other in addition to the location of a group as a whole. In those cases where only a single hole is involved which must maintain its position in relation to elementary surfaces, the problem is simple. In most cases it can be solved by the application of methods previously discussed for elementary surfaces. In other cases, the functional requirements may be such as to demand a functional gage similar to those shown in Figs. 25 and 30.

Concentricity and Alignment

The expression of permissible variations in concentricity and alignment introduces another difficult problem. The succeeding examples offer one solution. As in the case of the locations of holes, if these solutions are accepted, the corresponding interpretations, expressed in terms of inspection gage requirements, must also be accepted.

We will assume that the stud shown in Fig. 31 must always assemble into the hole shown in the same sketch. In the process of manufacture, a certain amount of eccentricity will develop. If we attempt to give on the component drawings the permissible eccentricity in every case, the drawing will become more and more complicated. The more complicated the drawings become, the greater the possibility of undetected errors. With the following interpretations of the drawings, the conditions of eccentricity are almost automatically covered.

There is a minimum clearance on diameters of 0.004 inch between the parts shown in Fig. 31. Inspection gages to test the concentricity of these parts are functional gages and invade this minimum clearance to a fair amount. In general, this should not be over fifty per cent. The lengths of the studs and depths of the holes do not enter into this discussion. They are elementary surfaces which should be readily maintained and checked. The gages for testing the concentricity of these parts are shown in Fig. 32. It will be noted that the diameters invade the minimum clearance by an amount equal to fifty per cent. A somewhat similar

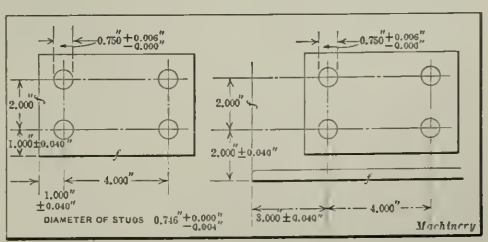


Fig. 29. Another Method of Dimensioning with Tolerance Part shown in Fig. 24

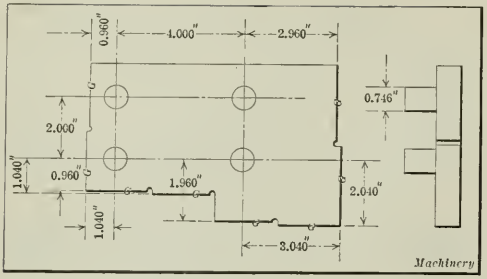


Fig. 30. Functional Gage for the Part shown in Fig. 29

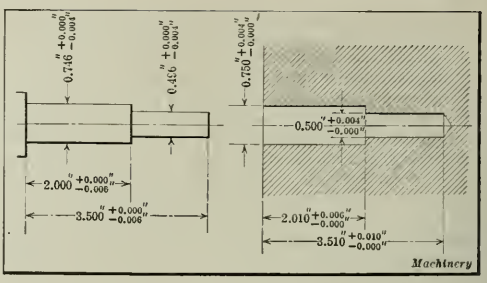


Fig. 31. Methods of Dimensioning Holes and Studs to fit

condition which involves the alignment of slides, or profile grooves and tongues, has been previously discussed in connection with Fig. 10 in the article in the November number. Functional gages for such conditions are shown in Fig. 12.

Occasionally, the situation arises where a sub-assembly as a whole must meet such conditions as are described above. This may entail individual tests for concentricity or alignment on individual component parts of the sub-assembly. The minimum clearances must, therefore, be subdivided proportionately. In such cases, it is good practice to include on the component drawing an outline with the dimensions of the functional gage required to test the conditions of concentricity or alignment. This practice will eliminate many arguments in the course of future production.

Gears

Gear teeth offer another problem of composite surfaces. In general, the tolerances on the tooth forms can best be given by specifying the permissible amount of backlash between the pair. No tolerances should ever be given on pitch diameters of gears. Specifying a limit on the backlash makes it possible to eliminate all compound tolerances. Furthermore, the most effective inspection of the gears is obtained by measuring this backlash with the gears at a fixed center distance. All the foregoing examples are comparatively simple ones. They should, however, be sufficient to indicate the manner in which a component drawing with tolerances should be dimensioned.

As stated previously, it is seldom possible at the very start to collect and record on the component drawings all of the detailed information which belongs there. The development of tools, gages, and other equipment and the final solution of many of the manufacturing problems will make apparent omissions and errors. Therefore, the component drawings should not be considered as complete until the product is actually being produced in strict accordance with them. This requires that the designer, responsible for the accuracy of the drawings, keep in close touch with both the designers of the manufacturing equipment and the various manufacturing departments in order to keep these component drawings up to date. In order better to illustrate this matter of proper dimensioning, the succeeding article will take as an example a small unit assembly and will discuss in detail the requirements of dimensions and tolerances.

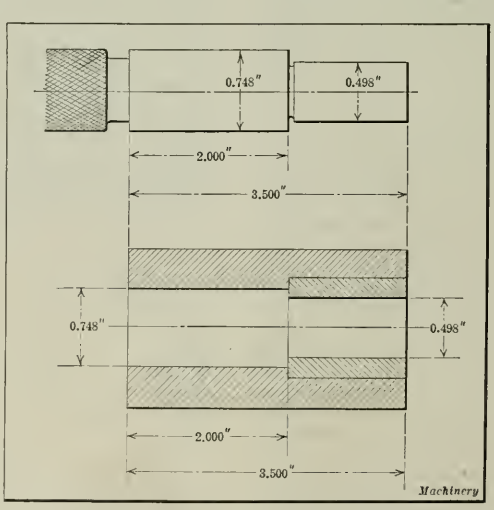


Fig. 32. Functional Gages for Part shown in Fig. 31

TESTING ALLOY STEELS

In a paper on "The Present and Future of Alloy Steels," presented before the annual meeting of the Steel-Treating Research Society by John H. Mathews, reference is made to the importance of accurate and reliable methods of testing alloy steels. When plain carbon steels were used for construction purposes, chemical analysis and tensile tests proved, in general, a fairly satisfactory indication of suitability, especially when the question of weight of construction was not of particular importance. The advent of high-powered machinery, and especially of automobiles and airplanes, resulted in a demand for material that will withstand exceptionally high stresses, and the question of lightness is of prime importance. These demands have created a wide market for alloy steels which, incidentally, are used nearly always in the heat-treated condition. The study of alloy steels, and the specific influence of the metals entering into them involves, in addition to chemical and tensile tests, microscopic methods of examination, impact tests, vibratory tests, and various other tests, the object in each case being to reveal some new information that will assist the engineer in designing for maximum efficiency and light weight. It would be desirable if non-destructive tests could be developed in order to determine the true conditions in the finished part without destroying it and without assuming that the material of the finished part is the same as indicated by tests made on samples from other portions of the material. Considerable work has been done in developing magnetic methods of analysis, but so far with little promise of success, except in particular instances. Electrical conductivity values follow changes in the molecular constituents of the steel, but it is not possible as yet to interpret the conductivity tests in terms of other properties.

* * *

Flexible fabric couplings or universal joints have been used by a number of automobile and motor truck manufacturers. These flexible couplings are noiseless in operation and they yield sufficiently to cushion the shock when the clutch of a heavily-loaded truck is engaged for starting. For this reason, the parts of the transmission are not subjected to such severe stresses as would otherwise be the case. These couplings are said to be durable and strong, but their use is restricted to "straight line" drives or cases where the driving shaft is inclined at an angle of only a few degrees.

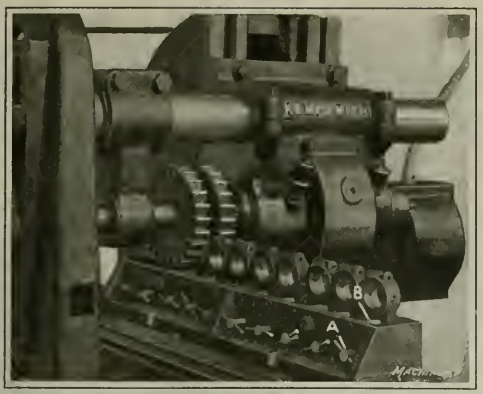


Fig. 1. Kempsmith No. 33 Lincoln Type Milling Machine equipped with Stellite Cutters for straddle-milling Gear-box Levers

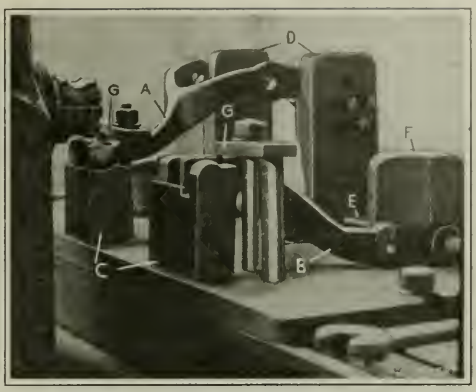


Fig. 2. Kempsmith No. 3 Plain Milling Machine equipped for milling a Convex Surface on Clutch Shifter Yoke Forgings

String Milling Fixtures

A Discussion of Typical Examples of Design and Results Obtained in Operating the Fixtures—First of Two Articles

By EDWARD K. HAMMOND

WHERE it is necessary to perform milling operations on large numbers of duplicate parts it will frequently be found desirable to make use of the familiar string type of work-holding fixture. This type of fixture may be used on practically any kind of milling machine. One of the important advantages resulting from its application is that provision is made for setting up a number of parts at a time, so that the milling machine is kept running for a considerable period before it becomes necessary to stop the spindle, unload the fixture, and return the table to the starting point. Owing to this possibility of extending the period during which the machine can be kept running without interruption, the ratio of idle time to operating time is substantially reduced.

Method of Loading String Fixtures

Variations in the conditions under which milling machines are operated will make it necessary to modify the method of loading and unloading string fixtures. Where either the size of the pieces to be milled or the rate of feed that must be employed allows sufficient time while a piece of work is passing between the cutters to enable the operator to set up a blank in an adjacent station of the fixture, the best method of procedure in operating machines equipped with string fixtures is to unload the milled parts as soon as they have passed out of engagement with the cutters. Then after the last station on the fixture has been unloaded and the table has been returned to the starting point, the milling machine operator sets up a piece of work in the station nearest to the cutters and starts the feed mechanism. He then occupies his time in setting up pieces of work in the remaining stations, working from the position nearest to the cutters toward the opposite end of the fixture. In this way, the machine is kept idle for a minimum length of time, and the operator also wastes a very small part of his working day. It frequently happens, however, that the pieces to be milled are so small or that the rate of feed is so high, that insufficient time is allowed, while one piece of work is fed between the cutters, to allow the operator to set up a piece in the next station. Under such conditions, it is necessary for several of the stations to be loaded or for the fixture to be completely loaded, before the feed is engaged; but even when such conditions are encountered, a substantial reduction on production time will be effected through the use of string fixtures, as compared with many other types of fixtures in which only one piece can be set up at a time, and where it is necessary to stop the machine and return the table after each separate piece has been milled.

Milling Kempsmith Gear-box Levers

There are several interesting features of the milling operation which is shown in Fig. 1. Not only does this illustration show a good example of string fixture design, but the job is also of interest because the cutters are made of stellite. The parts being milled are levers for use in the gear-box on either the No. 2 or No. 3 plain or universal milling machines built by the Kempsmith Mfg. Co., Milwaukee, Wis. This firm has large numbers of these levers to manufacture, and a method of performing the milling operation on a quantity production basis has been developed, which would compare favorably with the best results obtained in automobile plants and other establishments where the most approved methods of scientific management are supposed to exist. The machine on which this milling operation is being performed is of the Kempsmith No. 33 Lincoln type; and the string fixture holds ten castings which are straddle-milled on their opposite faces. The fixture has been so designed that the work of setting up can be very readily accomplished. There is a projection on each piece of work, which extends down into a channel in the fixture. Each casting to be milled has a transverse hole drilled through it, which is utilized as the locating point by sliding a T-head pin *A* through holes in the walls of the fixture and through this hole drilled in the work. At the opposite side of the fixture there is a set-screw at each of the ten stations, and when a casting has been located by means of pin *A*, this set-screw is tightened to provide for forcing the casting up against the finished face of a hardened steel stop *B*. It wil be evident that the simplicity of this fixture design makes it possible for castings to be set up and removed with very little loss of time. The material being milled is cast iron and the stellite milling cutters are driven at 60 revolutions per minute, which corresponds to a cutting speed of 125 feet per minute. The work is fed to the cutters at a rate of 8 inches per minute, and the rate of production obtained on this job is seventy-six pieces per hour.

Milling Clutch Shifter Forks for Kempsmith Milling Machines

Another good example of milling practice in machine tool building plants is illustrated in Fig. 2, which shows the method used by the Kempsmith Mfg. Co. in milling clutch shifter forks for use in No. 33 Lincoln type milling machines of this company's manufacture. This operation is performed on a Kempsmith No. 3 plain milling machine, which, as it will be seen, is provided with a string fixture that enables two pieces of work to be operated upon at each traverse of the table. Owing to the offset form of the forgings to be milled, it was found necessary to so design the work-holding fixture that provision could be made for supporting one piece of work as shown at *A* and the other in the position illustrated at *B*. In the case of each piece of work, it will be apparent that the end to be milled is supported on one of the blocks *C*, these two blocks being arranged to hold the ends of the two pieces of work at the same height from the table. Then to compensate for the offset form of the forgings, and also to afford means of clamping them in the fixture, it will be evident that use is made of the holes drilled in the opposite ends of the forgings. A sliding pin is passed through these holes and also through holes in blocks *D*, in order to provide for holding the end of fork *A* at such a level that its opposite end will be supported by the top of block *C*. Similarly, the piece of work shown at *B* is held by a pin *E* that slides through holes in the work and through two other holes drilled so that they will be in accurate alignment in the bottom of block *D* and in block *F*.

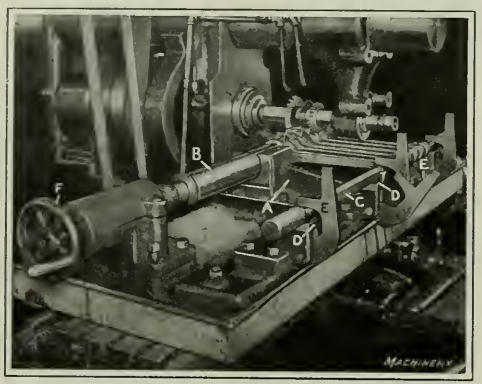


Fig. 3. R. K. LeBlond No. 3 Plain Milling Machine equipped for simultaneously milling Top and Bottom of Bolt Bosses of Hudson Connecting-rods, and cutting off Crank-pin Bearing Caps

It will be evident from the illustration that by holding one forging with its offset end extending downward and the other forging with its offset end extending upward, the opposite ends of these two forgings are so located on blocks *C* that they may be milled by a single passage under a formed milling cutter, which produces a convex surface on the work of the required radius of curvature. It will also be apparent that posts are provided on the bed of the fixture to support two straps *G* which hold the pieces of work down on the tops of blocks *C*. In order to facilitate loading and unloading the fixture, it will be seen that these straps *G* are slotted, so that by merely giving the clamping nuts a half turn, it is possible to draw the straps back from their position over the work, instead of having to remove the nuts from their bolts in order to lift the straps off. In this way, a substantial saving is effected in the setting-up time. After the two forgings have been milled while held in the position shown in Fig. 2, they are removed from the fixture and each forging is then reset in the opposite position from that in which it was formerly located, in order to provide for milling the other side of the work. In the performance of these operations, the 3-inch formed milling cutter is driven at a speed of 92 revolutions per minute, which corresponds to a cutting speed of 72 feet per minute. The work is fed to the cutter at a rate of 1 11/16 inches per minute, and the rate of production is seventeen completely milled pieces per hour, which represents the time taken from floor to floor.

Milling Hudson Connecting-rods

After the crankpin and wrist-pin bearings have been bored in connecting-rod forgings, at the plant of the Hudson Motor Car Co., in Detroit, Mich., it is necessary to straddle-mill the top and bottom faces of the bosses in which holes are drilled for the bolts that hold the crankpin bearing cap in place, and to cut this cap off from the forging. These two straddle-milling operations and the cutting off of the bearing cap are simultaneously performed on a No. 3 heavy-duty plain milling machine, built by the R. K. LeBlond Machine Tool Co., Cincinnati, Ohio, which is equipped with a fixture of the form shown in Fig. 3. This fixture is designed along such lines that it combines features of both the string and indexing types. It is primarily a string fixture, but provision has been made for performing the milling and cutting-off operations on six forgings held in one station while the six milled forgings held in the other station of the fixture are being unloaded and fresh blanks substituted in their places.

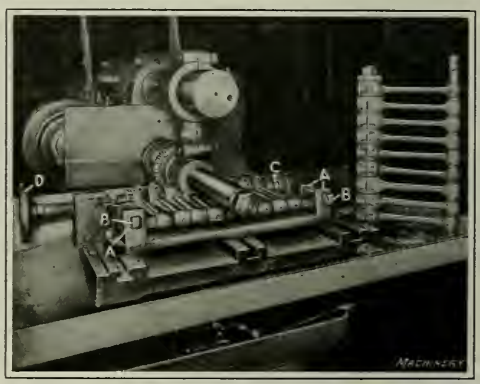


Fig. 4. Cincinnati No. 2 Plain Milling Machine equipped for straddle-milling Top and Bottom of Bolt Bosses on Continental Connecting-rods, and cutting off Crankpin Bearing Caps

Mention has already been made of the fact that when the connecting-rod forgings come to this machine, they have already had the crankpin and wrist-pin bearings bored. These two holes in the work are utilized as locating points in setting the pieces up in the fixture. It will be apparent that at a point near the center of the milling machine table, there is a bracket *A* which supports two mandrels *B* that project out from bracket *A* toward the opposite ends of the table. These mandrels are of such size that the crankpin bearing in the connecting-rods can just be slipped over them. Six pieces of work are located on each mandrel *B*, and after these six forgings have been set up, a sliding pin or bar *C* is pushed through the wrist-pin bearing holes. It will be apparent that this small bar rests on two hardened steel pads *D* and is held down by means of pivoted latches *E* which are swung up over bar *C* in order to hold it down on the pads *D* after the bar has been pushed through the wrist-pin holes in the connecting-rods. In order to afford outboard support for mandrels *B* which are called upon to support the entire pressure of the cut, it will be seen that a tail-center, manipulated by handwheel *F*, enters the outboard end of mandrel *B*, the same method of support being used at each end of the fixture.

Arrangement of Mechanism at Opposite Side of Fixture

At the opposite side of bracket *A*, there is exactly the same arrangement of mechanism, so that provision is made for setting up a complete set of forgings at each side of the central bracket, these two sides of the fixture being independent of each other. In operating this milling machine, the method of procedure is as follows: The operator sets up six forgings on that section of the fixture which is located at the left-hand side of the central bracket *A*, brings the table up to the proper level, and engages the feed mechanism. Then while the forgings carried in this section of the fixture are being fed under the cutters to provide for straddle-milling the bolt bosses and cutting off the bearing caps, the operator occupies his time in setting up a similar set of six forgings in the station of the fixture located at the right-hand side of central bracket *A*. After the milling operation has been performed on the first set of forgings, the table feeds across to bring the milling cutters into engagement with the second group of forgings. Then the operator moves over to the other side of the table in order that he may remove the milled forgings and be ready to set up fresh blanks in their places. After the operation has been finished on the second group of forgings, the table is lowered sufficiently to allow it to be traversed back to the starting point without interference from the milling cutters. The table is then raised to bring the work into proper relationship with the milling cutters, as determined by a stop, after which the left-hand side of the fixture is loaded and the feed mechanism is again engaged. This cycle of operations may be repeated indefinitely with very little loss of time for either the machine or its operator.

There is just one criticism to make of this tool design, namely, that after the bolt bosses have been milled and the bearing cap cut off at one side, the six forgings must be removed from the fixture, turned over, and again set up in the same fixture ready for performing a similar operation on the opposite side of each piece. An improvement of this condition could be made in either of two ways. If it were required to use the same milling machine which is now employed, this could be done by so constructing the fixture that the entire string of forgings could be taken out, turned over, and reset, without requiring the individual forgings to be removed from their supporting mandrel. This idea will be readily appreciated by reference to Fig. 4, in which provision is made for handling the work in just this way. An even better arrangement is accomplished at the plant of the Studebaker Corporation, where this operation is performed on a semi-automatic milling machine equipped with two spindles. With a tool of this type, the straddle-milling operations and the sawing off of the bearing cap may be simultaneously accomplished at both sides of the connecting-rod forgings, thus greatly reducing production time through eliminating the necessity of resetting the work and performing a second operation. In performing this milling operation on the machine equipped as shown in Fig. 3, the cutters run at 60 revolutions per minute, and owing to variations in their diameters they have speeds of 79, 63, and 55 feet per minute, respectively. The work is fed to the cutters at the rate of 3 inches per minute, and the rate of production is 300 connecting-rods in an eight-hour working day.

Milling Continental Connecting-rods

In Fig. 4 there is shown the method used by the Continental Motors Corporation, in Detroit, Mich., for performing the same milling operation on connecting-rods which is illustrated in Fig. 3. This job is done on a No. 2 miller built by the Cincinnati Milling Machine Co., of Cincinnati, Ohio. Although the methods of performing this operation which are used by these two companies are quite similar in their essential principles, the plan of setting up the work differs in several important details. Referring to Fig. 4, it will be apparent that instead of having a central bracket, with mandrels projecting out in opposite directions to provide for holding six connecting-rod forgings at each side of the fixture, the means provided on this machine make it possible to set up a string of nine forgings on two mandrels through the crankpin and wrist-pin bearing holes. These mandrels are entirely separate from the body of the fixture, so that the work and mandrels may be removed as a unit and turned over to enable a straddle-milling and cutting-off operation to be performed on the opposite side of the work. Such a unit can, of course, be much more quickly removed and set back in the fixture than is possible where individual forgings must be taken off the mandrels and put back separately after being turned over. The mandrel which passes through the wrist-pin bearings in the rods is squared, so that it may be dropped into place between yokes *A* at opposite ends of the fixture, and held down on finished seats machined in these yokes by means of tapered pins *B*. The mandrel which passes through the crankpin bearings is centered at its ends, so that it may be supported by means of a fixed center *C* and an adjustable center which is manip-

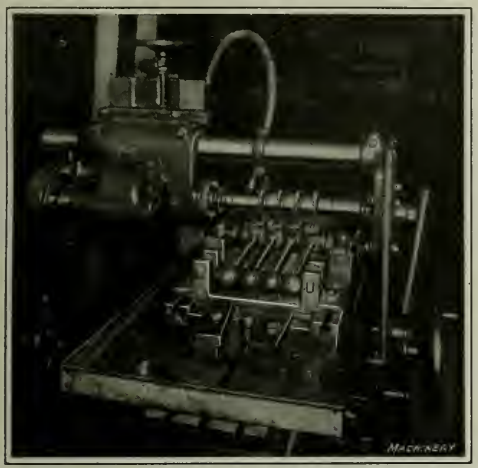


Fig. 5. Brown & Sharpe No. 13 B Lincoln Type Milling Machine equipped for roughing out the Clearance Spaces between Bolt Bosses on Continental Connecting-rods

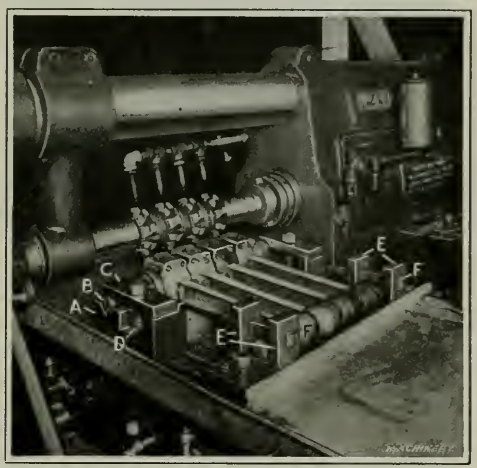


Fig. 6. No. 4 Cincinnati Milling Machine equipped with Formed Cutters for finish-milling Clearance Spaces between Bolt Bosses on Continental Connecting-rods

ulated by handwheel *D*. It will be seen that the form of the milling cutters and method of mounting them on the arbor are the same as in the equipment described in connection with the preceding illustration. This operation is performed at a cutting speed of 94.2 feet per minute, with a feed of 2.30 inches per minute. The rate of production is forty completely milled connecting-rods per hour, or 320 in an eight-hour day.

Milling Clearance between Bolt Bosses on Connecting-rods

On some types of connecting-rods for motors made by the Continental Motors Corporation, a practice is made of milling out the clearance between bosses provided for bolts that

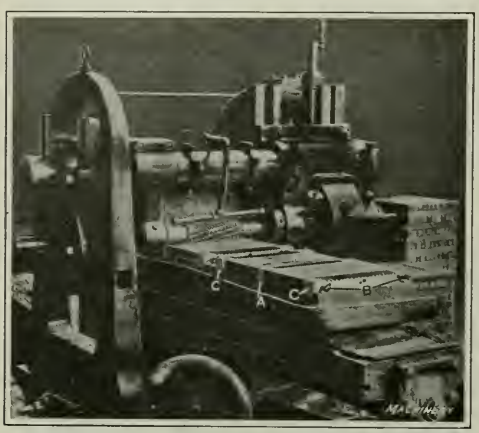


Fig. 7. Kempsmith No. 33 Lincoln Type Milling Machine equipped for milling Teeth of Racks, at the Plant of the Walker Mfg. Co.

secure the caps in place on the connecting-rods, instead of forging these bosses on the work. For the performance of this clearance milling operation, use is made of two machines which perform a roughing and a finishing operation, respectively. The machines used for this purpose are illustrated in Figs. 5 and 6. Fig. 5 shows a No. 13B Lincoln type of machine built by the Brown & Sharpe Mfg. Co., Providence, R. I., on which the first operation is performed; and after this miller has done its work, the two mandrels on which four connecting-rod forgings are carried, are removed from the machine with their work as a single unit, and transferred to the No. 4 Cincinnati milling machine, illustrated in Fig. 6, on which the four forgings are set up ready for the performance of the finish-milling operation in the clearance grooves. As the mandrels on which the work is carried are transferred from one machine to the other, it will be apparent that the work-holding fixtures used on both machines must be of the same design. The only difference in the equipment of these two machines is that plain milling cutters are used for the roughing operation, while formed cutters are employed for finishing the grooves. The best idea of the work-holding fixture will be gathered from Fig. 6, to which attention is called in connection with the following description.

Forgings which are to have milling operations performed on them by the machines shown in Figs. 5 and 6 are clamped to the mandrel which passes through the crankpin bearings. This mandrel has a collar at one end, and it is threaded at the opposite end; but in order to facilitate assembling forgings on the mandrel, the clamping nut is made of such a size that it will pass through the crankpin bearing. A C-shaped washer slips under this nut, the washer being of sufficient size so that it affords a bearing surface on which the pressure of the nut is applied to the work, in order to clamp it firmly against the collar at the opposite end of the mandrel. At the wrist-pin end, the connecting-rod forgings are held on a small mandrel which is merely a sliding fit through these bearings without being clamped in place, the function of this mandrel being merely to support the end of the forgings and hold them in the desired alignment. Mention has already been made of the fact that four connecting-rods are assembled on these two mandrels to constitute a unit which may be removed from the machine on which the first operation is performed and transferred to the second machine. Attention has also been called to the fact that on both machines, the design of the work-holding fixture is the same.

Reference to Fig. 6 will show that at the front end of the fixture there are V-blocks *A* which hold the round ends of mandrel *B* on which the work is clamped. A strap *C* at each end of the mandrel provides for holding it down in the V-block, and it will be noticed that a compression spring *D* is placed under each of these straps so that when the nut is loosened, the strap is raised, without requiring any attention from the operator. The mandrel which passes through the wrist-pin bearings in the connecting-rods is squared at each end to rest on hardened steel pads placed between blocks *E*. When the mandrel is dropped into place, two wedges *F* are driven into openings in the blocks *E* to provide for holding the squared ends of this mandrel down on their seats in the fixture. On the roughing operation, the cutters are driven at a speed of 60 feet per minute, and the rate of feed employed is 1 1/4 inches per minute. On the finishing operation, the cutters are driven at 42.8 feet per minute, and the rate of feed employed is 2 1/4 inches per minute. On each operation, twenty-two connecting-rod forgings are milled every hour.

Cutting Racks on a Milling Machine

At the plant of the Walker Mfg. Co., in Racine, Wis., a No. 33 Kempsmith Lincoln type milling machine is used to cut eighteen spur teeth in racks made of steel stock measuring 1 by 1 inch. It will be evident from Figs. 7 and

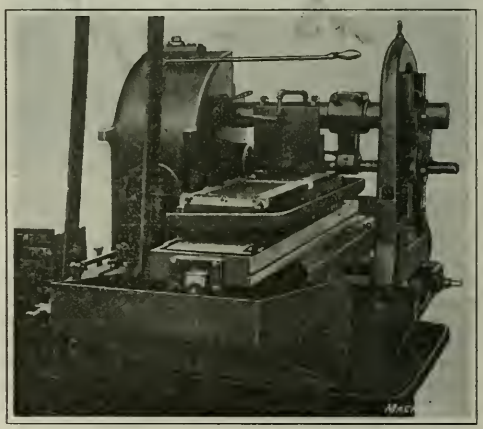


Fig. 8. Opposite End of Kempsmith Milling Machine working on the Rack-cutting Operation that is illustrated in Fig. 7

8 that a gang of rotary gear-cutters is mounted on the milling machine arbor to provide for simultaneously cutting all of these teeth; and these cutters are set up with their teeth staggered relative to each other, the purpose being to so distribute the teeth that there will be no tendency for all of them to come into engagement simultaneously, thus setting up a "hammer blow" action.

To facilitate the work of loading and unloading this fixture, and to avoid having the milling machine operator left without employment while the machine is in operation, the fixture in which these blanks are held is made in four sections which may be loaded and unloaded independently of each other. As a result, the operator can load the first

section of the fixture and then engage the feed mechanism. Six blanks are mounted in each section of the fixture, and as the rate of feed is one inch per minute, this allows the operator six minutes in which to load the second section of the fixture. As a matter of fact, this is more time than he requires. After the last section of the fixture has been loaded, the operator goes around to the back of the machine and starts removing milled racks from the fixture, so that after the last rack comes out from under the cutters it is merely necessary to unload the last section of the fixture before the table is returned. This method of operating the machine not only reduces the idle time of the operator, but also effects a substantial reduction in the idle time of the machine. The fixture is of very simple design. Each of its four sections holds six blanks, and two sections are divided by a stop-bar *A*, against which the six pieces in each section are clamped. Set-screws *B* are carried in end bars *C*; and by tightening these set-screws, the rack blanks are clamped against opposite sides of the stop-bar *A*. The cutters are driven at a speed of 71 feet per minute, and the rate of feed employed is 1 inch per minute. On this operation, the rate of production attained is 60 racks per hour, which includes the time of loading and unloading the fixture.

Use of Milling Machine Vise as a String Fixture

At the works of the Studebaker Corporation, in Detroit, Mich., it is necessary to perform a slot milling operation in the brake-lever for the passenger car built by this company. The slot milled in these small levers must be located at an angle to the axis of the lever arm, and in order to provide for the convenient performance of this simple operation, it was found possible to utilize an ordinary milling machine vise. The work is done on a No. 3 LeBlond plain milling machine, and Fig. 9 shows a close view of the vise set on the table of this machine to provide for holding a

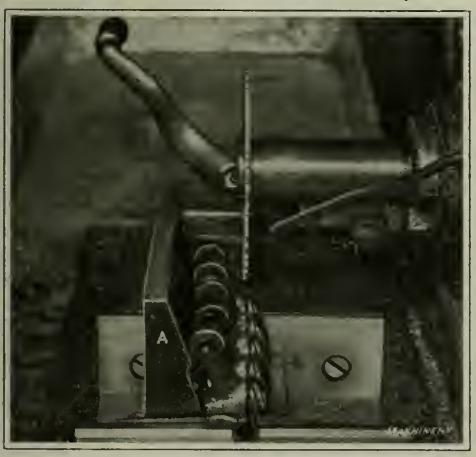


Fig. 9. R. K. LeBlond No. 3 Plain Milling Machine, used by the Studebaker Corporation for Slotting Operation on Brake-levers

string of five brake-levers. So far as clamping the work is concerned, the milling machine vise answers every requirement, but it is also necessary to locate the pieces of work at exactly the proper angle; and for this purpose, a block is bolted to the bed of the vise. This block has a face *A* that is inclined at such an angle to block *B* upon which the ends of the pieces of work rest that each piece is held at an angle which enables a slitting saw carried by the horizontal arbor in the machine spindle to cut the slot in exactly the proper position. It will, of course, be apparent that blocks *A* and *B* must be made short enough to allow the five pieces of work which are set up in the vise at a time to have a total length just exceeding the length of these five blocks. Consequently, when the movable jaw is tightened, the work is secured between the vise jaws, ready for milling. An advantageous feature of this method of holding the work is that five pieces may be set up and removed from the fixture in a very short time, the period required being only a half minute. The rate of production obtained is 75 milled brake-levers per hour.

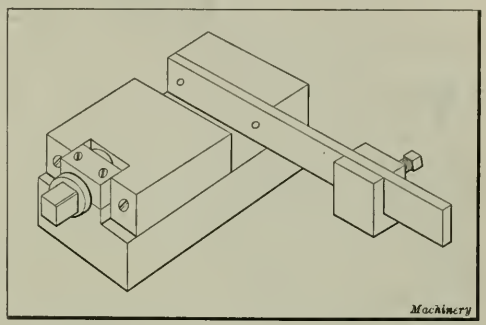
Additional examples of string milling fixtures will be illustrated and described in the December number of MACHINERY.

* * *

BROADENING THE SCOPE OF A MILLING MACHINE VISE

By DONALD A. HAMPSON

It is frequently necessary to perform milling operations on work that is not conveniently handled because the shop



Attachment for accurately setting Steel Bars to be milled

equipment is not adequate for the requirements of the work. Such a case occurred in a shop where it was required to finish a number of pieces of 3/4- by 2-inch cold-drawn bar steel to a length of 18 inches, within limits of 0.001 inch. The operation had to be performed on a machine that was too small to permit the pieces to be milled from the bar to the specified length, nor was the arbor long enough to permit the ends of the work to be straddle-milled, while the vise could hold but one piece at a time. Thus it was necessary to saw the pieces from the bar, allowing approximately 1/8 inch over length, finish one end of all the pieces with an end-mill or a side milling cutter, and finally finish the other ends with the same cutter. This case is typical of facing jobs where the parts are most easily held in a vise but where the vise cannot receive all of them at one loading, and where time can be saved and spoiled work avoided if some method can be devised other than the cut-and-try method, whereby all the work can be accurately machined to the same dimension.

The illustration shows the way the milling machine vise was rigged up in order to produce the work. A long jaw, which extended out from the machine was substituted for the regular standard jaw on the vise. The extended part carried a stop or gage, against which the work was held while tightening the vise. After one end of all the parts was finished, a piece of work of the correct length was used to set the stop the proper distance from the cutter, in order to finish the other end to the specified length. All of the pieces were then accurately milled to size. The same result could have been obtained by tapping a hole into the side of the vise and screwing a rod into this hole, on which the stop could have been mounted; but the practice of using regular machine parts in this manner is to be discouraged. For gaging work that is shorter than the width of the vise, a rod could be screwed into the inside of the stop, against which the work could be held. This device was inexpensive, and satisfactory results were obtained by its use.

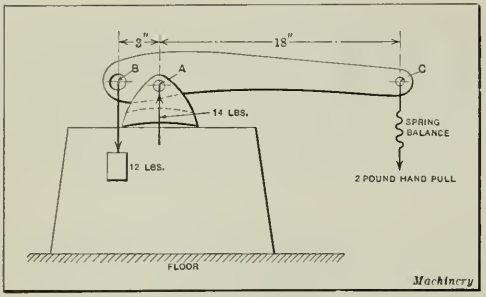


Fig. 1. Example of Simple Brake Lever maintained in Equilibrium by Known Forces

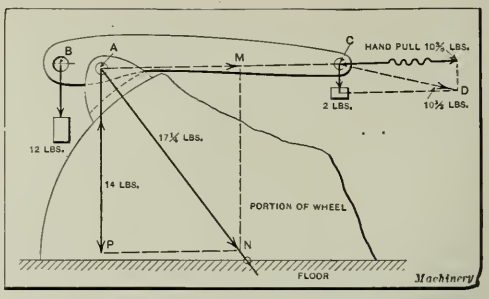


Fig. 2. Example showing Effect of Direction of Brake-shoe Pressure on Brake Rigging Design

Brake Lever Design

By VICTOR M. SUMMA, Engineering Examiner, American Brake Co., St. Louis, Mo.

WHILE the present article deals specifically with problems encountered in the design of brake levers and brake riggings for railway equipment, it nevertheless presents data and information which may be employed to advantage in designing brake levers intended for other purposes. Through some fault in design brake levers often fail to meet requirements satisfactorily, and it is the purpose of this article to present data which has been found useful in correcting mistakes frequently made when designing these parts. Before attempting to solve any practical problems, it is perhaps well to consider the theories and important principles involved in lever design. First, let it be assumed that the lever shown in Fig. 1 is made to balance itself at A; now apply a weight of 12 pounds at B, 3 inches from A. The pull of the spring balance at the point C—18 inches from A—is, of course, 2 pounds and the reaction at A, 14 pounds. While it is a well-known fact that these conditions obtain with brake levers arranged as shown in Fig. 1, the all-important principle back of it is not always followed when the levers are arranged as shown in Fig. 2. The reason for this may be that it is not thoroughly understood; therefore it is well to follow closely the simple experiment illustrated in Figs. 1 and 2 before attempting any further theoretical considerations. In reviewing the theoretical side of this problem, it is advisable to define the principle involved in terms of the following rule:

Rule—If a lever is in equilibrium, the moments of any two of the forces about the point of application of the third are equal and opposite.

Now bearing in mind that the moment of a force about a point is the product of the force and the perpendicular distance between the point and a line representing the direction in which the force acts, let the equation representing the moments about points A, B, and C of the lever shown in Fig. 3, be written as follows:

$$F \times a = R \times b = \text{moments about point } A$$
$$F \times g = Q \times e = \text{moments about point } B$$
$$Q \times f = R \times d = \text{moments about point } C$$

Now referring to Fig. 1, it will be seen that besides the well-known moments about point A, $12 \times 3 = 2 \times 18 = 36$, there are also two other identities to be considered, namely, the moments about points B and C. These may be written as follows:

$$2 \times 21 = 14 \times 3 = 42, \text{ moments about point } B$$
$$12 \times 21 = 14 \times 18 = 252, \text{ moments about point } C$$

The preceding is the analytical method of expressing the principle of the lever, but there is also a graphical method which may be defined by the following rule:

Rule—If a lever is in equilibrium and the forces acting on it are all in the same plane, the lines representing the direction in which the forces act will either meet at some point or they will be parallel with each other; these lines may represent both the magnitude and direction of the forces; also, the forces maintaining equilibrium in a simple lever such as shown at A, Fig. 4, may be represented by the so-called triangle of forces.

The simplicity of this method is shown by referring to Fig. 4. R and F in the illustration at A represent the two forces, while Q represents the reaction at the fulcrum pin. The triangle of forces shown at B is constructed by first drawing F_1 to some scale representing the magnitude and the direction of the force F; using this same scale, draw line R_1 representing force R. Now draw the line Q_1 connecting the ends of these two lines. The line Q_1 represents the magnitude and direction of the reaction Q. The preceding rules are simple, and may be easily remembered,

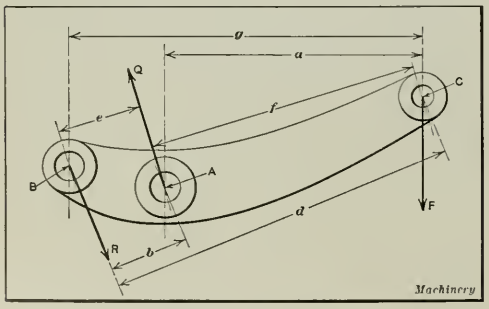


Fig. 3. Diagram illustrating Analytical Method of expressing Principle of the Lever

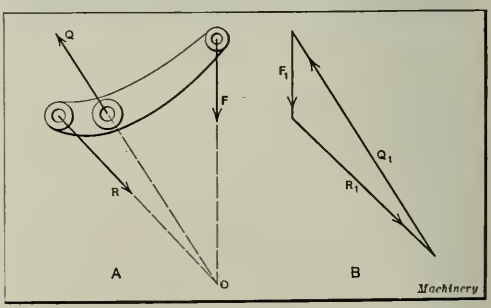


Fig. 4. Diagram illustrating Graphical Method of expressing Principle of the Lever

and are therefore to be preferred to the old-time rule which divides the levers into three distinct kinds or classes.

Bearing these essential rules in mind, we can now consider the problem illustrated by Fig. 2 which forms the main subject of the present investigation. In the arrangement shown, the 12-pound and the 2-pound weights are still required to keep the lever horizontal and perfectly balanced; the effect on the wheel, however, obviously is not the same as on the level block shown in Fig. 1. In order to prevent the lever and the shoe from sliding off the wheel, it is necessary to exert an additional pull at *C*. The spring balance will show a hand pull of approximately 10 3/8 pounds if the direction of pull is along the line *AC*, provided the surfaces of contact are sufficiently smooth. The pin *C* would therefore be subjected to a total load of 10 1/2 pounds, which is the resultant of the hand pull and the 2-pound weight; while the wheel itself would be subjected to a radial pressure in the direction indicated by line *AN* equal to 17 1/4 pounds, or the resultant of the 10 3/8-pound hand pull and the 14 pounds original pressure as given by the parallelogram of forces *MAPN*. By applying the two rules of graphics, namely, the principles of the concurrence of three balancing forces and that of the triangle of forces, these resultants can be arrived at more readily. This is shown in Fig. 5 where the forces converge in the point *O*

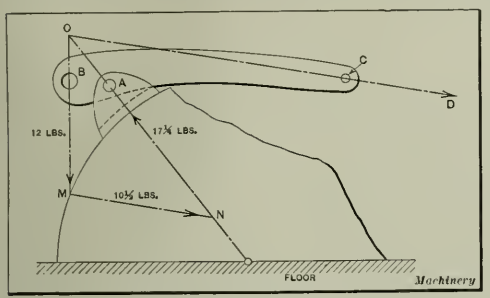


Fig. 5. Diagram illustrating Graphical Method of solving Problem shown in Fig. 2

and where the magnitude and direction of the unknown quantities may be determined by the sides of triangle *MON*.

In order to apply these rules properly, it is necessary to know the direction of the line *AN* representing the position of the shoe pressure. This is easily determined by an axiom which has been fully established in the study of mechanics, that is: *The mutual pressure between two bodies at rest acts along a common normal to their surfaces of contact.* Now for wheels and brake shoes this normal must necessarily pass through the center of the wheel. Therefore when railroad specifications call for a certain braking power, it should be universally understood that the required force is to be applied to the drivers in a radial direction. The specifications could not mean anything else, as otherwise the so-called braking power might not have the desired retarding effect on the drivers, for by simply changing the direction or the location of the pull-rods, it would be possible to obtain a wide variation in the actual braking force. From this it will be seen that specifications for the brake shown in Fig. 2 should not refer to the original 14-pound force but should specify the 17 1/4-pound radial pressure as indicated in Figs. 2 and 5. If care is not taken in this respect, skidding will result.

The actual driver brake rigging shown in Fig. 6 is materially the same as that given in Figs. 2 and 5 except that the effect of frictional force has been taken into consideration. Friction was purposely disregarded in the other problems in order to simplv the experiments. Now referring to illustration *L*, Fig. 6, it will be noticed that instead of the normal force *W* we have the new force *Q* or the resultant of the braking power required and the assumed shoe friction. The pin *C* is carrying, in the direction of line *OC*, a load equal to *MN*, represented by the side of the triangle *NOM* which is paralleled to *OC*. This load is not found by combining *f* with the 2-pound load as represented by *R* in the diagram at *H*, but resultant *R'*, represented in the diagram at *K*, gives the required value, being the resultant of the force *f* and the 10 1/2-pound force. When it is realized that the loads at *C* as determined by these rules show values more than twice those obtained by the methods of calculation frequently though erroneously employed, the importance of exercising care in designing brake levers will be more fully appreciated. The difficulties experienced with brake levers designed without taking into consideration the factors just dealt with may be summed up as follows:

1. Skidding of drivers, flat tires, loss of braking energy.
2. Lack of a common standard shoe pressure between brakes designed by private companies and railroads, which prevents an intelligent comparison of their experiences and investigations.
3. Hanger-lever top pins entirely too weak.
4. The production of a second bending moment on all return hanger levers besides the usual bending moment of plain flat levers, due to the upward pull at *C*.
5. Hanger lever brackets often too weak at the root of the projecting arm.

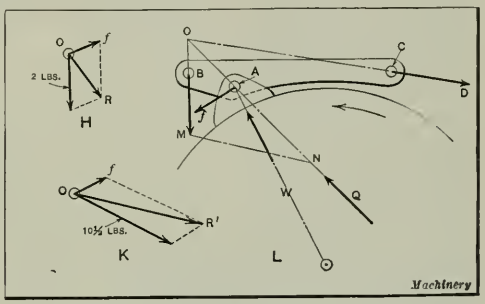


Fig. 6. Diagram illustrating Method of determining Effect of Frictional Force

6. Inadequate fastenings between hanger lever brackets and frame due to errors in calculating magnitude and direction of the force acting on pin *C*.

* * *

METHOD OF CLEANING COIL SPRINGS

By DONALD A. HAMPSON

A certain manufacturer who produces coil springs from copper-finished steel wire had considerable trouble in keeping them bright and free from oil. These springs are 2 inches long and have an extension at each end that projects at right angles to the axis of the spring. In the production of these springs, the use of a lubricant is imperative in the operation of the forming machine, which results in the presence of oil on the finished product. Unless this oil is removed, the bright copper finish of the wire becomes dull, and thus the selling qualities are lessened. This objection is now overcome by the method to be described.

The springs are packed in a wooden box having a removable cover. A 1-inch shaft passes through the box and is secured to its sides by flanged collars. The shaft is supported by a bearing on each side of the box, and carries a driving pulley on one end by means of which the box is revolved at the rate of forty revolutions per minute. After the box has been filled with springs, a quantity of sawdust is dumped in and the cover fastened on. By revolving the box for about twenty minutes, the sawdust is circulated through the springs, during which process the oil is completely absorbed and the springs are given a uniform polish. The springs tend to become tangled if the box is revolved longer than the time stated, or if the box is only partly filled.

Turret Lathe Practice

Examples of Turret Lathe Practice Based upon the Experience of the Gisholt Machine Co.
Third of a Series of Four Articles

By ERIK OBERG

IN the first two articles of this series, the machining of flywheels, auto truck wheels, tractor axle housings, wheel hubs, and motor frames was dealt with; in the present article tooling equipments and orders of operation for machining cylinders, piston rings, clutch cones, and miscellaneous parts will be described. The article on turret lathe practice in the January number of MACHINERY will deal with the machining of valves.

Fig. 1 shows the general outline of the cylinder for the Liberty truck engine, the heavy lines indicating the surfaces that are finished on the turret lathe. One operation only is required for finishing these surfaces, the tool lay-out for this operation being shown in Fig. 2, while Figs. 3 and 5 show the tooling equipment. Fig. 3 shows a complete view of the whole equipment, and Fig. 5 shows an expanding boring-bar for finishing the enlarged chamber in the bottom of the cylinder, just ready to enter the cylinder. The material from which the cylinder is made is a semi-steel casting. The step-by-step methods used in finishing this casting are as follows: (1) The work is held in a special fixture made to suit the casting, the general design of which is best seen from Fig. 5. This fixture, in turn, is bolted to the chuck of the machine. At the front part of the fixture there is a hinged arm that encloses the cylinder when it has been mounted in place. A pin or stud is inserted at the chuck end of the fixture which centers and locates the cylinder (see Fig. 2). The segment of cast iron shown at the top of the fixture in Figs. 2, 3, and 5 is simply provided to counterbalance the weight of the lower part of the fixture. (2) Surfaces *E*, *F*, *G*, *H*, and *I* (Fig. 2) are rough-machined with tools *K* and *L* in the toolpost. At the same time, bore *C* of the cylinder is rough-bored with cutters in a head on the boring-bar mounted in Side 1 of the turret. This bar is supported by means of a steadyrest, indicated in Fig. 2, having a bushing which fits the outside of the bushing *M* shown mounted on the bar. (3) The bore *C* of the cylinder is finished with a cutter held in the bar mounted in Side 2 of the turret, this bar being supported by the steadyrest in the same manner as the bar mounted in Side 1 for roughing the bore. (4) The bore *C* of the cylinder is reamed with the reamer mounted

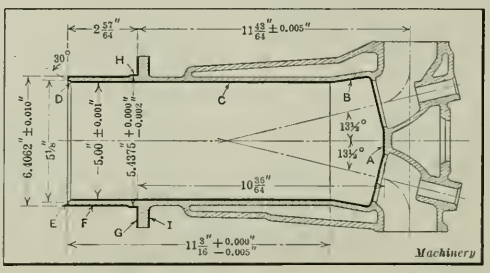


Fig. 1. Outline Section of Liberty Truck Engine Cylinder

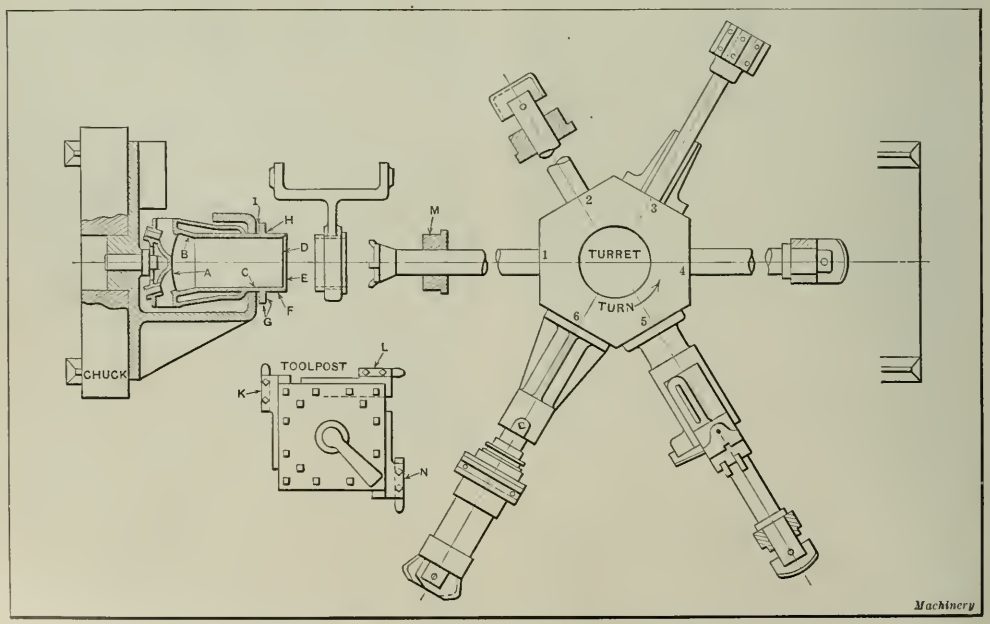


Fig. 2. Tool Lay-out for finishing Liberty Truck Engine Cylinder

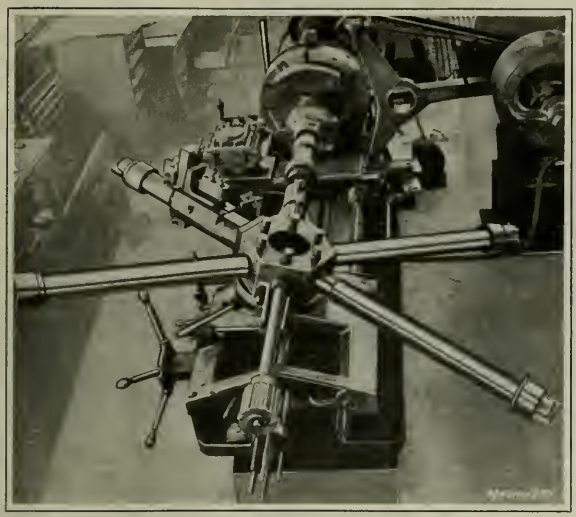


Fig. 3. Tooling Equipment for Engine Cylinder set up in Machine

in Side 3 of the turret. (5) The bottom *A* of the cylinder, or combustion chamber, is rough-faced with a cutter held in the bar mounted in Side 4 of the turret. This bar is provided with a bushing that is steadied by the bore of the cylinder itself while in action. (6) Surfaces *A*, *D*, *E*, *F*, *G*, and *H* are finished with cutters held in the facing head and bar mounted in Side 5 of the turret. (7) The bore of the cylinder, at *B*, is bored with cutters held in the bar in Side 6 of the turret. These cutters enlarge the bottom or dome of the cylinder; they are of the expansion type, so that after having entered the cylinder and reached the bottom, they may be spread, and thus machine the enlargement at the inner end of the cylinder. The bar is provided with a ball thrust collar which is connected with the cutters in such a manner that when the collar strikes the end *E* of the cylinder and the bar still continues to feed in, the cutters are caused to expand. This collar is clearly shown in Fig. 5. (8) The under side of the flange at *I* is finished with tools held in the holder *N* in the toolpost. The total time required for finishing the cylinder as outlined is 25 minutes, floor to floor time.

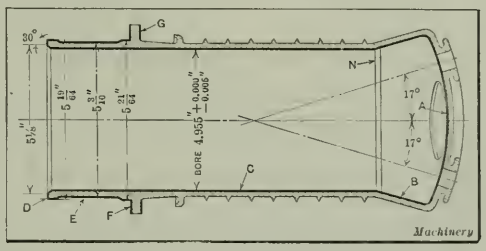


Fig. 4. Section of Liberty Airplane Engine Cylinder

Tooling for the Liberty Airplane Engine Cylinder

Fig. 4 shows a section of a Liberty airplane engine cylinder. This cylinder is made from a steel forging. It is finished in the turret lathe as indicated by the heavy black lines. Fig. 6 shows the tool lay-out, while Fig. 7 shows a view from above, indicating the arrangement of the tools and showing the expansion boring-bar, which is of the same type as that shown in Fig. 5. Fig. 8 shows a detail view, indicating how the cylinder is held in a special fixture.

The operations performed on the cylinder are as follows: (1) The cylinder is held in place in a fixture provided with special hard jaws, gripping it at the lower end; screws support it toward the outer end as indicated in Fig. 6. (2) Surfaces *D*, *E*, *F*, and *G* are rough-machined with tools *H* and *I* held in the toolpost. At the same time, the bore *C* is roughed out with the cutters held in the bar mounted in Side 1 of the turret. This bar is provided with a bushing which enters into a steadyrest supporting it while in action. This steadyrest is not shown in its working position in the illustrations Figs. 7 and 8. (3) Bore *C* of the cylinder, Fig. 6, is reamed with the reamer held in Side 2 of the turret. (4) The concave bottom *A* of the cylinder is roughed out with a cutter held in the bar mounted in Side 3 of the turret. This bar is supported, after it has entered the work, by a bushing guided by the previously reamed bore of the cylinder. (5) The bottom of the cylinder at *A* is finished with a cutter held in the bar mounted in Side 4 of the turret. This bar is supported in the same way as the bar used for roughing the cylinder bottom. A tool is also provided on this bar for finish-facing the end *D* of the cylinder. (6) The enlarged bore at the end of the cylinder, at *B*, is finished with an expanding cutter mounted in Side 5 of the turret. This cutter is expanded in the same manner as that shown in Fig. 2 and described in connection with the tool lay-outs and the operations for the Liberty truck cylinder. The total time required for the various steps in finishing the Liberty airplane engine cylinder shown in Fig. 4 is 30 minutes. The two examples of cylinder work shown indicate what can be done along this line on the turret lathe.

Fig. 9 illustrates a machine arranged for making concentric piston rings in the turret lathe. The casting from which the rings are made is clearly shown in Fig. 10, held in the chuck of the machine. The casting has a chucking flange at the rear end, cast solid with it, this flange being at an angle of 15 degrees, and the jaws of the chuck are bored to fit this flange. The work performed on the casting consists in boring, turning, and cutting off the rings. A special rear toolpost is used in this case, and a right- and left-hand feed-screw is provided passing through to the rear

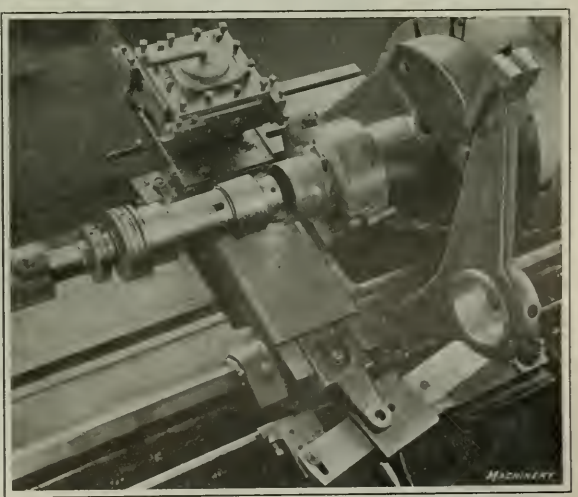


Fig. 5. Liberty Truck Engine Cylinder set up in Machine

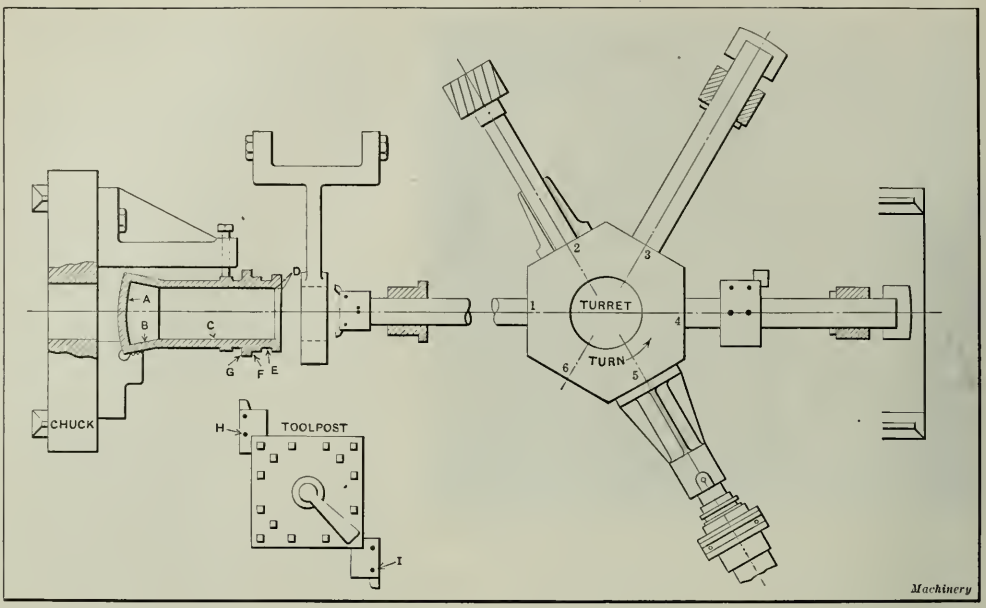


Fig. 6. Tooling Lay-out for Cylinder shown in Fig. 4

toolpost. By this arrangement it is possible to use both the front and rear toolposts for rough-turning, simultaneously. This arrangement balances the cut and prevents unequal strains on the castings, and it makes but one cut necessary, no finishing cut being required, as the rings must be re-turned after having been split and sprung together.

At the same time as the turning of the outside of the casting is being completed, a boring-bar with two cutters enters the bore. The end of this bar is supported in a bushing in the chuck. The boring head is of the adjustable type, so that one head will take care of several different sizes of bores; hence, a complete line of piston rings may be made with a comparatively small tool equipment.

The next step is to finish-bore the inside of the casting, after which a multiple cutting-off tool-block held in the front toolpost is brought into use. This multiple tool-block may be seen both in Figs. 9 and 10 on the outside of the toolpost, which is indexed to a working position before the multiple cutting-off tool is brought into action.

Machining a Clutch Cone Gear

Fig. 11 shows a clutch cone gear which is machined on all the surfaces indicated by heavy lines in the illustration. The work is performed in two operations, tooling equipment and the means for holding the work being shown in Fig. 13, for the first operation, and in Fig. 14 for the second operation. It will be noted that in the first operation the clutch cone is held by the large conical end next to the chuck, special chuck jaws bored to fit the outside tapered surface being employed. In this operation, the hub is faced, the hole is bored, and the front end and the outside of the gear are machined.

The clutch cone gear is then turned around and held as shown in Fig. 14, the machined outside circumference of the gear being gripped and the work held in position by soft jaws. The outside tapered surface of the clutch cone is rough- and finish-turned by tools held in the toolpost. The inside tapered surface is bored by a special taper-boring head illustrated in Fig. 15. The inside and the outside are bored and turned simultaneously as indicated in Fig. 14, where both the turret tools and the toolpost tools are shown in action.

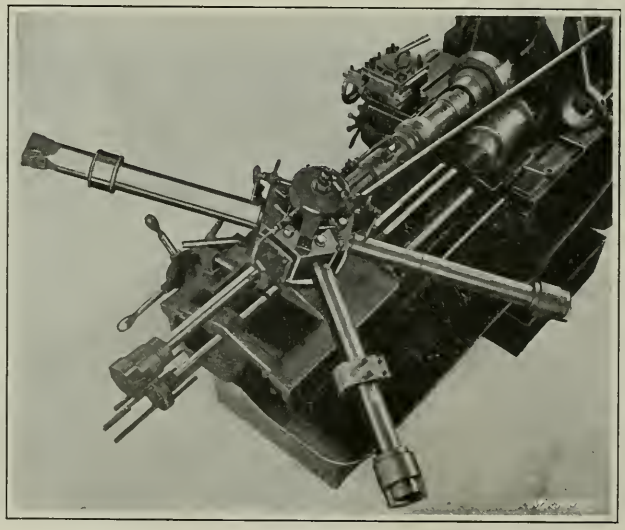


Fig. 7. View of Tooling Equipment for Cylinder shown in Fig. 4

In Fig. 15 a clutch cone part is shown in section in order to illustrate the action of the taper-boring head. The cone shown is of slightly different design from that illustrated in Fig. 11, but the principle of the action of the head is the same. The taper for the friction is bored with a single-point tool,

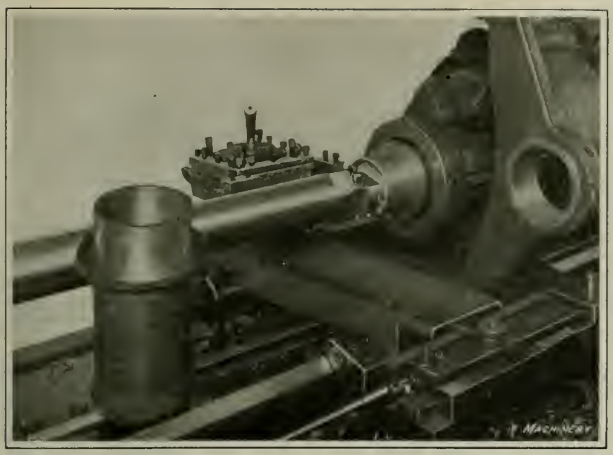


Fig. 8. Detail View showing Cylinder held in Special Fixture

properly guided in order to insure a correct angle. A pilot enters the bushing on which the clutch cone is centered, insuring that the friction cone will be concentric with the bore in the hub. A ball thrust bearing is provided at *A* which bears against the end of the bushing in the chuck and thereby prevents the pilot from entering further into the hole; by this means the tool is properly located with relation to the tapered surface. As the head is fed forward over the pilot, a pin resting against the angular surface *B* guides the tool in at the correct taper, the slide holding the tool being forced down by a spring as the head feeds inward.

In performing the second operation, the recess at *A* in Fig. 11 is cut with the tool held in the long tool-holder shown clamped in the toolpost at the front in Fig. 14. This recess must be finished in order to provide clearance for the tool in the taper-boring head mounted in the turret. The total time required for the first and second operations, completely finishing the clutch cone gear, is 60 minutes. The clutch cone is also finished on the turret lathe in the manner described in the following.

Machining the Clutch Cone

Fig. 12 shows a drawing of the clutch cone which fits the clutch cone gear shown in Fig. 11. This cone is finished on the surfaces indicated by heavy lines. The material is cast iron. The work is completed in two operations, Fig. 17 showing the method of chucking and the tooling equipment for the first operation, while Fig. 18 shows the set-up for the second operation.

In the first operation (Fig. 17), the clutch cone is held in the chuck by special chuck jaws which grip it on the inside at the small end of the taper. The outside of the clutch cone is then rough-and finish-turned with tools held in the toolpost, and at the same time the inside is rough- and finish-bored and reamed by the tools held in the turret.

In the second operation, the work is held by soft chuck jaws on the outside of the large end of the tapered surface, as shown in Fig. 18. The small end of the cone is then faced by a tool held in the toolpost, which completes the operations. The total time required for both operations is 25 minutes.

Machining a Tractor Driving Axle Arm

Fig. 16 shows an irregular piece machined on a 24-inch Gisholt turret lathe. The greatest difficulty in handling pieces of this kind is met with in deciding upon the proper holding and clamping means. This arm is machined as indicated by the heavy lines. The material is cast iron. In the first operation, a diagrammatical illustration of which is shown in Fig. 19, the work is held on a special angle-plate

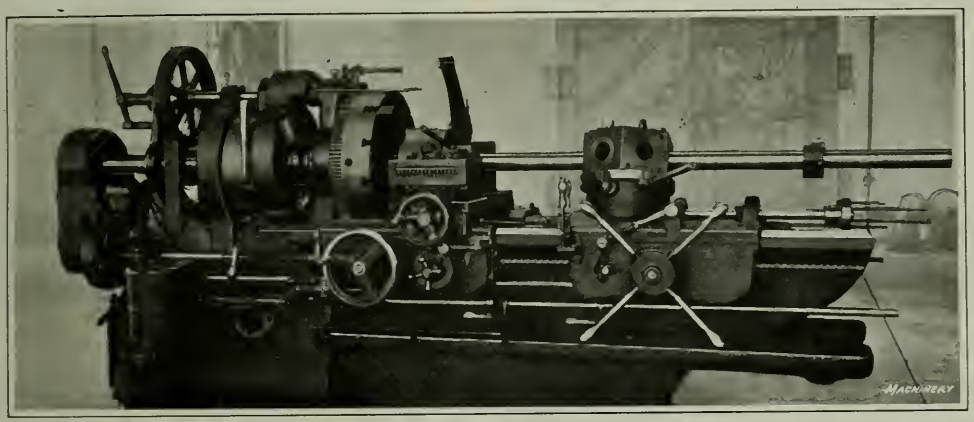


Fig. 9. Machine set up for making Concentric Piston Rings

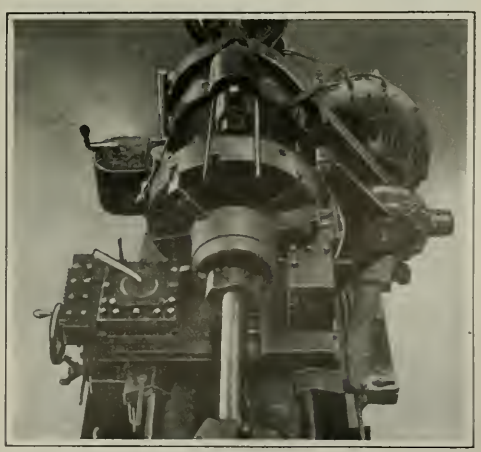


Fig. 10. Casting from which Piston Rings are made, held in Chuck

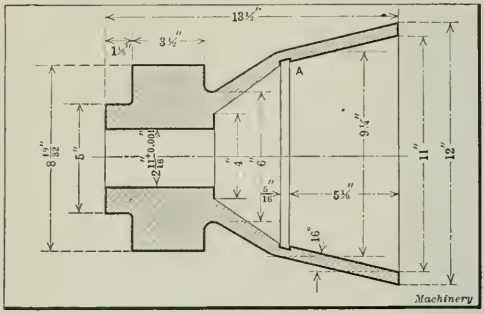


Fig. 11. Clutch Cone Gear to be finished in Turret Lathe

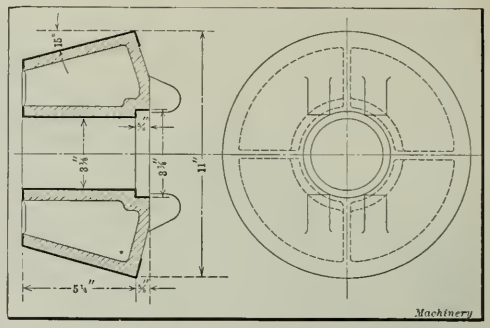


Fig. 12. Clutch Cone to be finished in Turret Lathe

in V-blocks, and rough- and finish-machined on the surfaces *A* and *B* with tools held in the toolpost. The time required for this operation is 9 minutes.

The second operation, the tooling lay-out of which is shown in Fig. 20, consists in boring the hole in the outward end of the arm and facing the flange, as well as facing the rear side of the hub at *E*. The step-by-step order of operations is as follows: (1) The work is placed in a special fixture, the main features of which are indicated in Fig. 21, and held by clamps forcing the finished bottom flange against the chuck plate. In addition, an auxiliary supporting clamp is used, steadying the arm near the end where it is machined. (2) Flange *C*, Fig. 20, is rough-faced with tool *F* in the toolpost. (3) Hole *D* is rough-bored with cutters held in a bar mounted in Side 1 of the turret. (4) Hole *D* is finish-bored by cutters held in a bar mounted in Side 3 of the turret. (5) Hole *D* is reamed with a reamer held in Side 5 of the turret. (6) Face *C* is finished with tool *G* in the toolpost. (7) The rear face *E* of the hub is faced with a tool held in the bar *H* mounted in the toolpost. This bar is clearly shown in the front of the toolpost, Fig. 21. The total time required for the second operation is 9 minutes.

As mentioned in a previous installment, the turret lathe is sometimes not kept fully busy on the work for which it has been procured and for which it is especially adapted.

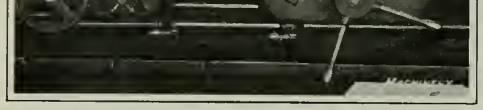


Fig. 13. Equipment for First Operation on Clutch Cone Gear

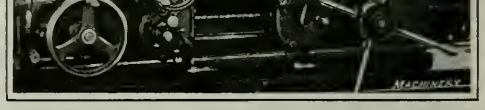


Fig. 14. Equipment for Second Operation on Clutch Cone Gear

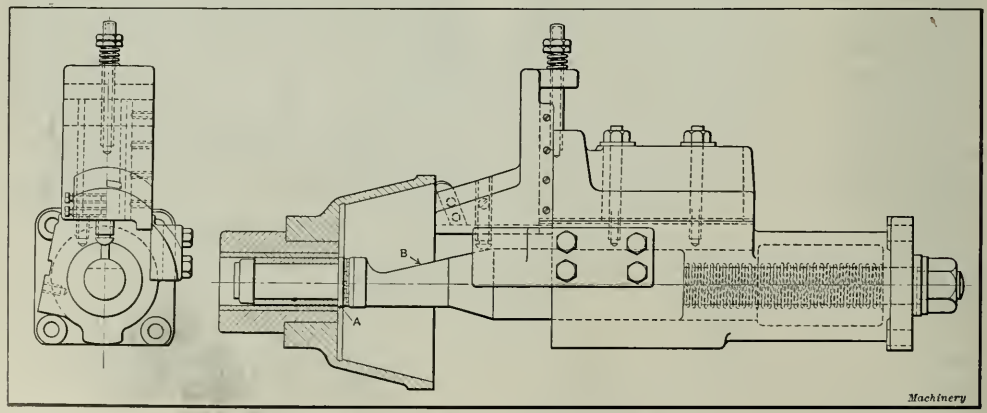


Fig. 15. Taper-boring Head for boring Clutch Cone Gear in Fig. 11

In cases of that kind, it is of advantage to use the turret lathe for other work for which the machine might not have been purchased, if there had been no other work to do, but which, when the machine is available, can be performed on the turret lathe more rapidly and, therefore, more cheaply than on other machine tools. An example of work of this kind is illustrated in Fig. 22, where the turret lathe is shown employed in facing the flange of a steam trap. Later operations include the drilling of holes in the same trap. The material is cast iron, and the work is performed in a 21-inch Gisholt turret lathe. The first operation, as illustrated in Fig. 22, simply consists in holding the steam trap by hard jaws supporting

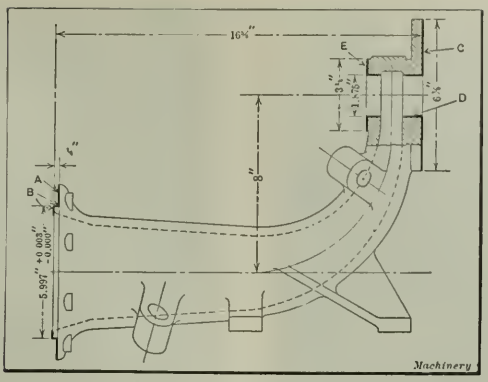


Fig. 16. Irregular Piece machined on the Turret Lathe

drilled and tapped at each end of the hub at the bottom of the trap. The tooling equipment of the turret lathe simply consists of a drill and a tap held in opposite faces of the turret. The work is mounted on an angle-plate fastened to the chuck, the steam trap being held on this plate by clamps bearing upon the flange. A counterweight is used on the chuck to balance the weight of the angle-plate and the trap. The hole is then drilled and tapped first from one side and then from the other. The total time required for the operation is 6 minutes.

The third operation is illustrated in Fig. 24, where a hole near the flange of the trap is drilled and tapped by a tooling equipment identical with that illustrated in Fig. 23. The

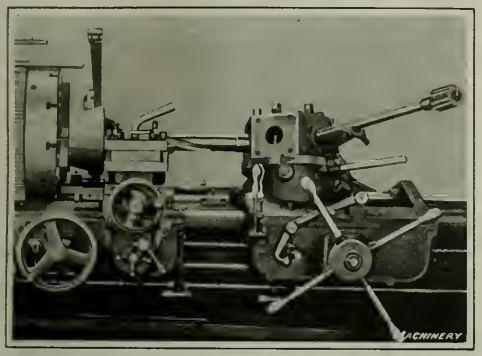


Fig. 17. First Operation on Clutch Cone shown in Fig. 12

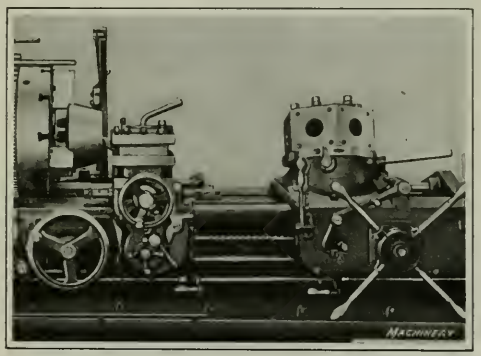


Fig. 18. Second Operation on Clutch Cone shown in Fig. 12

it at the rim of the flange, and then facing the flange with a tool held in the toolpost, as indicated. The time required for this operation is 3 minutes.

Fig. 23 shows the second operation, in which a hole is trap is held on an angle-plate with clamps, the same as in Fig. 23, but no counterweight is required in this instance, because the top part of the trap projects beyond the center of rotation and balances the angle-plate. The clamping,

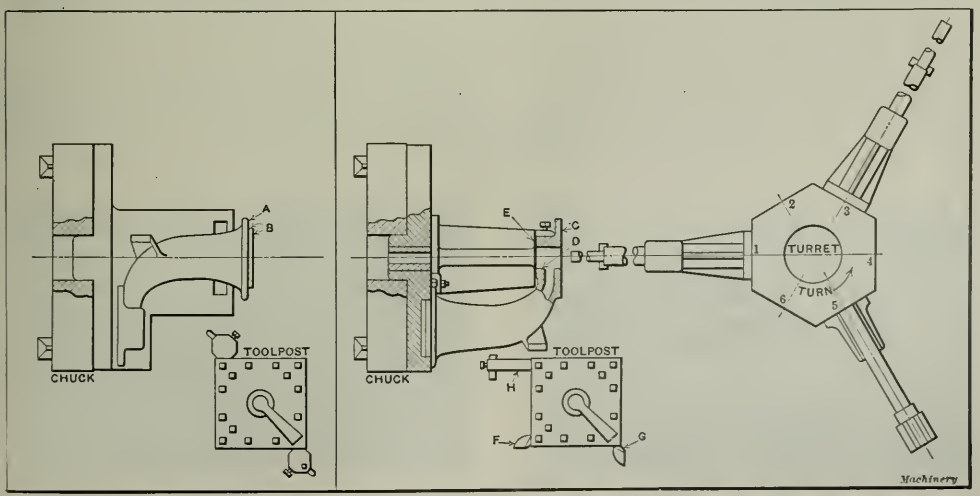


Fig. 19. First Operation on Piece (Fig. 16)

Fig. 20. Second Operation on Irregular Piece in Fig. 16

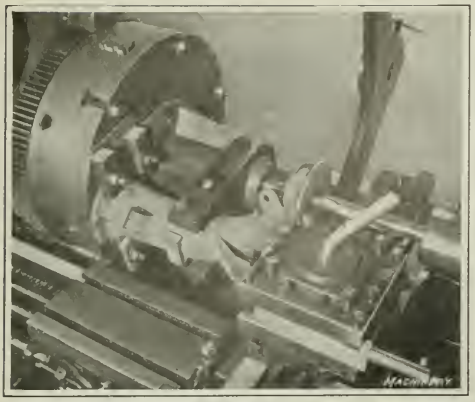


Fig. 21. Holding Piece (Fig. 16) for Second Operation

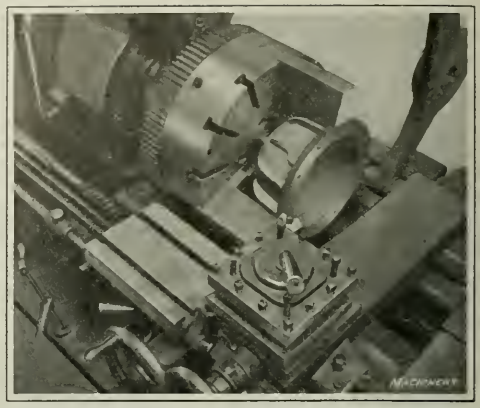


Fig. 22. First Operation on a Steam Trap—Facing the Flange

drilling, tapping, and removal of the trap from the machine requires a total time of 3 minutes.

Figs. 25 to 28 show similar odd operations performed on a steam trap cover the material of which is also cast iron. In this case, the first operation illustrated in Fig. 27 consists in facing the flange of the cover with a tool held in the toolpost, the cover being held by hard jaws as shown. The total time for the first operation is 3 minutes.

The second operation, the tooling lay-out for which is shown in Figs. 25 and 28, consists of five steps as follows: (1) Chuck the work by special eccentric jaws, holding it by the outside rim, as indicated in the illustrations. (2) Rough the boss *C* with tool *F* held in the toolpost. (3) Finish the boss *C* with tool *G* held in the toolpost. (4) Drill hole *D* with the drill held in Side 1 of the turret. (5) Tap hole *D* with the tap held in Side 4 of the turret. The total time required for the second operation is 6 minutes.



Fig. 23. Drilling and Tapping Hole in Steam Trap



Fig. 24. Another Drilling and Tapping Operation on Steam Trap

The third operation consists simply in drilling and tapping a hole in the cover, as indicated in Fig. 26. The cover is held on an angle-plate by clamps as shown, a counterweight being used on the chuck to balance the weight of the angle-plate. The time required is 4 minutes.

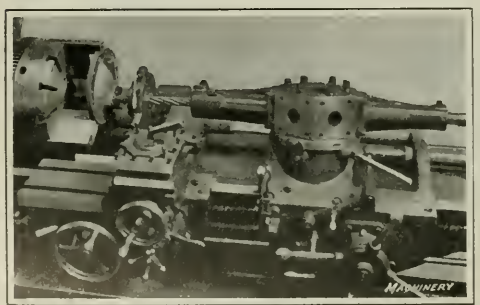


Fig. 25. Equipment for Second Operation on Steam Trap Cover

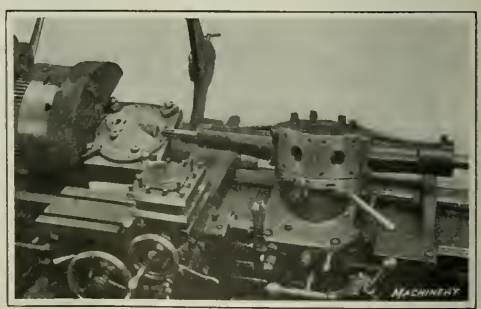


Fig. 26. Equipment for Third Operation on Steam Trap Cover



Fig. 27. Facing the Flange of a Steam Trap Cover

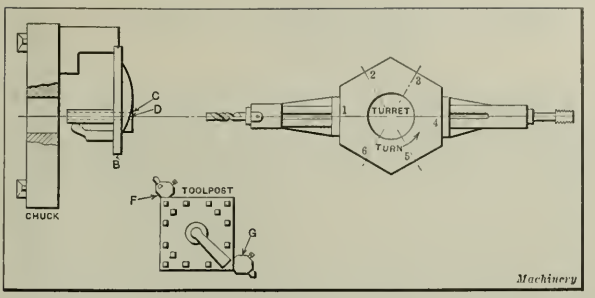


Fig. 28. Tooling Lay-out for Second Operation on Steam Trap Cover

STORAGE AND HANDLING OF OILS

All petroleum products, including lubricating oil, throw off an explosive vapor. Gasoline is more dangerous to handle than dynamite, as with it there is more likelihood of an explosion. With lubricating oils, however, the danger is chiefly caused from spontaneous combustion, where waste, sawdust, or shavings are used to absorb the oil spilled on the floors. It is a common mistake to neglect the accumulated refuse which in time bursts into flame. Paint oils, such as linseed oil and turpentine, should also be carefully handled. A piece of cotton waste saturated lightly with equal parts of linseed oil and turpentine will burn from spontaneous combustion in about three hours' time if left in a closed room.

Aside from the growing danger to life and property caused by carelessness in handling and storing oils, the increasing prices of all kinds of oil products should be given serious consideration. Much money is lost annually from deterioration of quality and from waste in handling oils. Over-heating of bearings can frequently be traced to deteriorated or contaminated oils. The trouble is usually traceable to poor oil-storage.

Modern storage equipment for handling liquids of this type is divided into two general types. For storing volatile liquids such as gasoline or naphtha, underground tanks should be used. They should be cylindrical in shape, and if made of galvanized steel, all seams and rivets should be carefully made and soldered. If heavy metal is required for the tank, all seams and rivets should be carefully calked. Storage tanks for all volatile liquids require special care in construction, and tanks that hold water or steam-pressure are usually unfit for storing volatile liquids.

Above-ground tanks for lubricating oils are usually made in rectangular shape, a good practice being to maintain a constant height and length and to vary the width according to the desired capacity. This arrangement permits the addition of other units to the system and does not destroy the uniformity of the battery of storage equipment. Rectangular tanks should, of course, be made with the same care as those of cylindrical design.

Specially designed pumps of either measuring or non-measuring type are connected to underground tanks or inserted in the top of rectangular tanks. Gear-driven meters may be included for the purpose of checking the consumption. As a means of preventing unauthorized usage and a precaution against theft, locks should be supplied on both tanks and pumps. Where a battery of individual tank units is used, a barrel track and barrel drainers may be used in connection with smll chain hoists. This facilitates handling the barrels and enables them to be drained completely into the tank, which results in a considerable saving of labor and time, and also prevents loss due to the barrels not being properly drained. An arrangement of this kind will result in the exclusion of dirt, dust, and sediment, and also eliminate the danger of fire. This method furnishes a means for determining the rate at which the oil is consumed.

"LIBERTY FUEL"

The United States Fuel Administration, having received many requests for information concerning aviation fuel called "Liberty fuel," has made public the results of various investigations concerning its composition, the available supply of ingredients, and its efficiency. Tests made in the aeronautic laboratories of the United States Army and placed at the disposal of the Fuel Administration resulted in information that the fuel was made up of "approximately 65 per cent of benzol; 25 to 30 per cent of kerosene; and the remainder of a small percentage of amyl acetate and probably naphthalene and alcohol, together with, perhaps, small quantities of dissolved solids, and other volatile liquids as yet undetermined."

In this analysis the available supply of the fuel must depend on the amount of benzol, its chief constituent, that is obtainable. Investigation in this direction showed that if the total production of benzol (3500 barrels a day) were so used, the total production of Liberty fuel would be about 2 per cent of the present output of gasoline, which is approximately 90,000,000 barrels a year. Benzol, however, has other uses, notably in grease extraction and as a solvent for rubber.

A gumming and corrosion test, also conducted in the aeronautic laboratories of the Army, showed no perceptible corrosion, but "a tremendous amount of gumming—0.4 per cent, accompanied by extensive fuming and a penetrating odor." The tendency of the gummy residue in the fuel would be to plug up carbureters. In the same Army laboratory test, crystallization was found to set in at 18 degrees F. and to be "practically complete" at 15 degrees F. Boiling started at 175 degrees F., as against an initial boiling point of not more than 140 degrees for engine gasoline, which was an indication that the latter possessed better starting qualities.

According to the Bureau of Standards, the results of tests in an aviation engine indicated that Liberty fuel, compared with gasoline fulfilling the specifications for aviation gasoline, will, when consuming 10 per cent greater weight of fuel per horsepower-hour, develop about 3 per cent greater horsepower. The spark-plug used in Liberty fuel showed a slightly greater carbon deposit than the plugs used in the run of export gasoline.

Information furnished the Fuel Administration by the Navy Department states that a flight of 40 minutes was made with the fuel, and that "no observations were made which show that the fuel would accomplish any other results than to operate the engine in a manner similar to the aviation fuel which had been used." Arrangements were made, the Navy Department reports, for sufficient quantities of the fuel to make full tests, but the fuel was not supplied. A letter from Benedict Crowell, Assistant Secretary of War, states: "The situation has not reached such a stage that this office feels that any definite announcement can be made, or that it can express a definite opinion as to the fuel's true merits."

SUGGESTED IMPROVEMENTS IN MACHINE TOOL DESIGN

By CHARLES A. TRASK

Belt speeds of most lathes, especially those employing cone drives are, in the writer's opinion, too slow. Now that many makers are building the headstocks of their lathes with the front and rear spindle bearings tied together by a web reaching from about the center line to the bed, there seems to be no reason why the diameter of the cone cannot be nearly as large as the full swing of the lathe. Well-known authorities agree that the most efficient belt speed is approximately 4500 feet per minute. As a belt running at this speed will burn the hand, it is obvious that a shifter would be required to change speeds on a cone-driven lathe if this belt speed were employed. Good belt shifters for use on cone drives are available, but whether or not a shifter is used, there is one change in the cone design which would greatly improve this type of lathe. This change consists in adding one step to the smaller end of the lathe cone so that this cone would have one more step than the countershaft cone.

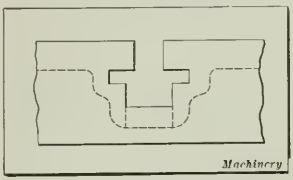


Fig. 1. Improved Form of T-slot for Drilling Machine Tables

It is not unusual to see work in a lathe running at about half the correct speed with the belt on the smallest step but one; this practice is followed because of the inconvenience of removing the belt from the smallest pulley when the work is completed. If there were an extra and smaller step on the lower cone, the operator could easily obtain sufficient slack to enable him to easily throw the belt on and off the largest step on the countershaft cone.

Now let us consider the speed of overhead belts. In circulars recently issued by ten well-known lathe builders, the specifications call for an average overhead belt speed of approximately 710 feet per minute. If the most efficient belt speed is approximately 4500 feet per minute, why should not the overhead belt speed be increased? In this connection, the writer cites the following instance in which 36-inch tight and loose pulleys were put on some lathe countershafts in place of 16-inch pulleys. Before this change was made, 6-inch belts were used at 1250 feet per minute. After installing the larger pulleys, only 3-inch belts were needed which ran at 2825 feet per minute. The former friction load on the hanger boxes was cut in two by this change, the 3-inch belts cost only half as much, and less power is now required.

Balancing Handwheels and Pulleys

Handwheels on tailstock and cross-slide screws should be carefully balanced, especially the former. Many a piece of work has been injured or spoiled by the tailstock screw backing up part of a turn due to lack of balance in the handwheel. Pulleys, gears, cones, etc., that revolve at any considerable speed should be balanced, and should not be put in operation until tests show them to be in perfect running balance. Recently two light drilling machines and two 16-inch lathes were purchased. The standing balance of all the cones on these machines was obtained by riveting a weight inside the largest step, which had been bored true with the holes, thus insuring reasonably accurate balance at this point before the weight was applied. In the case of the first drilling machine to be started, the running balance was very bad and threatened to tear the countershaft bracket off the column. The cone was removed and upon testing it was found to be in perfect static balance. The balance weight was removed and placed on the thin side of the cone about midway between the two ends. The cone was then replaced and the machine ran with but little vibration. The other machines were dealt with in the same way.

Tailstock Fastenings

Except for casting ratchet teeth in the beds of some types of large lathes, and providing a dog or a pawl on the under side of the tailstock which engages the ratchet teeth, little or no improvement in tailstock fastenings has been made in recent years. As a rule, bolts with hexagon nuts, many of which are located in more or less inaccessible positions, are still used to fasten the tailstock. A lathe manufacturer brought out a tailstock about thirty years ago that was held down by a 1-inch stud which screwed into the bottom of the tailstock base. Keyed to this stud was an eccentric gear, which was very eccentric. Under the rear end of the spindle, a handle was keyed to a short vertical shaft on the lower end of which was keyed another eccentric gear which mated with the gear on the stud. In the writer's opinion, this arrangement was the nearest approach to the ideal which he has ever seen. The lever or handle was always in place. One movement locked the tailstock securely, as the leverage through the eccentric gears was 2 or 3 to 1 in the operator's favor at the tightening position of the lever.

T-slots in the drilling machine table are a source of trouble to every machinist. Many of these troubles can be eliminated by providing drill tables with T-slots of the shape indicated in Fig. 1. In this form of slot, a common bolt and two common washers can be used so that it is unnecessary for the blacksmith to make up a lot of bolts with special heads. There should be one or two cored holes passing entirely through the bottom of the bolt slot as shown by the vertical dotted lines. These holes will let the chips fall through when the bolts are slid in place. Machinists will appreciate this feature, as they usually find it necessary to employ a slot scraper before attempting to insert the bolts in their required positions.

Counterweights for Drilling Machine Spindles

Another element of importance in drilling machine design which deserves considerable attention is the method of counterbalancing the spindle. It should be remembered that a drill chuck or tapping device is usually attached to the lower end of the spindle—therefore the counterweight should weigh a little more than the spindle and its sleeve instead of a little less as is the usual case. Counterweight chains are frequently too light, their size and wearing qualities being inadequate to meet requirements. These chains frequently break and the man in charge of the drilling department is all too often required to take out the foundation bolts and lay the drill on the floor, to repair broken chains.

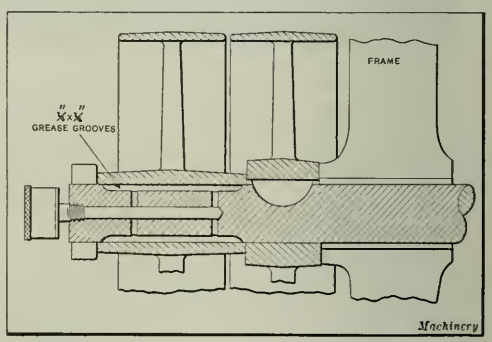


Fig. 2. Method of lubricating Loose Pulley on Drilling Machines

The writer has noted that with very few exceptions upright drilling machines have their tight and loose pulleys

outside the main frame bearing, and in nearly every case, the loose pulley is next to the bearing. This throws the strain from the belt pull, when the machine is running, farther away from the shaft bearing, thus placing a considerably greater strain on this bearing than if the loose pulley were on the outside. To change this arrangement so as to allow the tight pulley to be located next to the bearing, would, of course, necessitate the use of a set-collar to retain the loose pulley in position. This would add very little to the expense, however, and the writer sees no reason why this more logical arrangement should not be adopted.

Then again, most drilling machines should be provided with more efficient means of oiling the loose pulley. An ordinary oil-hole through the pulley hub is not sufficient, and trouble will develop if no other means of lubrication is provided. The writer has in mind an instance in which a machine was used for work that required a reasonably tight belt; in two years the loose pulley and shaft were removed six times. Each time the shaft and pulley were removed a new bushing had to be inserted in the pulley and the old shaft replaced by a new one. Finally a shaft was made as shown in Fig. 2. This shaft has been in operation for three years, and it seems to be in perfect condition at the present time.

* * *

INDIVIDUAL BENCHES FOR TOOLMAKERS

The manner in which toolmakers' benches are installed in the new factory of the Twin-O-Matic Machine & Tool Co., Brooklyn, N. Y., is shown in the accompanying illustration. These benches are about 4½ feet long by 3 feet wide, are spaced about 4 feet apart, and are located at right angles to the windows. It is claimed that this method of installation has a number of advantages over the usual long continuous type of bench which is set parallel to the windows. The men interfere less with each other and thus both the production and the accuracy of the work are increased. The comfort of working for each man is also increased. He has all his tools on a bench all to himself, he can arrange his work and his equipment to suit himself without fear of encroaching upon the space required by his fellow-workers, and he feels altogether more free to carry on his work to the best advantage to himself and the job in hand. He also has better light, as he does not face the window, but receives illumination from the side, which for most classes of work will be found more advantageous. The arrangement has been found satisfactory in all respects.

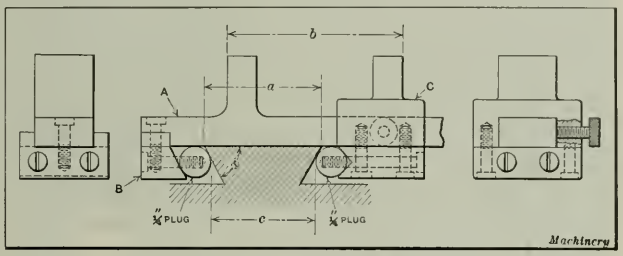


View of Toolmaking Department, showing Individual Benches

GAGE FOR MEASURING DOVETAIL TONGUES

By JOHN T. CLARK

The illustration shows a gage designed for measuring dovetail tongues. It consists essentially of a beam A, a stationary block B, and a sliding block C. The block B is secured to the end of beam A by machine screws, while block C may be moved along the beam in order to measure any tongue within the capacity of the gage. A 1/4-inch measuring plug is secured to each block, which bears against the angular surface of the tongue when a measurement is being taken. A measuring point is provided on both the beam and the sliding block to permit a micrometer reading of the dimension b. The measuring points were located so that dimension b would equal dimension $a + 0.500$ inch when angle x was equal to 60 degrees, so that, if on a 60-degree tongue dimension b measured 3.500 inches, dimension a would equal $3.500 - 0.500 = 3$ inches. Locating the measuring points in this manner, permits the plugs to come close together so that narrow tongues may be measured.



Method of using Dovetail Tongue Gage

It is obvious that subtracting 0.500 inch from dimension b will give dimension a only when angle x equals 60 degrees. If dimension a is retained and angle x decreased, dimensions c and b will also decrease. Thus, in calculating dimension a it is necessary to add a certain quantity to dimension b before subtracting 0.500 inch, when angle x is less than 60 degrees. When angle x is greater than 60 degrees it is necessary to subtract a certain quantity from dimension b before subtracting 0.500 inch. The constants which must be subtracted from dimension b when measuring tongues having various angles are given in the accompanying table:

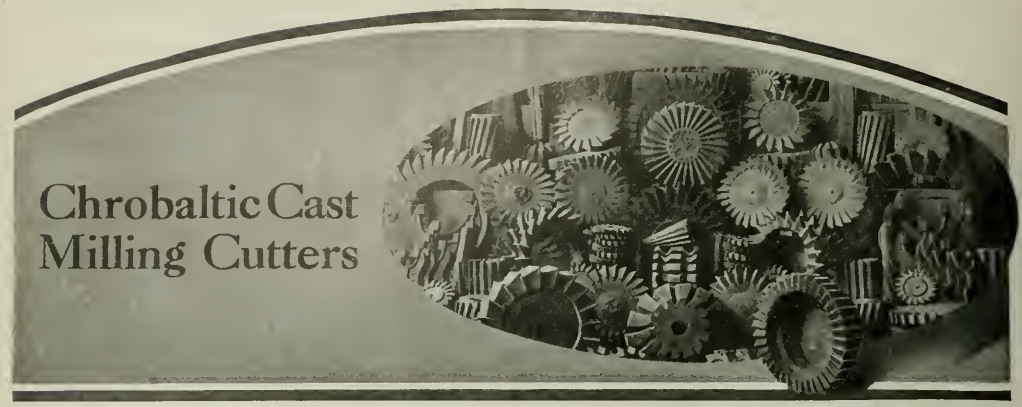
CONSTANTS WHICH MUST BE DEDUCTED FROM DIMENSION b TO FIND DIMENSION a

Angle x, Degrees	Amount to be Deducted for Various Angles, Inches
60	0.500
55	0.500 — 0.0142
50	0.500 — 0.0276
45	0.500 — 0.0406
40	0.500 — 0.0534
35	0.500 — 0.0654
30	0.500 — 0.0774

The following problem illustrates the use of the table: On a dovetail tongue where angle x is 45 degrees and dimension b measures 3.959 inches, dimension a would equal $3.959 - (0.500 - 0.0406) = 3.5$ inches.

* * *

In a rigid airship structure, it is said that there are 20,000 different parts, not including the machinery, and, in addition, 2,000,000 rivets. The total length of the structure material is 20 miles, and the length of wire, 60 miles.



Chrobaltic Cast Milling Cutters

Methods Used in Casting Milling Cutters from a Chromium-Cobalt Alloy Steel

By EDWARD K. HAMMOND

DURING the period of intense industrial activity which existed in Great Britain from the outbreak of war in 1914 until the armistice was signed, difficulty was experienced in obtaining the necessary supply of high-speed steel milling cutters and similar tools. The inadequate supply of tungsten for use in making high-speed steel was mainly responsible for this tool shortage. Obviously, the situation demanded immediate action, and a partial solution of the problem was finally worked out by Darwin & Milner, Ltd., of Sheffield, who developed an alloy of chromium and cobalt which possesses the necessary physical and thermal properties to enable it to serve as a substitute for tungsten high-speed steel, in addition to which the metal may be cast to shape. The castings have a remarkable degree of strength and density of structure, and when properly made are free from blow-holes. Owing to the fact that castings of high quality could be made from this alloy, it was found possible to cast milling cutters and other multiple-edged tools to the desired shape and size, so that very little subsequent machine work was needed to convert the castings into finished tools. This was the means of saving a great deal of labor and expense in toolmaking. In addition to the application of this chromium-cobalt alloy for making cutting tools, it is well suited for making blanking, punching, and drawing dies, and various kinds of gages, as the alloy possesses a high degree of resistance to abrasion.

How the Process was Developed

While this method of toolmaking was developed as a war-time measure, its extensive application was considerably retarded by the restrictions placed upon all classes of industry that did not have a direct bearing upon the production of military supplies. But the economies made possible through casting tools to a shape closely approximating the desired form, instead of requiring high-priced mechanics to spend long periods of time in machining them from solid blanks, represents such a signal advantage, that this method of toolmaking is now being developed on a commercial basis by the Chrobaltic Tool Co., which is a subsidiary of the Rich Tool Co., Railway Exchange Bldg., Chicago, Ill. This firm

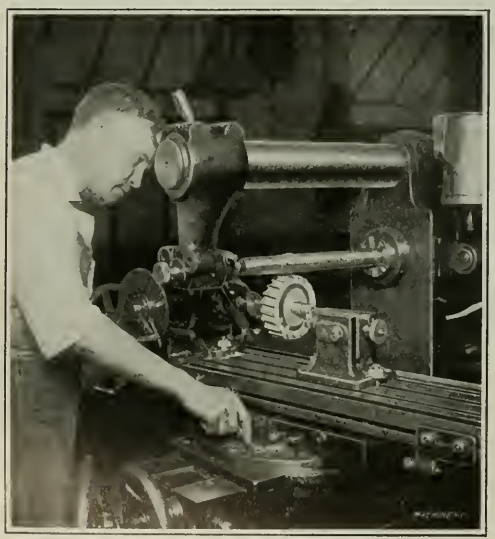


Fig. 1. Machining the Teeth in an Aluminum Milling Cutter Pattern



Fig. 2. Stripping Plate Machine making Plain Milling Cutter Molds



Fig. 3. Drying the Molds with a Torch Flame before They are closed

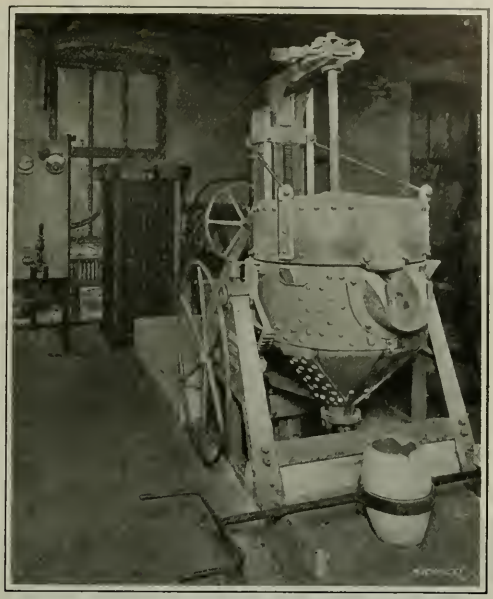


Fig. 4. Electric Furnace in which Chrobaltic Alloy is melted

is operating under a license to use the Darwin & Milner patent in the United States.

The following article explains how cast tools are made and gives information relating to the way that they stand up under actual conditions of service. Before entering upon this discussion however, it may be of interest to make mention of one or two other advantages claimed for cast tools.

Economies Resulting From Casting Milling Cutters and Other Tools

During the war an inadequate supply of tungsten was responsible for the development of the alloy from which chrobaltic tools are made, but under normal conditions of industry there is an adequate supply of this constituent of high-speed tool steel. Consequently, if cast milling cutters and other tools are to be sold in successful competition with high-speed tools made by the usual methods of manufacture, they must be of equal quality and have some advantage which will lead buyers to change over from tools made by an old and established method which is known to be satisfactory. In the case of cast tools, this advantage is stated to be a greater degree of economy, both in conducting the process of manufacture and in utilizing the scrap metal after the tools are worn out. In one case, in making milling cutters of the same size from high-speed steel and chrobaltic alloy, respectively, the time required to make the cast tools was only 27 per cent of that required to complete high-speed steel cutters by the usual tool-room method. Such



Fig. 5. A Corner of the Foundry, showing One Row of Molds closed and Ready to be Poured, and a Second Row Open, that have just been dried with a Torch Flame

a saving of labor is in itself significant, but does not represent the complete economy which is effected by this method of manufacture.

When a cutter is machined from a solid blank of high-speed steel, there is obviously a large amount of wastage resulting from the removal of metal from the bore, from the spaces between the teeth and from clearance spaces which are machined at each end of the cutter between the hub and teeth. With a cast cutter practically all of this waste of expensive steel is eliminated. In the case of the two cutters to which reference has been made, five pounds of chrobaltic alloy made a cutter of the same size as that which was machined from a high-speed steel blank that had an original weight of ten pounds, the cost per pound of these two materials being the same. Furthermore, when the cast cutter is worn out, the residual metal can be returned to the tool manufacturer, melted up and recast into tools of exactly as good quality as those produced from material that has not previously been used in the machine shop. With high-speed steel, while the scrap metal is valuable, it cannot be used again before subjecting the steel to a special metallurgical treatment in connection with the melting.

Cast tools may either be completely finished and supplied to the customer hardened and ground ready for use, or

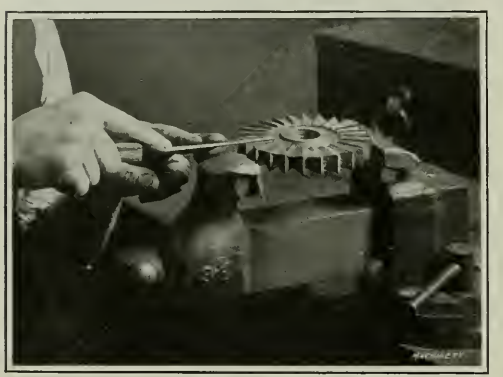


Fig. 6. Removing Slight Surface Defects from Casting with a File

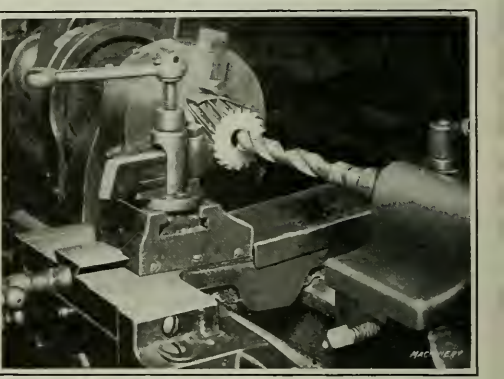


Fig. 7. Boring the Arbor Hole and facing the End of the Cutter

castings will be delivered annealed, ready to be machined to exactly the required size, after which they will be hardened and ground in the usual way. It is important to note that tools made of this material may be annealed and rehardened without detriment to the physical properties of the metal. Also they show very little tendency to rust and possess a high resistance against heat, which is important both from the standpoint of allowing the tools to be operated at high cutting speeds and heavy feeds, and to provide for hardening delicate forms of milling cutters and other tools without impairing their quality. The metal does not distort appreciably during the process of heat-treating.

From the preceding description it will be clear that tools made by the process of manufacture employed by the Chrobaltic Tool Co. are cast from molten metal. Such being the case it is obvious that patterns must be provided for use in making the molds. Where a considerable number of tools of a given type and size are to be cast, the usual practice is to make a metal pattern for use in the foundry; and after the blank for such a pattern has been turned up on the lathe, most of the subsequent work can be handled on a universal milling machine, as illustrated in Fig. 1. In machining the pattern, an allowance must be made for the shrinkage which occurs when molten steel solidifies; and it is also necessary to provide from one-sixteenth to one-eighth inch of metal on all surfaces that are to be subsequently machined, so that there is assurance that the casting will "clean up" properly. In some cases it is found possible to use a finished steel tool as a pattern, where only a few castings are to be made.

Application of "Multiple-purpose" Patterns

Another economy in regard to the use of patterns consists of the employment of a single pattern for making a number of tools of various widths. For instance, consider the case of plain milling cutters, of which a variety of face widths are likely to be ordered in the same diameter. The expense of making a series of patterns to cover such requirements would represent quite a heavy overhead burden; and there would be an additional item of expense in storing these patterns and finding the proper one when it was required for use. Such difficulty is completely overcome by making a single pattern of the maximum face width, and using this pattern on a stripping plate machine built by the Cleveland Osborn Mfg. Co., Inc., of Cleveland, Ohio. A machine of this type is shown in operation in Fig. 2, a small portion of the plain milling cutter pattern *A* being shown projecting both above and below the ramming plate at the top of the machine. In using a stripping plate machine of this type, the cope of the mold is dropped into place over guide pins *B* and with the pattern raised to its maximum height above the ramming plate, the molder proceeds to pack the sand into place in the cope of the mold. He then swings lever *C* to provide for drawing the pattern down through the ramming plate. On this plate there is a guide which exactly fits the pattern, and in the case of a spiral tooth plain milling cutter the withdrawal of the pattern from the mold consists of a combined downward and rotary movement. Were it not for this combination of motions, the pattern could not be withdrawn from the mold without destroying it. Mention has already been made of the fact that a single pattern can often be used for making a number of castings of different face widths. This result is accomplished by means of an adjustable pin *D* which may be placed in various positions in the stripping plate machine to provide for raising the pattern to different distances above the top of the ramming plate. Before the molds are finally closed, after the cope and drag have been separated to remove the pattern, the sand is thoroughly dried by applying heat with a torch flame, as shown in Fig. 3. Constituents of the chrobaltic alloy are melted in an electric furnace shown in Fig. 4, as it is found that there are numerous advantageous features in such an equipment, among which may be mentioned accurate regulation of the temperature that assures uniformity of the metal.

Aside from the making of patterns and the use of a stripping plate machine, there is nothing of exceptional interest in connection with the foundry practice employed for making these chrobaltic tool castings. The constitu-

ents of the alloy are carefully weighed out and charges are made up with the same degree of care that is exercised by a druggist in compounding a prescription. The molten metal is then placed in crucibles which have been preheated in an electric furnace. Fig. 5 shows the men engaged in pouring one line of molds, and another line is shown with the molds open. Before leaving the discussion of foundry work, it may be of interest to note that all molds are made with a horn gate that provides for delivering the molten metal from the bottom of the mold. Directly over the opening in the mold, a space is provided for a riser or feeder. The pouring is continued until the molten metal rises up in this feeder, and there is then a sufficient volume available so that adequate provision is made for taking up the shrinkage which occurs when the alloy solidifies.

Composition of Suitable Molding Sand for Casting Tools

It is of importance for the molding sand to be of the right composition in order to produce good clean castings. Chrobaltic alloy castings of good quality should appear more like forgings than castings, as the metal is usually close-grained and dense.

After the castings have been poured, they are allowed to stand in the molds over night in order that the steel may

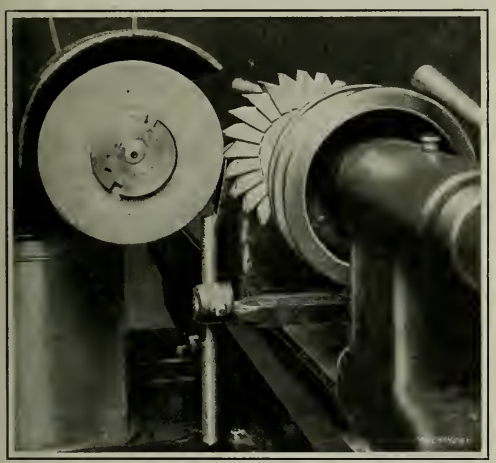


Fig. 8. Sharpening Side-tooth Milling Cutter Ready for Use

be partially annealed. The next morning the molds are broken open and the castings are annealed for eight or ten hours, the exact time depending upon the shape and size of the castings. The annealing furnace is kept at a temperature of 1450 degrees F. and the castings are left in the furnace to cool. This annealing operation gives the tools a scleroscope hardness of 38 degrees, and they can then be machined at a cutting speed of 25 to 30 feet per minute. The equipment used for annealing consists of a No. 353 gas furnace, made by the Standard Fuel Appliance Co., Detroit, Mich. After the annealing operation has been completed, the castings are taken to a Pangborn sand-blasting machine which removes all scale and particles of other foreign material which are clinging to them. The next step is to go over all surfaces with a file, as shown in Fig. 6, to remove fins and any particles of foreign material which may have escaped removal in sand-blasting, after which the cutters are set up in a lathe or chucking machine to have the hole bored and the hub faced at each end, this operation being shown in Fig. 7. The work is then transferred to a Wilmarth & Morman universal tool and cutter grinding machine to provide for grinding the outside diameter, as shown in Fig. 8, and the spaces between adjacent teeth. After being ground, the next step in the process of manufacture is to mark the tools with a number and the maker's name, this being done with steel stamps, as shown in Fig. 9, after which they are set up on a Mitts & Merrill keyseater to provide for cutting the keyway.

Method of Hardening Chrobaltic Alloy

In order to obtain the most satisfactory results from chrobaltic alloy tools, great care must be taken in conducting the process of heat-treatment, which is of special nature to meet the requirements of this metal. Tools to be hardened are placed in a Stewart furnace in which their temperature is raised to 1832 degrees F., after which they are allowed to remain in the furnace for a sufficient length of time to become thoroughly "soaked" with heat. The temperature is then allowed to drop from 25 to 50 degrees F., while the work remains in the furnace, and then the cutters are removed and allowed to cool in the air until they no longer show a red color when held in a position where there is no direct exposure to light. When this point has been reached, the tools are quenched in oil and allowed to remain in the bath until quite cool. The oil used for this purpose should have a flash point of 450 degrees F. The way in which the temper is drawn will



Fig. 9. Stamping Chrobaltic Imprint and Size on a Cutter

depend somewhat upon the nature of the service required of the finished tool, but in any case the temperature will be raised to some point between 800 and 900 degrees F.

Finish-grinding the Tools Ready for Use

After the heat-treatment has been completed, the tools are taken back to the Wilmarth & Morman universal tool and cutter grinder, for clearance grinding the cutting edges, making the tool ready for use. From the preceding description it will be apparent that the cast tools are not machined on the sides and other surfaces where a finish might add slightly to their appearance, but in so doing would also add an item to production cost without increasing the productive capacity of the tool. The tools are now ready to be packed for shipment to the user. It will be apparent that the preceding description applies where tools are completely finished ready for use; but mention was made of the fact that some customers prefer to buy annealed castings and machine them in their own tool-rooms. Where castings are produced for shipment to such consignees, the method of manufacture is exactly the same as that which has been described except that the work is carried through the annealing process and then shipped to the user's shop, where all subsequent work is done.

Results Obtained in Using Chrobaltic Cutters

In showing the results obtained with milling cutters made of chrobaltic alloy, it may be mentioned that there is practically no difference between the service obtained from these tools and cutters made of high-speed steel, where ordinary temperatures and other conditions of service are encountered. It is claimed, however, that where there is considerable abrasive action of the chips on the lip of the tool, as in the machining of phosphor-bronze, the chrobaltic cast cutter will give a substantially greater amount of service under given operating conditions.

The following examples of conditions under which these tools have been used will give a good idea of the amount of work of which they are capable. A milling cutter 3 inches in diameter by ⅜ inch face width, taking a cut ½ inch deep in a steel forging, was driven at 42 revolutions per minute with constantly increasing rates of feed. The feed was started at 1⅞ inches per minute, and was increased to 4¾ inches per minute, under which conditions the cutter operated satisfactorily. The feed was then increased to 6⅛ inches per minute, and under these severe conditions the cutter broke after making a cut 2 inches in length. In another case, a cutter 7 inches in diameter by ⅝ inch face width was used in conducting a test on a steel billet. The cutter was driven at 29 revolutions per minute, and in one case the feed was 1¾ inches per minute, with a depth of cut of ½ inch; while in the second case, the feed was 1⅞ inch, with a depth of cut of 1 inch. In both of these cases, the cutter operated satisfactorily and showed no signs of wear.

Until the invention of chrobaltic alloy, the theory prevailed that rolling, pressing, or forging was absolutely necessary in the production of steel for use in making milling cutters and similar tools, in order to give it the required density and toughness; but that equivalent physical properties to those obtained by forging are present in tools cast from chrobaltic alloy is attested by the fact that the tools are able to give entirely satisfactory service under severe conditions of operation.

As another example of results obtained in actual practice may be mentioned the milling of cast-iron gibs, 2¼ inches wide, from which from ⅛ to $\frac{3}{16}$ inch of material is removed. The feed rate is approximately 30 inches per minute, and the table feeds in both directions alternately; that is, the first piece will be fed against the direction of the rotation of the cutter, and the second piece with the direction of rotation. Under these conditions, the chrobaltic alloy cutter stood up for a complete day's output, and was apparently sharp at the end of the test.

A cast tire forming or scraping tool of chrobaltic alloy averaged twelve pairs of tires per grind on 66- and 72-inch driving wheels, the work being done on a No. 90 Putnam wheel lathe. Most mechanics, as well as most metallurgists, agree that worn locomotive tires by virtue of the metal itself, and the subsequent cold-rolling action in service, are more difficult to turn than almost any other regular operation, and that this is one of the hardest jobs to perform.

* * *

In the committee meetings at the International Trade Conference at Atlantic City, it was stated by French representatives that the only real needs of metals by France during the coming year will be confined to about 100,000 tons of ship plates, and about 90,000 tons of copper in bars, ingots and electrolytic copper. This modest demand is due to the extensive additions to French metal resources in the mines of Alsace-Lorraine. France will not only be able to meet all her domestic steel requirements, but also to produce an exportable surplus of about 2,000,000 tons. Copper needs will be met largely from the salvage of the waste of the battlefields, and aluminum will be utilized as a substitute wherever possible. The French coal deficit will be about 22,000,000 tons, and the French delegates are asking that as much of this come from the United States as can be spared.

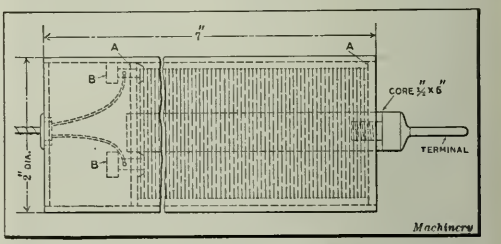
ELECTROMAGNET FOR SHOP HOSPITALS

By H. L. CAMPBELL

In metal-working plants, accidents are often caused by flying particles of steel which penetrate the flesh of the workmen. These chips have sharp, angular edges, and in injuries of this kind blood vessels are often severed. In order to prevent infection and irritation, it is necessary to remove the foreign particle immediately and to thoroughly disinfect the surfaces of the wound. The common practice is to enlarge the wound so that forceps may be used in removing the piece of metal, but if the wound bleeds freely this method is difficult. Under all conditions the practice of probing and digging for the metal particle is very painful.

As an aid in removing fragments of metal from punctured wounds, an electromagnet has been found of advantage. A pointed terminal made of refined iron is attached to the core of a hand magnet. When the exact location of the foreign particle has been determined, the terminal is sterilized and inserted in the wound. When the electric circuit is closed, the particle is attracted and may then be readily withdrawn by the magnet. After the fragment of metal has been removed, it is important that the internal surface of the puncture be thoroughly disinfected. Injuries to the eye should always be attended by a specialist, but in many cases the magnet may be used in removing minute particles of metal from the eye.

The electromagnet which is here illustrated, is constructed as follows: A wrought-iron core 1/2 inch in diameter



Electromagnet used to remove Particles of Metal from Wounds

and 6 inches long, is provided, in one end of which a 1/4-inch hole is tapped, 3/8 inch deep. On this core between two fiber disks *A*, one pound of No. 27 cotton-insulated copper wire is wound. A vulcanized fiber cylinder, 2 inches in diameter and 7 inches long, is used to enclose the coil. The cylinder is perforated with 1/8-inch holes, spaced 1 inch apart, to allow ventilation of the coil. It will be noticed that two binding posts *B* are provided for attaching the connecting wires. A third fiber disk covers the connecting end of the cylinder, so that the coil is completely enclosed. A number of threaded terminals should be provided, permitting the used ones to be readily removed, sterilized, and kept in readiness for further use as required. This instrument is of convenient size and has a strong magnetic attraction. It may be made with little expense at any electrical shop. A direct current of 110 volts is used.

* * *

Belting experts often find fault with the low speeds at which belts are being run, these low speeds being the cause of inefficiency and waste of power. Whenever possible, belts for transmitting power should be run at from 4000 to 4500 feet per minute, while they are frequently run at only 1000 feet per minute. As a result, wide belts are being used when a narrower belt, running at a high speed, would prove both cheaper and better. In addition, bearing pressures would be lessened and the friction and accompanying wear and power consumption reduced; thus, the expense for belts, fuel, and oil would be decreased to a considerable extent.

LETTERS ON PRACTICAL SUBJECTS

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UNIVERSAL SINE BAR

In reference to the article "Universal Sine Bar for the Toolmaker" which appeared in the August number of MACHINERY on page 1159, the writer fails to see how the gage shown in Figs. 2 and 3 can be clamped to the angle-plate and still rest upon the sine bar when grinding the 32

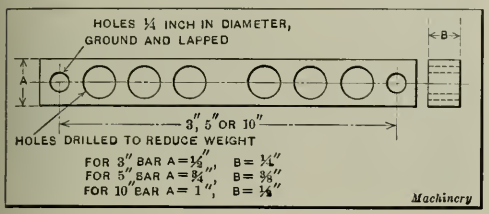


Fig 1. Sine Bar for Toolmakers

degree 17 minute angle. According to the dimensions given in Fig. 1, it would seem that the sine bar proper is 1¼ inches from the angle-plate, as the base projects that distance from the sine bar.

The writer has used a sine bar like the one shown in the accompanying illustration Fig. 1 for some time and has found it useful in checking and working up gages of all kinds. A 3- or 5-inch sine bar can be used for grinding small profile gages, etc., but whenever possible it is advisable to use a 10-inch sine bar because the longer the bar, the more accurate will be the angle.

The sine bar shown in Fig. 1 was made of machine steel, carburized and hardened, then ground and lapped on its four sides. The two ¼-inch holes at the ends were then ground and lapped to the proper distance apart and fitted or checked with two ¼-inch standard plug gages. In order to save time in setting this sine bar it is a good plan to square up an angle-plate, as shown in Fig. 2, and bore a series of ⅜-inch holes at required distances from the base of the plate. The dimensions from the base to each hole should be marked in plain figures. To prevent undue wear, hardened and ground bushings should be pressed into these holes. The holes in these bushings should be lapped to fit the ¼-inch plug used in connection with the sine bar. To mount the

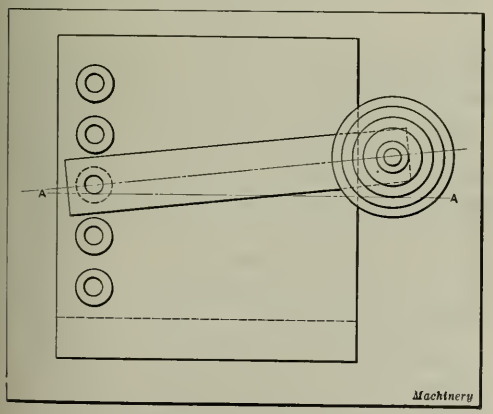


Fig. 2. Special Angle-plate used in Connection with Sine Bar and Plug shown in Fig. 3, for checking Angles on Standard Taper Gages

sine bar on the angle-plate the plug is first pushed into the sine bar and then into one of the bushings in the angle-plate, thereby forming a swivel or pivot. As the height of the stationary end is known, it is an easy matter to set the sine bar to the required angle by adjusting the movable end to the correct height, using a height gage or precision gage-blocks for this purpose. If a 10-inch sine bar is used, a height gage is sufficiently accurate for all practical purposes.

In Fig. 3 is shown a plug which can be used in connection with the sine bar for checking the angles on standard taper gages. The steps are ground to the required size, end *A* being ground to an accurate fit in the ¼-inch hole in the movable end of the sine bar. When checking tapers it is only necessary to insert the ¼-inch plug through the sine bar and the angle-plate as shown in Fig. 2, then insert the stepped plug in the movable end of the sine bar and use an indicator attached to a height gage or surface gage. The indicator should be set to zero on the plug at the stationary end and the movable end brought up until the indicator registers zero on the required step which is determined by the number of the taper being checked. It will be found that this stepped plug is a great time-saver.

Again referring to the sine bar in the article previously referred to, the writer is of the opinion that it possesses several features which would prevent it from being entirely satisfactory for tool-room use. First the screw at the pivot is too small to hold the sine bar in place properly after it

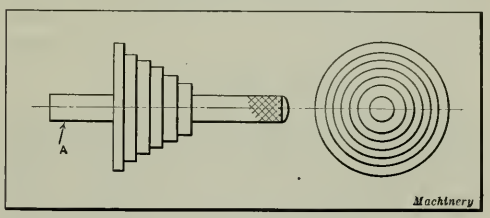


Fig. 3. Plug designed for Use in checking Standard Tapers with Sine Bar and Angle-plate shown in Figs. 1 and 2, respectively

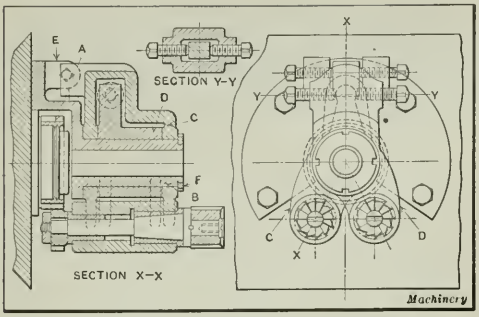
has been set. Then it seems as though the adjustable button on the movable end would be a source of constant trouble when setting the sine bar to any required angle. A certain amount of tapping would be necessary to adjust the button the proper distance from the base, and as a result the position of the movable button on the sine bar would frequently become changed a sufficient amount to render the setting inaccurate. The time saved by this type of sine bar might be offset by that lost in resetting the button if it were not handled with extreme care. Another objection is that it could not be conveniently used for grinding profile gages because the base prevents it from being brought up flush with the face of a regular angle-plate.

Detroit, Mich. WILLIAM BLAKESLEY

MILLING ATTACHMENT

The double-spindle milling attachment illustrated herewith may be used on a single-spindle machine for performing certain types of work which ordinarily require the use of a double-spindle machine. For squaring the ends of shafts having a shoulder, it has been found especially valuable, since performing this work by straddle-milling is impracticable on account of the cutters cutting into the shoulder.

Two cutters, which are of the shell end-mill type, are



Double-spindle milling Attachment for squaring Shafts

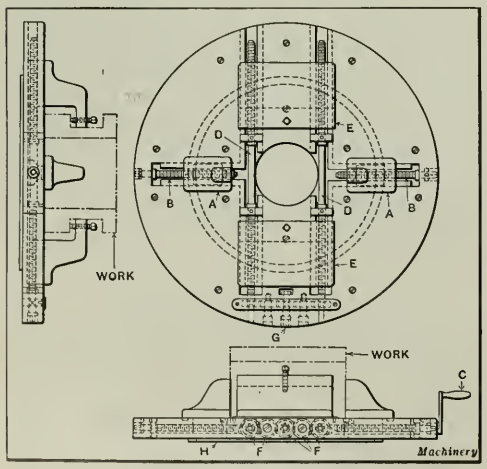
driven through gears on the opposite ends of the cutter-shafts. These gears mesh with the driver *A*, which is screwed to the milling machine spindle and is always in mesh with the cutter-spindle gears no matter what the adjustment of the cutters may be. The central bearing *B* has a flange which is attached by machine screws to the column of the machine so that the bearing proper is concentric with the spindle. There are two cutter-holders, both of which are free to swing on the bearing *B*, thus permitting a considerable "spread" for the cutters. The outside cutter-holder *C* has a tongue at the top by means of which the position of the cutter may be set as desired, by adjusting the binder screws which are carried in lugs *E*. The inside cutter-holder *D* has an adjusting finger projecting within a housing in the holder *C*—the method of adjusting the cutter being similar to that employed for the outside cutter. The attachment is secured in position after being assemhled by means of nut *F*, which is threaded to the end of bearing *B*, as shown.

Valentigney, France A. CLERC

BORING MILL CHUCK

The chuck shown in the illustration was designed for holding locomotive driving-wheel boxes while being machined on a 54-inch boring mill. The dot-and-dash lines indicate a box clamped in the chuck. The jaws are machined to fit slots milled in the chuck body. Jaws *A* are operated by means of screws *B* when they are revolved by turning handle *C*, the jaws being tapped underneath to suit the screws. The screws *D* which operate jaws *E* are revolved through the medium of gears *F* when the handle *C* is used to turn the short-headed shaft *G*. These jaws are tapped to suit screws *D* which have right- and left-hand threads at opposite ends to permit both jaws to be opened or closed simultaneously. A slot is milled through the body of the chuck to provide for the assembly of gears *F* which are covered by a piece of thin wrought iron. The ring *H* on the bottom of the chuck body seats in a corresponding recess on the boring mill table, so that the chuck may thus be readily located concentric with the machine. The fixture is secured to the machine table by fillister-head machine screws. This type of chuck could be adapted for holding various classes of work if the jaws were designed to suit the particular work to be held.

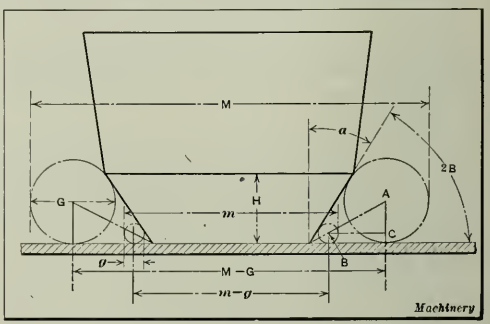
NORMAN MCCLEOD



Chuck used for holding Locomotive Driving-wheel Boxes

MEASURING THE ANGLES OF TAPERED PLUGS WITH TWO SIZES OF WIRES

The angle of a tapered plug may be measured by taking two micrometer readings over two pairs of wires of different sizes. This method is useful in the checking of the angle on the short taper of a small chamber check. When the distance *H* in the accompanying diagram is very short this method of measurement may be used to advantage. Referring to the diagram, *G* and *g* equal the diameters of the



Use of Two Sizes of Wires for measuring Tapered Plugs

maximum and minimum wires, and *M* and *m* the micrometer readings over the maximum and minimum wires, respectively. Then

$M - G$ = distance between centers of maximum wires;

$m - g$ = distance between centers of minimum wires.

In the triangle *ABC*,

$$\tan B = \frac{AC}{BC} \qquad (1)$$

But

$$AC = \frac{G - g}{2}$$

and

$$BC = \frac{(M - G) - (m - g)}{2} = \frac{(M - m) - (G - g)}{2}$$

Therefore, substituting in Equation (1):

$$\tan B = \frac{\frac{G - g}{2}}{\frac{(M - m) - (G - g)}{2}} = \frac{G - g}{(M - m) - (G - g)}$$

$a = 90$ degrees $- 2B$

and

$2 \tan a$ = the taper per inch

Richmond College, Va. V. E. AYRE

BORING RECESS AT BOTTOM OF HOLE

It is often necessary to form a recess at the bottom of a drilled hole in order to provide clearance for cutting threads or keyways. When a piece is so designed that such clearance must be provided at the bottoms of several holes it

usually requires considerable time to set the piece up on the lathe faceplate in the correct positions for boring the recesses, especially if the work is large or irregular in shape.

These recessing operations, however, can in most cases be easily accomplished in the drilling machine with a tool such as shown in the accompanying illustration. It will be seen that this tool is a modification of the old-fashioned flat drill. The operation of the tool may be explained as follows: Assume that it is required to drill the ¾-inch hole shown in the illustration 1 inch deep, and that the recess is ⅞ inch in diameter and ¼ inch deep. First drill the ¾-inch hole about 1⅛ inches deep in the usual manner. Then use the tool shown, the cutting part of which is equal in width to the diameter of the ¾-inch drilled hole. The point of this tool is ground off center, the amount of eccentricity being equal to one-half the difference between the diameter of the drilled hole and the recess, in this case $(⅞ - ¾) \div 2 = 1/16$ inch. The section of the tool which is ¾ inch wide should extend only about ⅛ inch, as indicated in the illustration. The sides and point of the drill should be backed off in the usual manner. The tool should be provided with a heavy shank, the diameter of which should not exceed ⅝ inch in this case, so that there will be 1/16

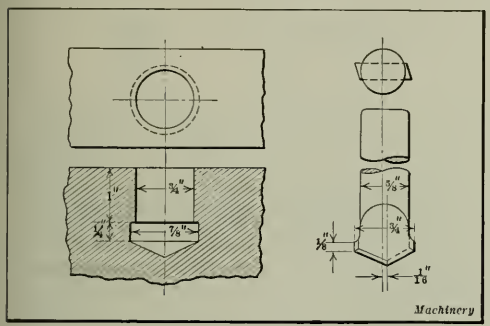


Illustration showing Dimensions of Recessed Hole and Tool used in Drilling Machine to bore Recess

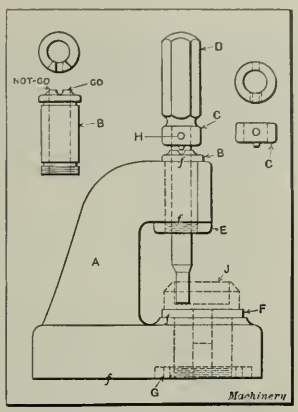
inch clearance all around when the tool is at work. In operation, the point follows in the center left by the point of the ¾-inch drill and as the cutting edge of one side is 7/16 inch from the center, it will cut a recess ⅞ inch in diameter. The whole width of the cutter being only ¾ inch, it may be brought to the center and lifted out of the hole when the recessing operation is completed.

Philadelphia, Pa. S. B. Royal

LIMIT GAGE

The accompanying illustration shows a limit gage which has proved to be one of the most practical designs yet evolved for gaging the thickness of the bottom of a bobbin case. Limit gages embodying the same general principles could be made for gaging similar work which would doubtless prove equally as satisfactory. The gage has a cast-iron body *A* having four finished surfaces which must be parallel to each other. The head of the bushing *B* is so designed that proper limits can be established by the points "Not Go" and "Go." This bushing is made from machine steel and is casehardened and ground. The machine steel collar *C* is also casehardened and ground and is a drive fit on spindle *D*. The pin *H* is used simply to fasten the collar in a fixed position on spindle *D*. Spindle *D* is made from standard machine-steel hexagonal stock and is casehardened and ground to a sliding fit in bushing *B*. The parts *E* and *G* are machine steel nuts employed to hold the bushings in a fixed position.

The gage is used in the following manner: First, the spindle *D* is raised a sufficient height to allow the stem of the bobbin case *J* to be inserted in bushing *F*. The end of the spindle should then be brought into contact with the work, care being taken to have the tongue on collar *C* located in the relieved portion of bushing *B*. Should the bottom of the bobbin case *J* be too thin, the tongue on collar *C* will prevent the spindle from being turned counterclockwise by coming in contact with the surface designated "Go." Should the bottom of piece *J* be too thick, the tongue will pass over the point designated "Not Go" when turned in the opposite direction. If the thickness of the bottom of piece *J* is correct, the tongue will pass over the "Go" point, but not over the point designated "Not Go." It will be observed that the parts of this gage are so designed that they may be easily removed and repaired if necessary. This is a distinct advantage in gages of this type which are subjected to constant wear.



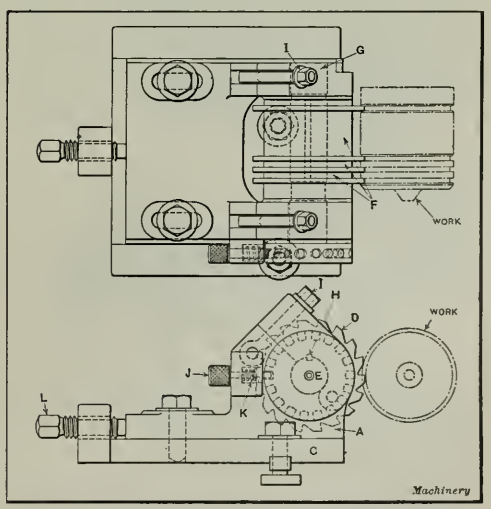
Limit Gage designed to gage Thickness of Bobbin Case

Bridgeport, Conn. Max Slutzky

MULTIPLE TOOL-HOLDING FIXTURE FOR GROOVING PISTONS

In the accompanying illustration is shown a multiple tool-holding fixture for grooving pistons, which was designed by the writer. The principal advantage possessed by this device is that circular milling cutters are used in place of single-point tools such as are usually employed. Each of the circular cutters has eighteen teeth, thus allowing eighteen different cutting edges to be employed successively before resharpening becomes necessary. Two arbors and two sets of cutters are provided so that one set may be sent to the toolroom to be ground while the other is in use.

Referring to the illustration, casting *A* is fastened to the



Multiple Tool-holding Fixture for grooving Pistons

machined base *C*, which, in turn, is fastened to the carriage of the lathe. The cutters *D* are assembled on the arbor *E*, being properly spaced by collars *F*. Nut *G* and key *H* serve to hold the cutters securely in position on the arbor. The split bushings in which the ends of the arbor rest are tightened by two lock-nuts *I*. When one set of cutter teeth becomes dull, nuts *I* are loosened and the arbor indexed to bring the next set of teeth into the proper cutting position. The plunger *J* which is normally held in the position shown by means of spring *K*, must, of course, be withdrawn before indexing the arbor. The screw *L* is provided simply to facilitate proper adjustment of the fixture after the cutters have been ground.

Lansing, Mich. O. H. KARCHER

DESIGNING DIES FOR SAFETY

Dies designed to prevent accident or injury to the operator often increase productive capacity besides affording greater safety. In this connection the writer recalls a die, the design of which required the operator to put his hand under the punch when placing the work in position. This die produced a right-angle bend in a piece of work *W*, shown between the punch and die, Fig. 1, and also in the guides in Fig. 2. This piece is made of 24-gage galvanized iron, and has two sides and one end turned up as shown. With the original die shown in Fig. 1, the operations were as follows: A piece was picked up with one hand and passed to the other in the correct position for placing in the die, and with the index finger extending along the piece. While held in this manner, the piece was pushed to the left, knocking the finished piece from under the punch. It was then placed in the correct position over the die and slid to the right, the end flange acting as a stop to locate it longitudinally.

In grasping the piece, the operator frequently caught hold of it with his index finger extending so far along the piece that there seemed danger of its becoming caught between the punch and die. It was therefore decided to change the die so that it could be operated under an inclinable press, as it could then be fed by gravity. The positions of the punch and die were reversed in the new design, shown in Fig. 2. This arrangement permits the work to slide down the guides with the flanges up. There is a guide at each end of the work made of two angle-irons *A* and *B*, formed from 14-gage sheet iron and riveted to short pieces of 1½-inch angle-iron *D*. The two lower guides *A* extend beyond the end of the upper guides *B*, thus forming a table on which the work is placed when the slide is being filled. The guides *A* end at the beginning of the bottom former *F*, but the upper guides *B* continue far enough to allow the work to slide over the bottom former and against the stops located at *E*. The work will then rest on the bottom former, and as the right-hand side is longer than the left, the left side will tip up until it bears against guide *B*. There being no lower

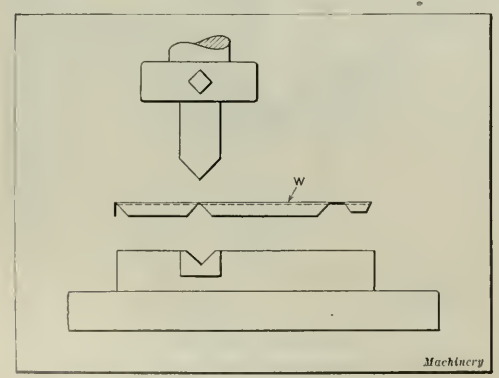


Fig. 1. Die employed to produce Right-angle Bends

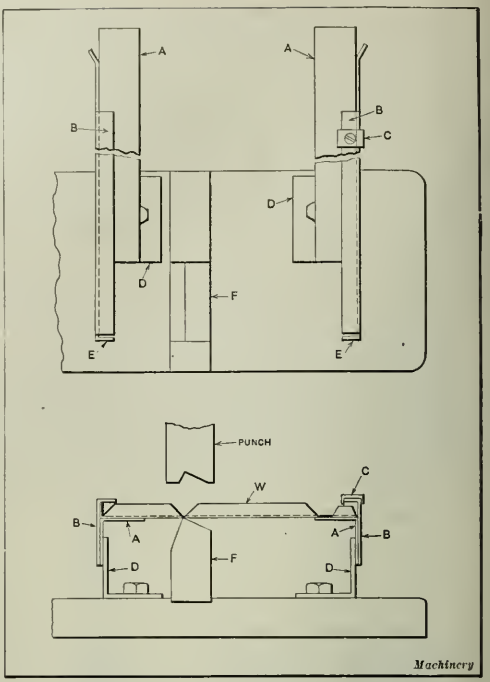


Fig. 2. Improved Design of Bending Die, which reduced the Possibility of Injury and also increased Production

guides at this place, space is allowed for the ends to pass down as they are formed by the punch. The finished work can then pass out of the back of the press.

After this die had been in operation for a short time the operator suggested that a stop be put on the slide in such a position that it would prevent any piece of work from being placed incorrectly in the slide. By referring to the illustrations it will be seen that the height of the flange on the right-hand end of the work is less than that of the other flanges of the piece. By making a stop *C* to catch any piece that might enter in a reverse position, all loss from this source was stopped. With this die, the operations consist merely of placing the pieces in the slide and allowing the press to run until the slide is nearly empty, at which time the press must be stopped and refilled. This is necessary because the pieces cannot be placed in the guides as fast as the press operates. This scheme proved entirely satisfactory from a safety point of view and has also more than doubled production.

Evanston, Ohio WALTER H. WEBSTER

MILLING MACHINE KINK

The following method of adjusting the index-head center to the same height as the center of the milling machine spindle is frequently employed by the writer and may be of value to others. A piece of machine steel is first turned to some convenient decimal diameter and placed in the spindle chuck, after which the arbor is placed between the index-head and footstock centers. The arbor must be true and its decimal diameter known. The table is then raised so that a feeler will be held snugly between the arbor and the turned piece in the milling machine chuck. The additional amount, of course, required to raise the table to the desired height is equal to the thickness of the feeler plus one-half the sum of the diameters of the arbor and the turned piece in the chuck. This will locate the table accurately in the desired position.

Brazil, Ind. OSCAR CRAFT

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW AMERICAN METAL-WORKING MACHINERY

Toledo Vertical Milling Machine. Toledo Milling Machine Co., Toledo, Ohio 363
Warner & Swasey No. 6 Turret Lathe. Warner & Swasey Co., Cleveland, Ohio 365
Sibley Drilling Machine. Sibley Machine Co., 8 Tutt St., South Bend, Ind. 366
Cleveland Face Grinding Machine. Cleveland Machine Tool Co., 3215 Superior Ave., Cleveland, Ohio 366
Toledo Traveling Wall Crane. Toledo Bridge & Crane Co., Toledo, Ohio 367
United Molding and Tube-rolling Mill. United Machine & Mfg. Co., Canton, Ohio 368
"Stamco" Crank Shaper. Streine Tool & Mfg. Co., New Bremen, Ohio 368
Eclipse Inverted Counterbore. Eclipse Interchangeable Counterbore Co., Inc., Letroit, Mich. 369
Fosdick Pneumatic and Hand Radial Drill Column Clamp. Fosdick Machine Tool Co., Cincinnati, Ohio 369
Foster Hand Screw Machines. Foster Machine Co., Elkhart, Ind. 370
Urban Bench Lathe. Urban Machine & Tool Co., 2424-2430 St. Clair Ave., Cleveland, Ohio 372
American Pneumatic Milling Vise. American Pneumatic Chuck Co., 9 S. Clinton St., Chicago, Ill. 372
Robinson Adjustable Lathe Center. Robinson Adjustable Center Co., 1310 Twelfth St., Detroit, Mich. 373
Economy Parallel Ruler Attachment. Economy Drawing Table & Mfg. Co., Adrian, Mich. 373
Lovejoy Right-hand Tool. Lovejoy Tool Co., Inc., Springfield, Vt. 374
H. H. Arnold Reamers and Counterbores. H. H. Arnold Co., Rockland, Mass. 374
Cowan Metal Feet for Transveyor Skids. Cowan Truck Co., 16 Water St., Holyoke, Mass. 374
E. F. Hauserman Tote-box. E. F. Hauserman Co., Cleveland, Ohio 374
Elwell-Parker Electric Shell Truck. Elwell-Parker Electric Co., Cleveland, Ohio 375

Toledo Vertical Milling Machine

The Toledo Milling Machine Co., Toledo, Ohio, has placed on the market a vertical milling machine that is illustrated in Figs. 1 and 2. This machine, which is styled the No. 3-V, is the first of a line of millers that will be developed by this concern. In working out construction details, an effort was made by the designers to attain the maximum degree of rigidity for the machine and consequent accuracy of the work produced on it. For use in toolmaking and die-sinking, it is believed that there is a demand for a vertical milling machine that would operate on very heavy dies and similar work, providing for accurate heavy milling, even upon the extreme ends of such dies, without deflection, chattering, or impairment of accuracy.

Attention is called to the design and weight of the main column of this miller. It is machined from a casting weighing 1½ tons, and the metal is so proportioned as to give the greatest resistance against strain. The base of the column is made particularly heavy, which is a feature that enables the machine to work on large drop-forging dieblocks, taking milling cuts to the very ends without chatter or deflection or unbalancing of the machine. As a test, a 1,000-pound die was held upon the table and traversed to bring the extreme end of the block under the milling cutter. The machine was not bolted to the floor and even without taking this precaution, it is said that the operation was as smooth as though the block and table were at the center.

The unit construction idea has been followed in designing this machine. Not only are the table, saddle and knee quickly removable, but the feed-gear case with its gears intact may be taken off by simply removing six screws.

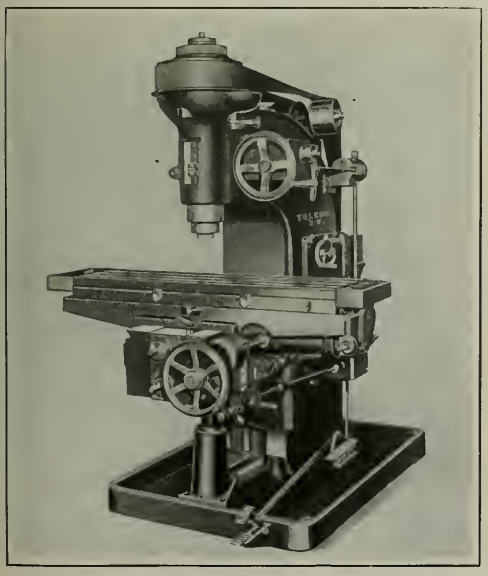


Fig. 1. Vertical Spindle Milling Machine Built by the Toledo Milling Machine Co.

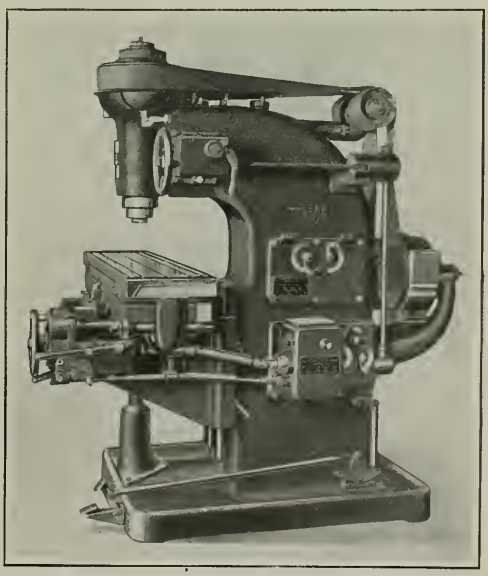


Fig. 2. Side View of the Toledo No. 3-V Vertical Spindle Milling Machine

Similarly, the speed gears and their case may be removed; the spindle and its bearings in the sleeve are quickly removable; and the same is true of the spindle feed-box and the knee and table reverse gears. Although this machine is a general-purpose miller, and is said to be as well adapted for manufacturing as for tool work, a feature that will appeal to die-sinkers and toolmakers is the central control of all table and spindle movements. From the one operating position at the front, all the movements of the machine, except for feed and speed changes, are under control. This is a feature in machine tool design that is being given more and more attention.

The Knee and Table

The knee is of conventional design and liberally proportioned. The usual ball bearing telescopic elevating screw is provided. Particular attention is called to the manner of mounting the knee upon the column. This mounting is arranged on a tapered central gib principle but the bearing surfaces are made of exceptional width. Here again, the object of this method of mounting is to provide extreme accuracy on heavy die work. In operation, it has been proved that accurate cuts could be taken, even without tightening the usual knee binders that are provided. The saddle and table are extra heavy and of box construction. The saddle is made 4 inches longer than the table proper, to provide an additional support when at the extreme ends of its travel, the question of support being well taken care of by the extra wide bearing of the saddle upon the knee.

Knee, Saddle, and Table Movements

Movements of the knee, saddle, and table are all controlled from one operating position, and the feed mechanism is so designed that it is absolutely impossible to engage any two feeds at the same time. Because of this feature the operator, even although he may be inexperienced, cannot possibly damage either the machine or the work from this cause. By means of engaging levers at the knee, any of the knee, saddle, or table movements may be put under control of the centrally located handwheel on the knee. This feature permits the operator to handle irregular work to the greatest possible advantage.

Rapid traverse of the knee, saddle, or table is secured from the rapid traverse lever at the front of the knee. In order to operate the rapid traverse movements, a plunger must be disengaged and the lever held in the proper position while the rapid traversing is taking place. When the quick traverse is applied to either the knee, saddle, or table movement, any other regular feed is automatically released by the same lever; and at the end of this rapid traverse movement, the original feed is again engaged by the return of the rapid traverse lever to its natural position. All knee, saddle, and table movements, whether forward or reverse, are controlled by the straight lever shown at the right-hand side of the knee in Fig. 1. At times, a vertical milling machine operator must be at the back of the table to watch the operation. For this reason, provision is also made to control the table movements from this position.

Spindle Construction

The method of mounting and driving the spindle is a feature of this vertical milling machine. The spindle is made of forged chrome-manganese steel and is ground to the finished size. The main section of the spindle is 3¼ inches in diameter and it runs in two phosphor-bronze bushings, each 4½ inches long and spaced 3 inches apart. These bushings are furnished with an oil reservoir from which lubricant is drawn. To provide means of compensating for wear, this main bearing is split and furnished with end adjusting nuts that enable the bearing to be closed in to take up wear. The outside taper of this bronze bearing is supported by a large sleeve, with a corresponding inside taper. The spindle sleeve is liberally proportioned to withstand the heaviest service. It is split for taking up wear, and in one of the recesses there is embedded a felt strip which acts as a retainer for lubricating oil. Mounted on one side of the spindle sleeve there is a steel rack with which the elevating gear meshes. End thrust of the spindle is taken by ball bearings at either end of the main bearings; and the pull of the spindle driving belt has no effect upon the main spindle bearing, because this pull is taken by a large auxiliary bearing at the top of the machine. In this bearing, which is adjustable, there are incorporated two specially designed ball bearings that take care of the spindle belt pull.

Spindle Lubrication

At the top of the spindle pulley and integral with it, there is an oil chamber holding sufficient oil for the lubrication of the auxiliary bearings, back-gear and spindle bearings. In addition to the auxiliary ball bearing that receives the belt pull of the spindle, the main driving shaft and idler pulleys are similarly mounted on ball bearings. Throughout the machine there are twenty-nine ball bearings, and all other bearings are bushed with phosphor-bronze. The spindle may be fed by hand or power. When feeding by hand, the large handwheel at the front controls the movement; and when it is pushed in, this handwheel feeds the spindle directly through the spur gear and rack previously mentioned. Conversely, when the handwheel is pulled out, the feeding is through a worm and wormwheel, thus providing for accurate control.

Speeds and Feeds

All speeds and feeds of this machine are in geometrical progression. Through the speed gears, sixteen changes are obtainable. With an open belt drive, eight changes of speed may be secured—97, 113, 141, 177, 226, 263, 329, and 411 revolutions per minute. The spindle is provided with back-gearing in the ratio of 5.5 to 1. By means of these back-gears the speeds obtainable are 18, 21, 26, 33, 42, 49, 61 and 76 revolutions per minute. There are sixteen rates of feed which are governed by the speed of revolution of the spindle. The feed-case is driven through spur gears directly from the spindle. Therefore, it is the speed of rotation of the spindle that absclutely controls the rates of feed. These feeds are in geometrical progression, and the available rates are 0.004, 0.006, 0.009, 0.013, 0.018, 0.025, 0.035, 0.049, 0.069, 0.094, 0.136, 0.186, 0.264, 0.361, 0.520 and 0.710 inch per spindle revolution.

Cutter Mounting

The spindle of this machine is provided with a No. 13 B. & S. taper. Cutters are attached to the spindle by a straight fit at the spindle nose, and they are held in place by a draw-bar and bolt, with an enlarged head. Also, there are two hardened steel keys secured in two slots at the spindle nose by screws. These keys engage similar slots in the cutter and thereby provide for driving it.

Range of Feeds

The following outline shows the range of feed movements on this machine: Longitudinal table movement, 46 inches; traverse table movement, 14 inches; vertical knee movement, 14 inches; and spindle feed, 6½ inches. Some of the important dimensions are: Throat distance, 19 inches; greatest distance from end of spindle to top of table, 22 inches; and size of table surface, 56 by 14 inches. There are three ⅝-inch T-slots and ⅜-inch tapped holes in the edge of the table for side straps. Starting and stopping of the machine is governed by a foot-treadle at the right, and oiling is accomplished from a central oil reservoir, from which oil tubes lead to the various bearings. All gears throughout the machine are of steel and heat-treated, with the gears in the speed- and feed-cases arranged to run continuously in grease. The machine may be equipped with a rotary attachment, having all regular and quick-traverse feeds; and it is readily adapted for motor drive. The total weight is 7000 pounds.

WARNER & SWASEY NO. 6 TURRET LATHE

To meet the demand for a turret lathe possessing ample power and strength for machining gear blanks, forgings, and various parts made of tough alloy steel, the Warner & Swasey Co., Cleveland, Ohio, has recently added to its line the No. 6 turret lathe which is here illustrated and described. This machine is said to be especially adapted for use in plants engaged in the manufacture of automobiles, tractors, and electrical apparatus, as well as in railroad and miscellaneous machine shops. It is equipped with double friction back-gears and either with or without an automatic chuck, bar feed mechanism and power feed to the turret; and either a standard or heavy duty carriage may be provided, according to the requirements. Nine spindle speeds are available, three for each step of the driving pulley, and the power obtainable with the double friction back gears permits of taking heavy forming and facing cuts on both bar and chucking jobs.

When used for severe service of this kind, the heavy duty carriage will be found to give the most desirable results. It is provided with power cross and hand longitudinal feeds, and the cross feed can also be operated by hand. Provision is made in the apron design for obtaining six power cross feeds and reverse, the three finer feeds being suitable for forming, and the three coarser ones for facing operations. The cross-slide is fitted with a dial graduated to 0.002 inch, and adjustable stops are provided for either direction. It is possible to swivel the front toolpost to any angle, and a cutting-off tool-holder is regularly furnished at the rear. Either of these tool-holders may be removed and forming or various other tools substituted.

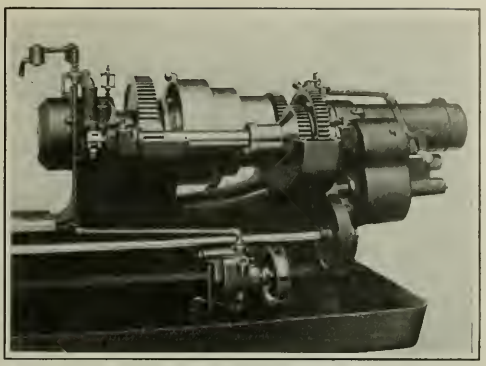


Fig. 2. Rear View of the Head End, showing Arrangement of the Back-gears

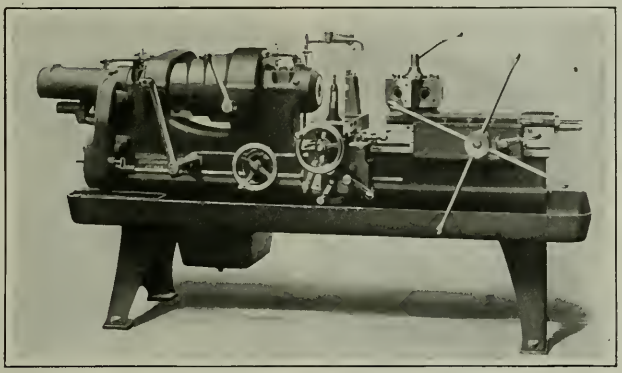


Fig. 1. No. 6 Heavy-duty Turret Lathe built by the Warner & Swasey Co.

When a standard carriage is furnished on this machine, it is of the type that has been used on Warner & Swasey turret lathes for several years, hand longitudinal and cross feeds being included among its regular features. Work requiring the use of power cross-feed is more conveniently handled with the heavy-duty carriage which has power cross-feed and adjustable stops for the cross-slide. The toolposts are similar to those previously mentioned. Both the automatic chuck and bar feed are operated by a long lever at the front of the head. A stepped wedge automatically adjusts the collet for slightly varying diameters, and a master collet and bushing pads are regularly furnished with this machine, for holding 2¼-inch round stock. Bushings for hexagonal stock can be held in this collet, but square stock requires a special master collet and bushing pads. Extra-capacity collets can also be furnished.

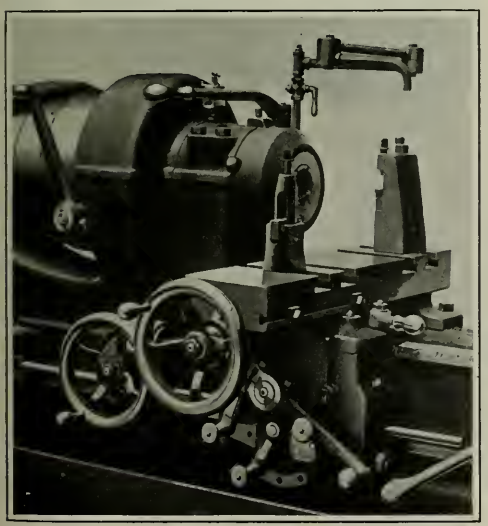


Fig. 3. Close-up View of the Cross-slide and Collet Chuck

It will be seen that the head and bed are cast integral with each other. Provision is made for holding tools with or without shanks on the hexagonal turret. The turret is revolved automatically by the backward movement of the slide and the locking bolt is placed on the front end of the slide. It enters tapered steel bushings inserted in the bottom of the turret close to the outer edge and directly under the cutting tools. Independent adjustable stops operate automatically for each position of the turret and provide for disengaging the power feeds. A supplementary tapered base for the turret saddle provides for adjusting the tool holes in the turret to a position exactly opposite the center of the spindle; and tapered gibs fitted over the entire length of the saddle at each side provide means of adjusting the slide sidewise. Power feed for the turret-slide may be furnished as special equipment, and any of four changes is instantly obtainable by moving a lever. The automatic trip operates in connection with independent adjustable stops for each hole in the turret. The oil-pump is so designed that it operates when the machine is run in either direction. A complete line of standard turret lathe tools for use on this machine is kept in stock.

SIBLEY DRILLING MACHINE

The Sibley Machine Co., 8 Tutt St., South Bend, Ind., has recently placed on the market a sliding-head drilling machine with positive geared feeds, in which proved features of preceding types of drilling machines of this company's manufacture have been incorporated together with a number of new ones. This machine is now being built with a swing of 24 inches, and it has been designed to meet the requirements of modern production methods. There is a wide range of selective speeds and feeds, and to adapt the machine for heavy duty the base has been substantially ribbed to give it the necessary strength and rigidity. T-slots on the base provide for clamping large pieces of work. The head and spindle are counterbalanced by a weight supported inside the column by a Diamond chain operating over large-diameter sheaves. All gears are enclosed to assure the safety of the operator, and belt guards can be furnished as a special equipment.

One of the new features of this machine is the fitting of all driving shaft bearings with die-cast split bushings made of anti-friction metal, these bushings being interchangeable and assuring long life for the bearings. There is plenty of movement for the head and spindle to provide for the use of large jigs. A ball thrust bearing is provided for the spindle. Another feature is the geared feed mechanism that provides four changes of feed and a neutral position. These feed-changes are obtained by moving a conveniently located knob in the center of the hand-wheel in connection with a sliding spline, four changes of feed being provided for each spindle speed. The initial drive of the feed-shaft is from the top cone-shaft through spur and spiral gears. Not only does this afford a compact construction, but it also allows the gears to be completely enclosed so that they may run in oil. A steel worm which meshes with the large wormwheel also runs in an oil-pocket.

An adjustable automatic stop of new design is quick and positive in action. Hand feed and quick return of the spindle is effected through the medium of a three-legged spider located at the right-hand side of the feed-box. Special attention has been paid to the provision of means for lubricating this machine. All bearings are equipped with oil-cups and channels, insuring proper distribution of oil to the vital points. The loose pulley is furnished with a self-oiling bearing and will run for several months without requiring attention, while all of the feed-gears are completely enclosed and arranged to run in oil. A positive geared tapping attachment, geared or belted motor drive, a round or square table with T-slots and an oil-pocket, an oil-pump outfit, and a quarter-turn countershaft can be furnished as special equipments for use on this drilling machine.

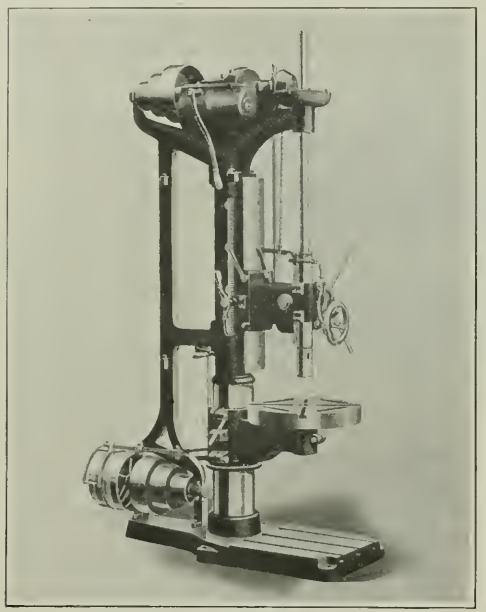


Fig. 1. Sliding-head Drilling Machine Built by the Sibley Machine Co.

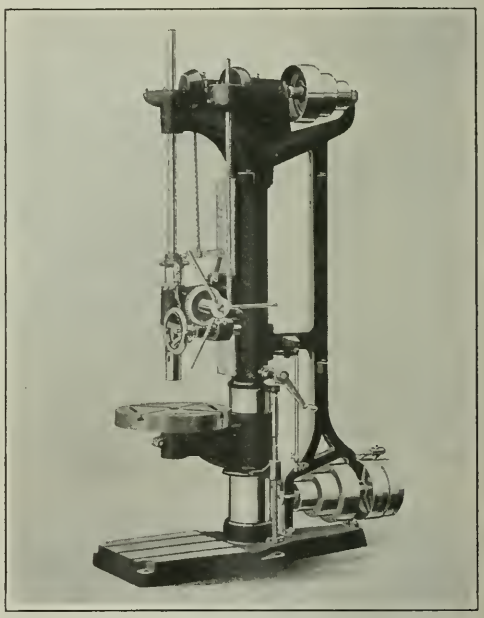


Fig. 2. Opposite Side of the Sibley Drilling Machine shown in Fig. 1

CLEVELAND FACE GRINDING MACHINE

For use in grinding metal slitting saws, hubs of milling cutters, faces of bushings, arbor collars, and for the performance of a great variety of similar face grinding operations that come within its range, the Cleveland Machine Tool Co., 3215 Superior Ave., Cleveland, Ohio, has recently placed on the market a face grinding machine which is here illustrated and described. This machine is constructed with an L-shaped column of one-piece box section, which affords ample strength and rigidity. There is a door at the front, permitting easy access to the working parts for oiling and adjustment, and in Fig. 1 the machine is illustrated with the column partially broken away in order to show the mechanism. There is also a door at the side, as shown in Fig. 2, which makes a large part of the space in the column available for the storage of tools, grinding wheels, etc.

One V-shaped and one flat way support the table, which is made larger than the ways so that the bearings are always covered and kept free from dust and grit. A crank-handle adjustment is provided for the table, by means of which the arc of oscillation can be readily changed to meet the requirements of different jobs. The table is oscillated by a crank disk driven by a worm and wheel, which assures a uniform motion. Adjustment of the arc of oscillation ranges from 0 to 6 inches, which means that work up to 12

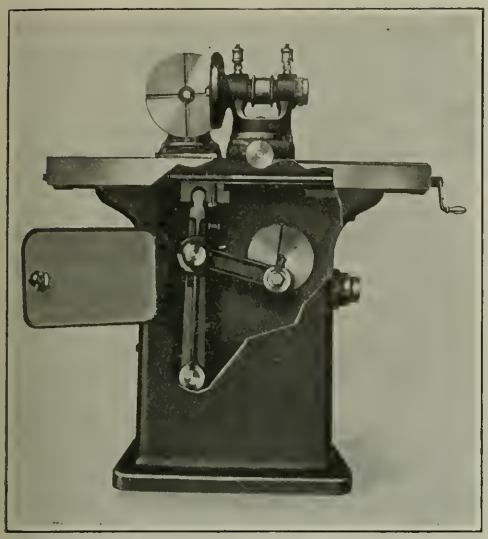


Fig. 1. Face Grinding Machine Built by the Cleveland Machine Tool Co.



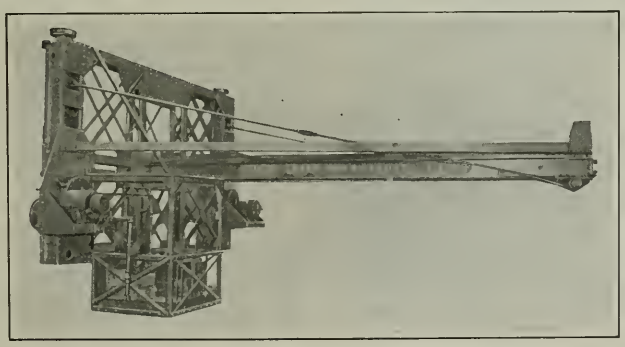
Fig. 2. View of Cleveland Face Grinding Machine showing the Door in the Side

inches in diameter may be ground. Six changes of feed are available, any of which can be obtained by means of a three-step cone pulley and a two-speed countershaft.

A dovetail slide supports the saddle on which the grinding wheel head is mounted. This saddle has a lateral adjustment of 2 inches on the table and is designed so that dust is excluded from the bearing surfaces. The saddle adjusting screw is equipped with a micrometer dial and the grinding wheel head is pivoted and can be turned to any desired angle, thus permitting the use of wheels of various shapes. The head is graduated in degrees over an arc of 30 degrees. A special grade of steel is used for making the grinding wheel spindle which is hardened and ground and runs in phosphor-bronze bearings. Large grinding wheel flanges are provided and also a wheel guard large enough to accommodate wheels up to 8 inches in diameter.

The work-head is secured to the wing of the column by a dovetail slide, and rests on its own saddle which has a longitudinal adjustment of 6 inches. A hand clamping screw fastens the saddle to the column, thus providing easy adjustment, and a gib makes this slide adjustable for wear. The machine will accommodate work up to 6 inches in thickness without overhang of the saddle, and by allowing the saddle to overhang slightly and using a grinding wheel approximately 5 inches in diameter, work exceeding 10 inches in thickness can be ground. By having the work-head pivoted on the saddle, it can be swung to any angle and is graduated in degrees to facilitate setting.

A No. 11 Brown & Sharpe taper hole is provided in the work-spindle which is hardened and ground and runs in phosphor-bronze bearings. The nose of the spindle is threaded to receive a 10-inch faceplate which has two 7/16-inch T-slots at right angles, permitting of rapid clamping of the work. Two draw-bolts and ½-inch and 1-inch collets are furnished as regular equipments. Especial attention has been given to provision for lubricating the bearings and protecting them from dust. All cylindrical and flat bearings, and all oil-holes have dustproof oil-caps, and the four spindle bearings are provided with large sight-feed oil-cups. The table and saddles are so constructed that their bearings are protected, and the spindle bearings are furnished with specially designed dust covers. A self-contained countershaft is used, which should run at 400 revolutions per minute.



Traveling Wall Crane Built by the Toledo Bridge & Crane Co.

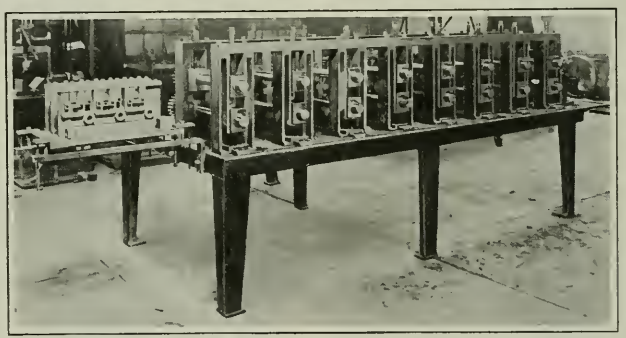
TOLEDO TRAVELING WALL CRANE

A traveling wall crane of the type described in this article has proved useful in a great many plants as an auxiliary to the standard overhead crane equipment or where the wall type is used exclusively. It has recently been placed on the market by the Toledo Bridge & Crane Co., Toledo, Ohio, and is regularly furnished in capacities of three and five tons, with an effective reach up to thirty feet. This traveling wall type of crane has proved in many plants a satisfactory solution of the handling problems. Used as an auxiliary to the overhead crane, it avoids delays and congestion and leaves the overhead cranes free for the heavier loads and longer runs. The design is of the four motor type and can be furnished with direct- or alternating-current motors.

The back framing and boom consist of rolled steel channels, beams, plates or angles, and truss rods or eye bars are used to give stability to the boom. Two motors are provided for

the longitudinal travel, which are connected in parallel and operated through one controller. The motor pinion engages directly into the driving gear that is pressed and keyed on the double-flanged cast-steel truck wheel. A foot-brake operated from the cage effectually controls the longitudinal travel and stops the crane without the necessity of plugging the motors. This brake is of the band type, the brake wheel being mounted directly on the armature shaft of one of the motors. The operator's cage is of structural steel, with a plank floor, and it is of sufficient size to contain all controllers, the switchboard, and resistance, and still leave ample room for the operator. The location of the cage is optional, and there is considerable leeway as to its position. When desired, the cage can be omitted, rope-operated controllers being provided so that all operations can be accomplished from the floor. With the floor-operated type of crane, the foot-brake is omitted and a solenoid brake substituted in its place, which is attached directly to one of the driving motors. A bumper bar and rail checks are provided at the end of the boom.

The hoisting mechanism consists of a one-piece cast frame on which is mounted the hoisting motor with its train of gears, the solenoid brake and hoisting drum. The hoisting cable leads from the drum through one set of idler sheaves on the trolley, through the bottom block sheaves, then through the second set of sheaves on the trolley, and is anchored at the end of the boom. The solenoid brake performs two functions. It serves to stop the motor, thus providing for rapid reversal, and it also acts as a holding brake when the load is brought to rest through the dynamic braking control. The brake wheel is mounted direct on the extended armature shaft and is accurately machined and balanced. The brake is automatic in its operation and is so arranged and connected that should the supply of current fail or when the controller is brought to the neutral or off position, the brake at once becomes operative, prevents the load from falling or slipping, and is released only by the application of power or by spreading the brake arms against the tension of the springs. When alternating-current motors are used, the hoist motor is provided with a solenoid brake, and as a holding brake the hoisting mechanism is equipped with a band type of mechanical brake. This brake is of the screw friction type, is automatic in operation, and the load can only be lowered by power operating in the lowering direction.



Molding and Tube-rolling Mill Built by the United Machine & Mfg. Co.

UNITED MOLDING AND TUBE-ROLLING MILL

The United Machine & Mfg. Co., Canton, Ohio, is now building an eight-spindle molding and tube-rolling mill which will produce sections having a developed width up to 13 inches at a speed of from 60 to 300 feet of finished molding or tubing per minute, the exact rate of output depending upon the width of the stock that is used and the complexity of the section to be produced. Eight sets of spindles give a wide range of section designs that can be rolled on this mill. Both the upper and lower spindles are power-driven, thus insuring a positive rolling action and a high class of workmanship in the finished product. The upper spindles have a wide range of vertical adjustment, adapting the mill to a variety of sizes and shapes of sections; and adjustment of the upper rolls provides for regrinding the roll dies, and insures the longest life that it is possible to obtain from each set of dies; this is said to be a distinctive feature of this machine that is found in no other tube mill. The spindles are made of high-carbon crucible steel, hardened and ground and carried in phosphor-bronze bearings. The keyways are cut for the full length of the spindles between the housings to permit the use of roll dies of various widths. Each spindle is enclosed and keyed to a hardened steel sleeve at the front housing, which runs in the phosphor-bronze housing bearing.

The roll housings are made of cast iron and liberally proportioned for the service required of them. The rear housings are bolted to the platen at the bottom and secured together at the top by a rolled steel tie-bar. These housings carry the spindle, gear and pinion bearings for the upper and lower roll dies. The front housings slide on ways on the platen, providing adjustment for the different widths of roll dies that may be used, and the housings are tied together at the top with a rolled-steel tie-bar. All bearings are made of ample size, bushed with phosphor-bronze and arranged with oil-pockets, cups or other approved means of lubrication. The arrangement of the gearing distributes power equally to the eight sets of spindles. Initial drive is from the rawhide motor pinion to the main distributing gears, and thence by gear and pinion reductions to the final drive of each set of rolls. All pinions are made of heat-treated high-carbon cast steel with cut teeth, and all gears are guarded.

The feeding-in device or guide is composed of a set of horizontal tool-steel rolls, hardened and ground and mounted in phosphor-bronze bearings, which, in turn, are carried in a housing having vertical adjustment. Different widths of stock are guided into the die rolls by the vertical grooved rolls of the feeding-in device, which are mounted on spindles carried on an adjustable cross-slide. The set of straightening rolls provides for straightening the finished product as it comes from the run-out end of the mill. These rolls are run in bronze bearings provided with means of lubrication. The roll bearing blocks are mounted in housings that can be adjusted transversely on the platen without changing the vertical feed of the rolls.

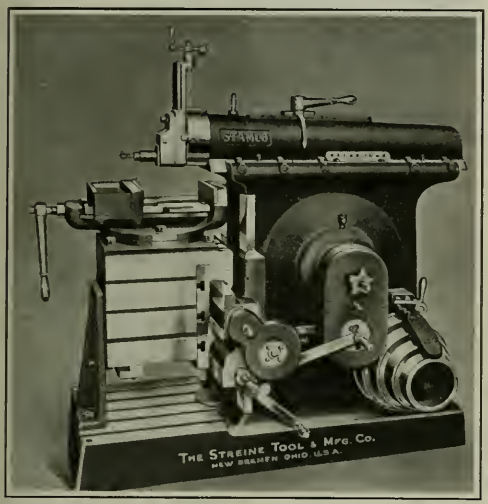
This mill is driven by one 25-horsepower multi-speed General Electric alternating-current motor, controlled by a rheostat starter, which, in turn, is operated by an extension handle running the full length of the tube mill.

"STAMCO" CRANK SHAPER

The 16-inch "Stamco" heavy-duty crank shaper, which has recently been placed on the market by the Streine Tool & Mfg. Co., New Bremen, Ohio, has a base of an extended type, which affords a solid foundation for the machine. It will be apparent from the illustration that there is a large plain surface on the base, which is furnished with T-slots running back to the column to provide for setting up large

pieces of work. This is a heavy-duty machine, and to afford a rigid construction, the column has been liberally proportioned and made of ample size at the base, thus lowering the center of gravity and providing a strong joint between the base and column. The bull-gear bearings are cast solid in the frame and have a large projected area, these two features being the means of effectually eliminating danger of excessive wear or tendency for the bearings to spring out of alignment. The total area of the bull-gear bearings is 205 square inches.

There are extended hubs on the bull pinion on which the intermediate gears are mounted on bronze bushings, as in planer construction. The driving gears are mounted on a long sleeve which slides on a key in the pulley shaft, the ratio of gearing being so arranged that the ram speeds are in geometrical progression. There are no conflicting gear ratios. A sleeve bearing bolted to the column supports the pulley in such a way that the shaft is relieved of all belt pull; and in this way all undue strain is taken off the shaft. A liberally proportioned bearing supports the ram, and by having a large projected area, unit pressure is reduced to a point where there is said to be practically no wear. The ram is clamped to a dovetail slide on the column, similar to the arrangement employed in milling machine construction; and the saddle fits into the narrow guide on the rail.

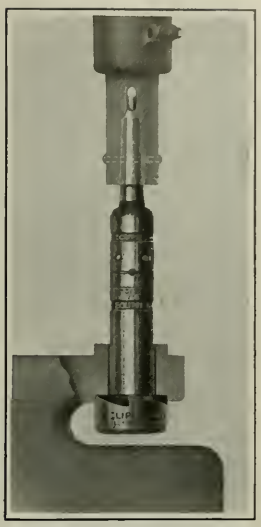


"Stamco" 16-inch Crank Shaper Built by the Streine Tool & Mfg. Co.

A telescopic elevating screw, provided with a ball thrust bearing, regulates the position of the table. As previously mentioned, large pieces of work can be bolted to the saddle or base after the table has been removed. A vise of substantial construction is furnished for use on this machine. Provision is made for varying or reversing the feed while the machine is operating, and any desired rate of feed can be instantly obtained. All adjustments are placed within easy reach of the operator and can be made while the machine is in motion. Micrometer collars graduated to 0.001 inch are furnished on all adjusting screws; and the head and vise are graduated in degrees.

ECLIPSE INVERTED COUNTERBORE

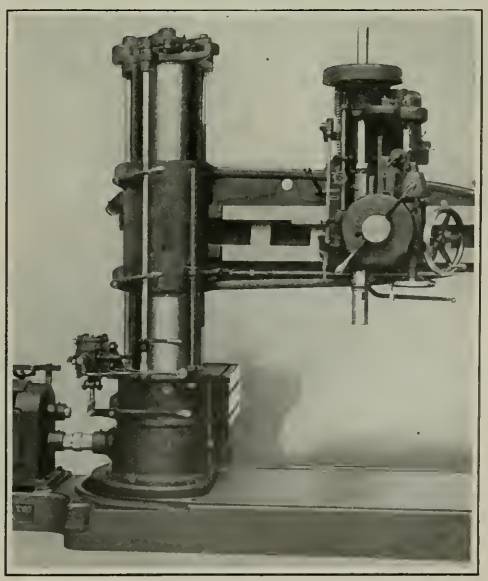
The advantages claimed for an inverted counterbore recently developed by the Eclipse Interchangeable Counterbore Co., Inc., Detroit, Mich., are that it may be attached and detached very quickly by hand without requiring the use of wrenches or screw-drivers. There are numerous classes of inverted counterboring and back-facing operations for which a tool of this type is adapted, and attention is drawn to the fact that this inverted counterbore has been standardized with other tools of this company's manufacture, so that it is interchangeable in much the same way as the standard Eclipse counterbores are. In other words, the inverted counterbore of a certain size will fit any of the piloted shanks of different diameters and vice versa. This tool is especially adapted for use with standard Eclipse counterbore holders, but it is also manufactured with a straight or a tapered shank. As shown in the accompanying illustration, it will be evident that the shank of the tool is inserted through a hole in the work to be faced and through the hole in the cutter, after which the cutter is given a slight turn to lock it in place ready for work. To detach the cutter, it is turned in the opposite direction.



Eclipse Inverted Counterbore

FOSDICK PNEUMATIC AND HAND RADIAL DRILL COLUMN CLAMP

For use in clamping the column of 4-, 5-, or 6-foot heavy-duty radial drilling machines of its manufacture the Fosdick Machine Tool Co., Cincinnati, Ohio, has recently developed a combination pneumatic and hand-operated device which is he e illustrated and described. The most noticeable feature is the location of the cylinder, which not only brings the pressure directly to the point of clamping, but eliminates quite a number of the usual working parts. It will operate



Fosdick Radial Drilling Machine Equipped with the Combination Pneumatic and Hand-operated Column Clamping Device

equally well on extremely high or extremely low pressure, and during tests operated very successfully on a pressure of 45 pounds. Relief valves are provided at each end of the cylinder, and they are regularly set for a pressure of 45 pounds, although 150 pounds or more will show no shock or jar in clamping or unclamping. This condition is secured by an air cushion at each end of the cylinder, formed by additional ports in the valve to cause a compression at the proper termination of each stroke. The valve (a six-ported flat-disk valve) is operated by mechanical connection to a horizontal shifter bar running along the entire length of the radial arm. The advantage of this device is that it has no connection with, and does not interfere with the moving of the spindle head. The advantage of the combination hand clamping feature will be appreciated by those experienced with air-operating devices. In case of failure of the air, petcocks at each end of the cylinder are opened, and the ordinary method of clamping by hand is used.

FOSTER HAND SCREW MACHINES

The Foster Machine Co., Elkhart, Ind., has recently brought out a complete line of hand screw machines embracing five sizes. These are to be known as the Nos. 0, 1, 3, 5, and 7, and they have respective capacities for holding bars 7/16, 13/16, 1 5/16, 1 13/16 and 2 9/16 inches in diameter. Several new features, which will be fully described later in this article, have been perfected and incorporated in the designs. Taken as a whole, however, these machines do not represent a radical departure from established practice in building hand screw machines, but they combine the latest developments in this type of machine in their construction. The power and rigidity that are provided are in excess of the requirements of the most modern tools made of high-speed steel and stellite. A margin above these maximum requirements has been added with the view of providing for any improvements in tool steels that may be made during the next few years.

Unit Principle of Construction

The unit principle of design has been carried out throughout this entire line of machines. As applied in the Foster hand screw machines, each individual machine is assembled from a number of separate units built and kept in stock, ready for delivery to the assembling department. This affords a considerable amount of flexibility in meeting the requirements of individual consignees to whom the machines are shipped. Three different styles of cut-off units, namely, the lever feed cut-off, hand screw feed cut-off and power feed cut-off are being built. These are interchangeable and any of the three can be furnished. Power feed to the turret is provided by a separate unit, and a machine can therefore be built with either power feed to the turret slide or with hand feed. The automatic chuck and bar feed are independent units and can be furnished or omitted as required. Comprehensive sets of jigs and fixtures have been developed for the interchangeable manufacture of the various parts and units entering into the construction of each one of the various sizes of machines.

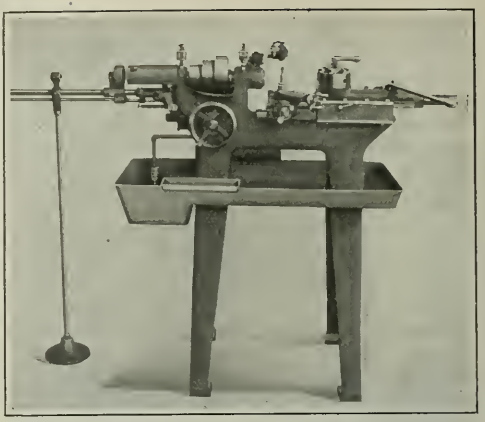


Fig. 2. Foster No. 0 Hand Screw Machine—the Smallest Size

Capacities of the Different Sizes

The No. 0 and No. 1 screw machines, which are of 7/16 inch and 13/16 inch bar capacity, respectively, are designed for high spindle speeds, and they have the sensitiveness of operation which is so essential in machines of the smaller sizes. They are built only in the three-step cone pulley plain head type. The turret-slide, which is operated by means of a hand-lever, has an effective longitudinal movement of 3 inches for the No. 0 machine and 5 inches for the No. 1 size. The No. 0 machine can be equipped with a compound rest, which is interchangeable with the lever feed cut-off, ordinarily furnished with this machine. On the No. 3 machine, the bar capacity of which is 1 5/16 inches, both plain head and friction head types are built. The No. 5 and No. 7 sizes, which are of 1 13/16 and 2 9/16 inches bar capacity, respectively, are built only in the friction head type. The large diameter cone pulley and the powerful friction provide more than ample power for the heaviest requirements. The turret-slide has an effective travel of 7 inches for the No. 3, 9 inches for the No. 5, and 11 inches for the No. 7 screw machine.

Design of the Head

Fig. 5 shows the friction head for the No. 5 Foster screw machine. The gear covers and spindle caps have been removed in order to more clearly show the design. A powerful friction clutch, mounted on the spindle between the cone pulley and the friction gear, serves to bring the spindle into driving connection directly with the cone pulley on one side or with the back-gears on the other. The frictions are of cone type and are operated by a hand-lever through the medium of a long movable sleeve and four fingers mounted on the spindle. This friction is very sensitive in operation and extremely powerful. The front and rear spindle bearings are made of a special grade of bearing bronze, and they are very liberally dimensioned. The spindle is made of a high-carbon steel forging. It will be noticed that the head is cast integral with the bed which is of a double girder type and heavily ribbed internally, a construction which is now found in various types of modern machine tools and which adds to the rigidity.

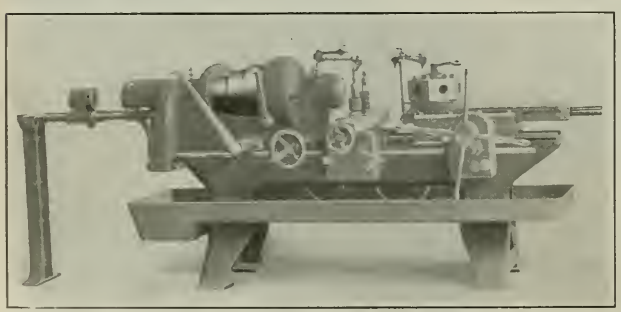


Fig. 1. Front View of the No. 7 Hand Screw Machine Built by the Foster Machine Co.

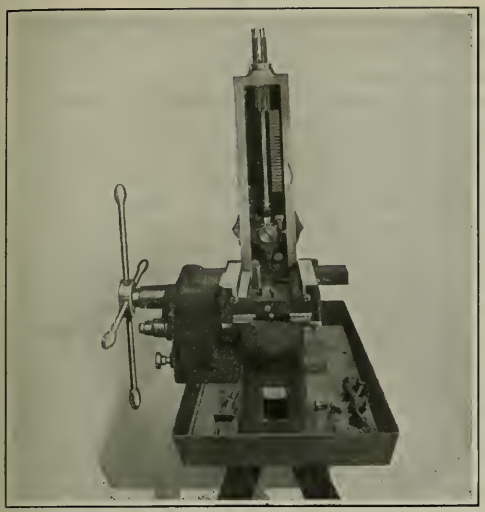


Fig. 3. Turret-slide and Saddle for the No. 3 Hand Screw Machine

Automatic Chuck and Bar Feed

Automatic chucks for use on these machines are of a standard spring collet type; and the automatic chuck hood and spindle nose have been designed to reduce the overhang from the front spindle bearing to a minimum. The collet-operating mechanism differs materially from the design which has heretofore been used by other screw machine manufacturers for this purpose. Instead of the well-known sliding fork principle, a fork-lever principle has been utilized, and the automatic chuck fingers have been equipped with rollers to eliminate friction at this point. This type of chuck mechanism enables an adequate gripping power to be applied by the chuck jaws through the application of only a moderate force to the operating lever. The bar-feed operating mechanism is also new in design. For the No. 0, No. 1, and No. 3 screw machines, a single supporting rod is used; but for the No. 5 and No. 7 machines, the stock support slides on two parallel bars. A continuation of the motion of the automatic chuck lever, as it opens the collet, feeds the bar forward. This is accomplished through a system of links and levers in such a manner that the automatic chuck and the bar feed are operated intermittently.

Turret-slide and Saddle

The No. 0 and No. 1 Foster screw machines are equipped with round turrets, while the No. 3, No. 5 and No. 7 sizes have hexagonal turrets, owing to the fact that flanged tools are desirable for handling the heavier work done on these machines. As previously mentioned, the turret-slide on the No. 0 and No. 1 machines is operated by a hand-lever pivoted on the top of the slide near the rear end. The turret indexing mechanism is very sensitive in operation. A vertical locking bolt is mounted underneath the front of the turret directly beneath the tool that is in operation. Fig. 3 shows a view of the No. 3 turret-slide and saddle with the slide tipped up and standing on its front end, and clearly illustrates the main working parts of the turret indexing mechanism. Attention is called to the fact that the end of the locking bolt lever, which intermittently engages the tumbler for withdrawing this bolt preliminary to the indexing of the turret, is equipped with a roller to increase its sensitiveness of operation and reduce wear. Backward travel of the slide indexes the turret by means of indexing pins in the bottom of the turret and a pawl pivoted in the saddle.

On the No. 3, No. 5, and No. 7 screw machines, a system of revolving independent stops is used, these stops being geared to the turret and indexed with it. The stop-screw working in conjunction with the working station of the turret abuts against a movable stop in the saddle. This stop stands in working relation with the mechanism, disengaging the automatic feed in the saddle apron. The system of independent stops for the No. 0 and No. 1 screw machines differs considerably from the one just described for the larger sizes. Instead of having the stops revolve with the turret, the stops are mounted in the end of the turret-slide. A revolving stop working in the slot between two lugs on the rear end of the saddle indexes with the turret and brings the proper stop into working relation with the forward turret station. Additional sensitiveness of indexing is obtained in this way, which is of especial importance in handling delicate work on small machines.

Power Feeds

At *B* in Fig. 4 there is shown the interior view of the power-feed apron for the turret-slide; and Fig. 3 shows the power-feed rack which is secured to the under side of the turret-slide. This rack engages the pinion on the long through shaft shown at *B* in Fig. 4. Motion is transmitted through a power feed-rod, seen on the front of the bed, to a worm and worm-gear in the apron, and three sliding gears provide means for obtaining the feed changes. These three changes are multiplied by a cluster of two sliding gears in the gear-box at the end of the machine, which provides six changes of feed. Provision is made for the power feed to be engaged and disengaged by a friction working in conjunction with a gear engaging the large driving gear of the pinion-shaft. A face cam on the outside of the apron and the drop-out lever serve the purpose of engaging the feed friction. This drop-out lever stands in working relation with the system of independent stops, as previously described. Attention is called to the fact that the apron is filled with oil up to a certain level and that the lower gears in the gear train, including the worm-gear, run in a bath of oil.

The cross-feed apron shown at *A* in Fig. 4 is similar in design to the saddle apron with the difference that additional sliding gears are introduced in the train to obtain a reverse of the feed movement. The feed friction which works in conjunction with the two large intermediate gears is operated by a rapid-acting and powerful cam, manipulated by a hand-lever. The power-feed apron together with the carriage and cut-off slide constitute a separate unit which is interchangeable with the hand screw cut-off, and also with the lever-operated cut-off, any of which three cut-off units can be furnished. A three-step sliding gear nests in the apron, in conjunction with the two changes obtainable in the gear-box, at the head end of the machine, as already described, and provides six changes of feed to the cross-slide.

An important feature of the design of this machine is

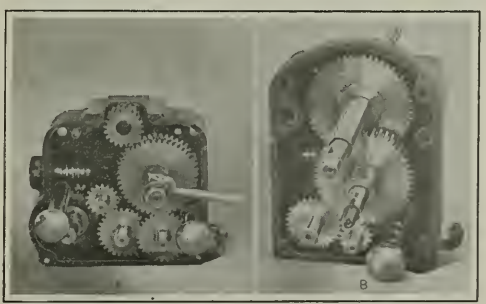


Fig. 4. (A) Apron for Power Feed to Cut-off for No. 3 Machine. (B) Apron for Power Feed to Turret-slide for No. 3 Machine—Covers removed

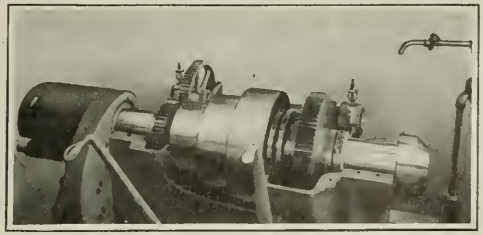


Fig. 5. Friction Head for the No. 5 Foster Hand Screw Machine

the location of the hand longitudinal feed-screw for the various cut-off units which is between the ways of the bed. The force moving the cut-off carriage on the bed is thus applied in the middle of the guide. Immediately inside the handwheel for the hand longitudinal feed there is mounted a large-diameter graduated dial equipped with observation stops. This facilitates the adjustment of the cut-off carriage longitudinally. A similar graduated dial with observation stops is also mounted on the cross-feed screw and used in conjunction with the movement of the cross-slide.

Control Systems

Attention is called to the centralized control and the ease with which the various control levers and knobs can be reached by the operator when standing in his natural position in front of the machine. All of the principal feed changes are located in the aprons. The lever operating the automatic chuck and also feeding the bar forward is placed within easy reach of the operator and, as already pointed out, it operates with unusual ease.

For applying the proper amount of coolant to the work and the cutting tools, the larger machines are supplied with a double system of piping, one working in conjunction with the turret-slide and the other with the cut-off. On the smaller machines, where a smaller amount of coolant is required, only a single system of piping is used.

URBAN BENCH LATHE

The Urban Machine & Tool Co., 2424-2430 St. Clair Ave., Cleveland, Ohio, has recently developed a screw-cutting bench lathe of quite unusual design. This machine is direct motor-driven with the spindle running in ball bearings, and due to the unusual method of mounting the carriage it is said to possess capacity for taking an exceptionally heavy cut without chatter. A machine of this type is said to be suitable for use in tool-rooms, experimental departments, laboratories, and on general commercial work, as it is adapted for handling from the lightest to the heaviest jobs that come within its range. From the accompanying illustrations the reader will at once notice the way in which a rather unusual application of direct-connected electric motor drive eliminates the need of using a belt, pulleys, or countershaft. A massive housing encloses all moving parts, including the motor which is built into the headstock. The

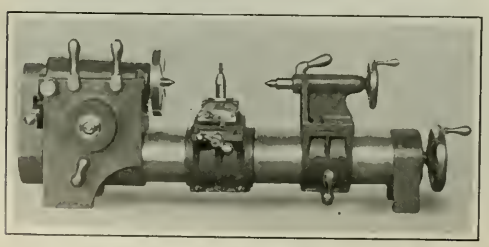


Fig. 1. Screw-cutting Bench Lathe Built by the Urban Machine & Tool Co.

gears are made of a special alloy steel, heat-treated to give the desired physical properties. They run submerged in oil, so that wear is reduced to a minimum. The bearings are of a radial thrust type, totally eliminating end play of the spindle which is made of 60-point carbon steel, heat-treated and ground to size.

One of the more unusual features of the design of this machine is its cylindrical bed, which is ground exactly to size and provided with a hardened and ground take-up gib. It will be seen that the tailstock completely embraces the bed, thus assuring a means of rigid clamping and allowing the tailstock to be set over to provide for the performance of taper-turning operations. Similarly, the carriage is ground to embrace the bed, and this method of support provides an unusually large bearing surface, which is said to eliminate chatter, and reduces wear to a minimum. A compound rest is provided which may be set at any desired angle; and longitudinal movement of the carriage is easily controlled and can be stopped instantly by throwing out a clutch lever on the headstock.

By placing the lead-screw inside the bed, it is thoroughly protected from chips and dirt. Provision is made for quickly detaching and easily changing gears to provide for cutting any standard threads from 8 to 64 per inch, including the 11½ pipe thread, and also for obtaining any desired

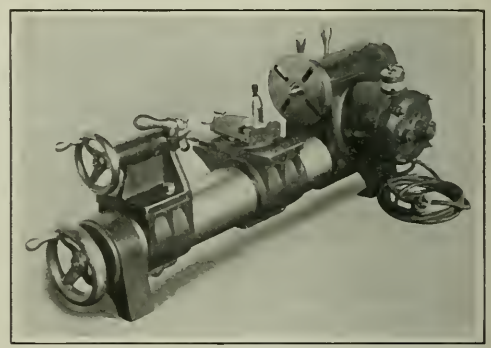


Fig. 2. Opposite Side of the Urban Bench Lathe, showing Direct-connected Motor Drive

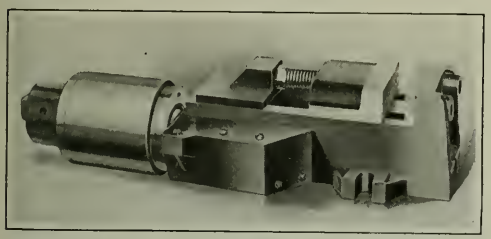
rate of feed. The motor is furnished with a cord for connection to a lighting socket, which makes the machine very easy to set up. This arrangement also makes the machine portable as it only weighs 200 pounds, and no overhead works are required for driving. This machine swings 8 inches over the bed and 5¾ inches over the carriage. The capacity between centers is 12 inches. Either an alternating- or direct-current motor can be furnished, and there are five selective speeds of 125, 250, 400, 650, and 1000 revolutions per minute, with a reverse speed of 300 revolutions per minute.

AMERICAN PNEUMATIC MILLING VISE

For use in holding work during the performance of milling operations, the American Pneumatic Chuck Co., 9 S. Clinton St., Chicago, Ill., has recently developed a vise which can be either operated by compressed air or by hand. It is of the same width, depth, and opening of the jaws as the regular hand-operated milling machine vises, and is made so that it may be placed either crosswise or lengthwise on the milling machine table. No parts extend above the jaws which hold the work, so that the milling cutters can pass over the entire vise without interference. The design is somewhat similar to that of a standard hand-operated milling vise, as the jaws and screw-slide are the same, and the body has the usual tongues and slots for the guides. By

making the vise body from a steel casting, ample strength and rigidity are assured and the vise is made capable of withstanding the usual severe service encountered by such tools when operated in the average machine shop. The adjusting screw slide is built into the body and is practically an integral part. It is claimed that one of the valuable features of this vise is that after a piece of work has been gripped by the jaws the air supply may be entirely shut off, thus effecting a considerable saving in the amount of air that is consumed and still assuring the work being held securely in position until the machining operation has been completed.

A considerable amount of power is required to hold a piece of work between the jaws of a vise, and realizing this fact, the manufacturer has provided this vise with an air cylinder 4 inches in diameter. With an air pressure of 80 pounds per square inch on the piston, it will be evident that about 1,000 pounds initial pressure is available; and by means of a toggle mechanism this initial pressure is multiplied more than thirty times. Allowing for friction losses, etc., the final gripping power applied to the jaws should be in excess of 25,000 pounds. Although the vise is capable of exerting this enormous pressure, the jaws can be so adjusted that it will hold the most delicate pieces of work without damaging them. The air cylinder is double-acting to provide for opening and closing the jaws, and the action can be made practically instantaneous or it may be so regulated that the jaw travels very slowly toward the work. The air valve is mounted directly on the cylinder, and only one hose con-



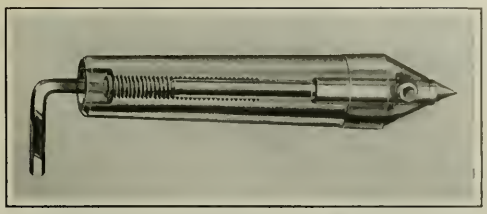
Air-operated Milling Vise Made by the American Pneumatic Chuck Company

nection is required. By merely moving a small handle, which can be done with practically no effort, the work can be clamped with such an enormous gripping power that it would be impossible to tighten it any further by means of a screw. The automatic action ranges from 0 to ¾ inch. Standard jaws furnished for use on this vise are plain, but special jaws may be made to meet the requirements of any specified job. Air-operated vises of this kind are made in four sizes known as Nos. 1 to 4, respectively, and having jaws 4, 5, 6, and 7½ inches in length.

ROBINSON ADJUSTABLE LATHE CENTER

The accompanying illustration shows an adjustable-point lathe center which is now being manufactured by the Robinson Adjustable Center Co., 1310 Twelfth St., Detroit, Mich. It is claimed that this new center will eliminate the waste of time and material caused by the necessity of frequently grinding lathe centers. The device is quite simple, consisting of four parts, namely, the body, center point, adjusting screw, and locking screw. The body is made of carbon steel, but the center point is high-speed steel, drawn just enough to relieve the strain of hardening. By holding all important dimensions within close limits of tolerance, the parts of this device are made interchangeable.

Not only does the high-speed steel point give from seven to nine times more service per grind than does an ordinary carbon steel center, but when it does become necessary to



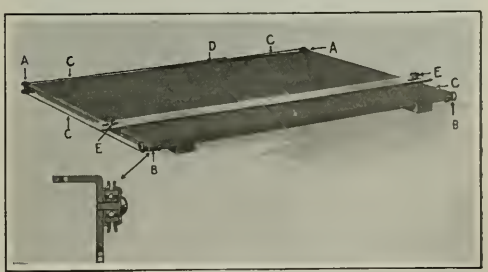
Lathe Center with Adjustable Point, Made by the Robinson Adjustable Center Co.

grind a new point there is a much shorter angle to be ground and a much heavier feed can be used, as the high-speed steel will withstand a greater friction heat than the carbon steel without its temper being drawn. This makes it possible to reduce the time of the grinding operation from the usual fifteen or twenty minutes to one to two minutes. As the point is gradually worn down, it is adjusted with the regulating screw, without having to shift the tailstock, and when finally worn out, only the small center point needs to be replaced, instead of scrapping the entire center. This adjustable center can be used in either the tailstock or the spindle of a lathe or grinding machine, and no job is too heavy for it.

ECONOMY PARALLEL RULER ATTACHMENT

An improved parallel ruler attachment for use on drawing-boards, which has recently been developed by the Economy Drawing Table & Mfg. Co., Adrian, Mich., consists of a set of two ball-bearing double pulleys *A* attached to the back corners of the board and two single ball-bearing pulleys *B* attached to the front corners. A wire cord *C* is placed around these pulleys, making a double lap around each end and at the back of the board; but there is no wire across the front. By crossing the wire at the back, the upper laps at both ends move forward or backward simultaneously. The ends of the wire are joined at the back through a steel spring *D*, and both ends of the straightedge are attached to the upper wire at the ends of the board by means of binding posts *E*, thus making it impossible to move one end of the straightedge without moving the other a corresponding amount in the same direction.

It will be obvious that the use of an attachment of this kind does away with the need of watching the head of an ordinary T-square, to make sure that it is always firmly against the edge of the drawing-board; and as a result, the draftsman using one of these attachments is able to work more rapidly than would otherwise be possible. Perfect accuracy is obtained because opposite ends of the straightedge are attached to the same wire and movement of one end of the straightedge can only be accomplished by a corresponding movement of the opposite end in the same direction. The straightedge will not slide off the board when it is in-

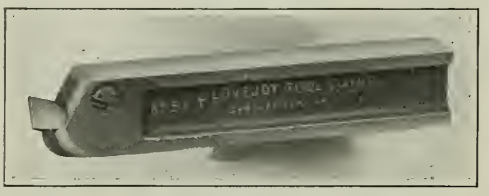


Parallel Ruler Attachment Made by the Economy Drawing Table & Mfg. Co.

clined, and it is possible to lift the straightedge clear of the board when changing drawings, without loosening any thumb-nuts. This straightedge can be set at any angle across the board, if so desired.

LOVEJOY RIGHT-HAND TOOL

In the accompanying illustration is shown a right-hand turning, facing, and planing tool, which has recently been added to the line of positively located inserted-cutter tools made by the Lovejoy Tool Co., Inc., Springfield, Vt. It will be seen that this tool is made without any projections that are likely to catch the workman's clothes or interfere with the work or machine on which it is used. A tool of this kind is especially adapted for operation on a machine that does not conveniently permit of the removal of the tools from the front side of the carriage, or where clustering is necessary, with no overhang. This tool is liberally proportioned, having a shank measuring 1⅛ by 1⅞ inches, and a



Right-hand Turning, Facing and Planing Tool-holder Made by the Lovejoy Tool Co., Inc.

¾-inch high-speed steel cutter that is mounted in the holder at such an angle that very little or no grinding is required except on the end. The tool is pushed forward to compensate for wear. By slightly modifying the end of the cutter, this tool is converted into an efficient and serviceable planer tool. It can be used for all ordinary jobs for which a solid forged tool of this size can be employed, and a saving of high-priced steel is effected through the substitution of an inserted cutter for a solid tool.

H. H. ARNOLD REAMERS AND COUNTERBORES

To reduce the cost of high-speed steel reamers, the H. H. Arnold Co., Rockland, Mass., has recently developed a method of manufacture by which high-speed steel blades are held in machine steel bodies by staking them in place. With reamer blades, the area of contact is so large in proportion

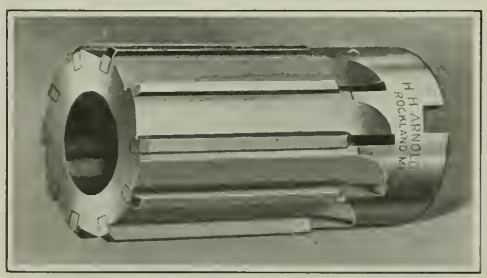


Fig. 1. Shell Reamer Made by the H. H. Arnold Co. with Inserted High-speed Steel Blades

to the pressure exerted, that ample holding power is said to be afforded by this method. Adjustment is provided by tapering the slots so that driving the blades forward increases the diameter of the reamer and maintains the cutting point at the end. The purpose of this adjustment is merely to compensate for wear; it is not practical to adjust for one or two over-size holes and then back to size. Driving the blades out and regrinding after they are worn down

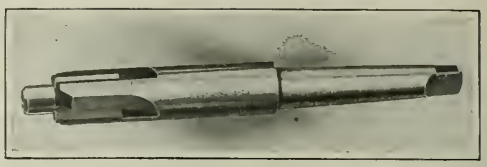


Fig. 2. Counterbore Made by the H. H. Arnold Co. with Inserted High-speed Steel Blades

below the specified limits of accuracy may be repeated several times and greatly increases the life of the tool.

Counterbores are made by this company, using the same general method of supporting high-speed steel blades in machine steel bodies; but in the case of counterbores, the blades are secured in place by brazing, in a manner similar to that employed in the case of milling cutters of this company's manufacture which were described in the July number of MACHINERY. On the counterbores, the pilots are interchangeable and they are hardened and ground and held in straight holes by means of set-screws. These counterbores are made in standard sizes from ¾ inch to 2⅝ inches outside diameter, and three standard shank sizes cover the entire range. The pilot sizes range from 7/16 inch up, and all stock sizes are made with Morse taper shanks.

COWAN METAL FEET FOR TRANSVEYOR SKIDS

To provide for increasing the length of service obtained from wooden skids used with elevating trucks or so-called "transveyors", the Cowan Truck Co., 16 Water St., Holyoke, Mass., is now manufacturing metal feet of the form shown in place on a skid which is illustrated in connection with this description. These feet are made of cast iron and

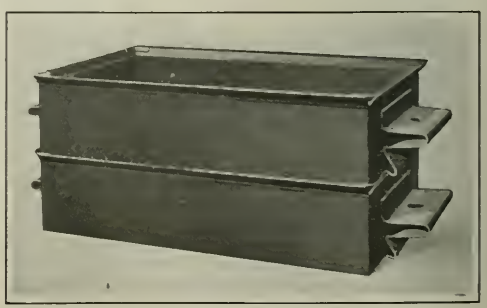


Metal Feet Made by the Cowan Truck Co. for Use on Transveyor Skids

bolted in place on the skid. They take the wear to which the wooden supporting surfaces would otherwise be subjected and are said to more than double the life of a skid on which they are used.

E. F. HAUSERMAN TOTE-BOX

To meet the requirements of manufacturing plants which have large quantities of small parts to be handled and stored, the E. F. Hauserman Co., Cleveland, Ohio, has re-



Steel Tote-box manufactured by the E. F. Hauserman Co.

cently developed an improved steel tote-box. It is claimed that the design has been worked out along such lines that boxes of this type are "pinch proof" in handling, and they may be stacked together to effect the maximum economy of floor space. These features are secured through the application of a special form of handles, and by the construction which is such that the top of each box cannot become distorted. At the upper edge, the metal on the sides and ends is folded back on the under sides and welded, and the insides of the upper corners are reinforced with electrically welded plates made of 14-gage steel. The handles are large and broad, assuring easy handling, and no edges of metal are left above the handles in a way which will allow them to become loose and constitute a constant danger of cutting the workman's hands. Two heavy 1-inch steel runners are welded to the bottom for the full length, and add greatly to the amount of service obtained from a box.

ELWELL-PARKER ELECTRIC SHELL TRUCK

The movement of shells of the larger sizes, when a crane is not available, has proved quite a problem. To provide for handling them without damage to the finished surface or copper bands necessitated developing a special equipment for arsenal use. The Elwell-Parker Electric Co., Cleveland, Ohio, has recently placed an equipment on the market which makes this work comparatively easy. Large shells weigh from ½ ton to 1½ tons, and when first landed by crane they are laid on 4- by 4-inch timbers on the floor. The electric ammunition truck approaches from the base end, and a special leather-lined hand-clamped belt is placed



Truck Built by the Elwell-Parker Electric Co. for Picking up and Carrying Large Shells

about the shell. Then the cables are payed out until the eyes in the lift-bars may be dropped over the clamp trunnions. The operator now closes an electric switch which starts the special Elwell-Parker low-voltage hoist motor that takes current from a storage battery. As the two cables are wound in, the shell is rocked into a vertical position and then lifted a few inches off the ground. At this point the cable sheaves strike the overhanging crane structure at the top. The whole crane frame is pivoted on the truck trailing axle, and as the drum continues to wind in the cables, the whole crane frame lined with wood blocks rocks with the shell backward over the axle, and is supported by the combined action of tension on the cables and the special spring buffers on each side. At a predetermined point, the hoist motor is stopped by an automatic tripping device actuated by the rocking crane. The shell is carried in this position. Exactly the reverse operation takes place in setting the shell down.

NEW MACHINERY AND TOOLS NOTES

Slide-rule: Knief & Co., 4168 W. 25th St., Chicago, Ill. A standard Mannheim slide-rule with a metal body made of nickel silver to which the graduated white celluloid facings are glued. The body or frame of the rule is die-cast.

Transformer: Westinghouse Electric & Mfg. Co., East Pittsburg, Pa. An improved line of distribution transformers which are so constructed that a reduction of weight exceeding 33 per cent is made possible. This is largely the result of substituting a welded sheet-steel case in place of one made of cast iron. These transformers are known as the "Steel-clad Type S."

Portable Kerosene Furnace: Champion Kerosene-Burner Co., Kenton, Ohio. A portable kerosene burning furnace which is adapted for use in heating rivets, tools and other work of a similar nature. It is a self-contained unit with the fuel tank carried by a lower platform of the stand. The tanks are made in various sizes, depending on the service required of the furnace.

Back-geared Engine Lathe: Rockford Lathe & Drill Co., Rockford, Ill. An "Economy" 14-inch double-back-geared, quick-change engine lathe which has been redesigned to meet the demand for a small heavy-duty machine having sufficient power for use in the production departments of progressive manufacturing plants where the work involves operation under high speeds and heavy feeds.

Face Masks: Julius King Optical Co., 10-12 Maiden Lane, New York City. A face mask designed to afford protection for men using autogenous cutting and welding torches. These masks are made of fiber and there is provision for a free circulation of air between the mask and the workman's face, which not only keeps him cool, but avoids tendency of the lenses to become fogged.

Abrasive Wheels: Wolf New Process Co., 711 Hanover St., Meriden, Conn. Abrasive wheels made by a process which is claimed to enable them to have a free cutting action. Any desired abrasive may be used in making these wheels, as the special process only concerns the bonding material. Wheels of this kind are made in any size or shape within the limits of present commercial standards.

Improved Features of Planer Construction: Cincinnati Planer Co., Cincinnati, Ohio. This company has recently made a number of noteworthy improvements in the construction of planers of its manufacture, which include the introduction of such features as forced lubrication, a box type of construction for the bed and table, the use of herringbone gears, and the provision of rapid-power traverse.

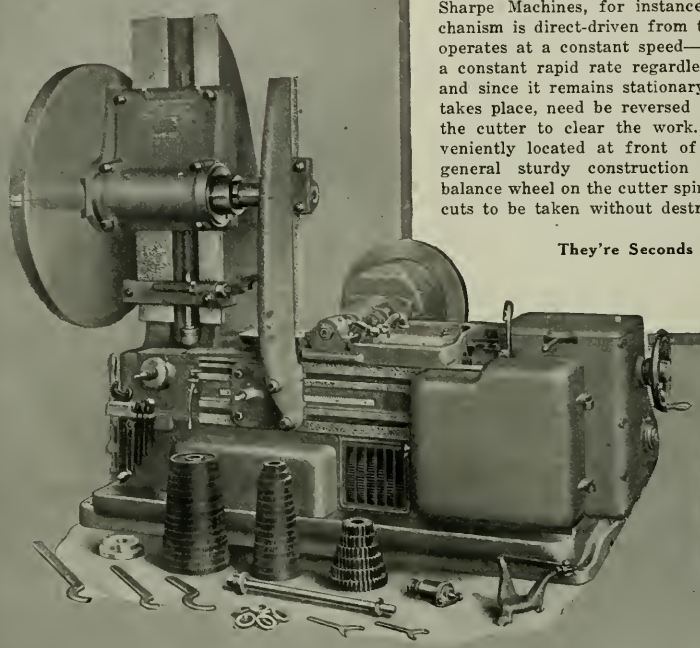
Unit Jacks and Bolt Couplers: Roberts Mfg. Co., 152 Brewery St., New Haven, Conn. For use in setting up and facing work in position on drilling, slotting, and planing machines, this company has developed a line of unit jacks and bolt couplers. This equipment takes the place of a miscellaneous assortment of clamps and blocks commonly used for the purpose, and reduces the time required for setting up work.

Automatic Water Heater: Bridgeport Machine & Tool Mfg. Co., Bridgeport, Conn. An automatically operated electrical water heater which provides for the delivery of hot water by simply turning the faucet. The result in this respect is the same as that produced by an automatic gas heater. This device is known as the "Ever Hot" water heater and is adapted for providing hot water in the washrooms of industrial plants, etc.

Horizontal and Vertical Milling Machines: Cincinnati Milling Machine Co., Cincinnati, Ohio. A Type M milling machine which is of similar design to the plain 18-inch manufacturing miller and the No. 5 high-power miller of this company's manufacture. The new Type M milling machine is made in Nos. 1 and 2 sizes and in three styles, namely, plain, universal, and vertical. All of these new machines are of the constant-speed type.

Cabinet Truck for Welding and Cutting Apparatus: Davis-Bournonville Co., Jersey City, N. J. This cabinet truck provides a convenient means of transporting oxy-acetylene welding and cutting equipments which can be used direct from the truck. An upright steel cabinet body is mounted on wheels, and there is a platform to support an oxygen and either a hydrogen or an acetylene cylinder, the cylinders being held in place by chains.

Make the *Seconds* Work



Time saving features are numerous on Brown & Sharpe Machines, for instance: the indexing mechanism is direct-driven from the drive pulley and operates at a constant speed—the slide returns at a constant rapid rate regardless of feed or speed and since it remains stationary while the indexing takes place, need be reversed only far enough for the cutter to clear the work. Controls are conveniently located at front of the machine. The general sturdy construction together with the balance wheel on the cutter spindle allow fast heavy cuts to be taken without destructive chatter.

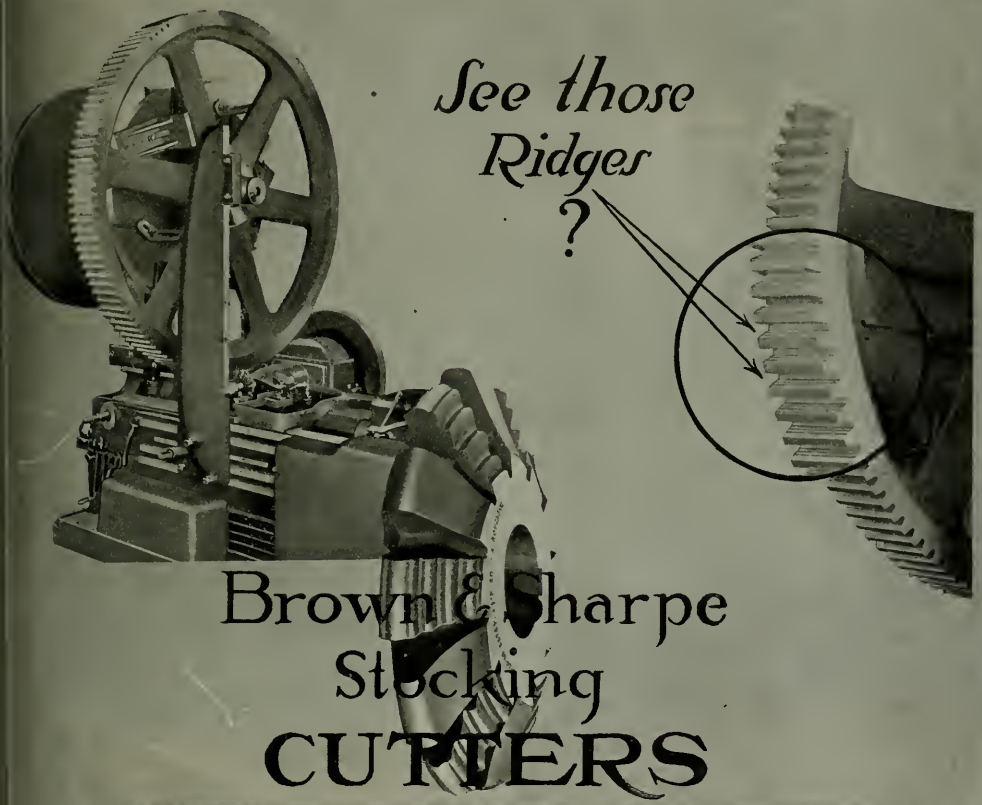
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Results: Greatly increased production, longer life for the cutters and a considerable saving in time otherwise spent in changing and sharpening cutters.

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Sterilizing Cutting Oils by Pasteurization and Centrifugal Separation

OPERATORS of automatic screw machines, gear-cutting machines, and other types of machine tools on which it is necessary to keep the cutters and work flooded with oil or one of the soluble oil cutting emulsions, have experienced trouble through the development of various forms of skin disease which are known under the general name of "compound poisoning." In some plants, this trouble has assumed such serious proportions that large sums of money have been spent in conducting investigations, with the idea of definitely ascertaining the cause of these eruptions which develop on the hands and arms of machine operators, and of removing the cause of infection.

Despite these efforts which have been made, there still seems to be no definite agreement as to the exact nature of the skin diseases caused by cutting oils, although they are quite generally attributed to the presence of bacteria in the oil. Not only are there a variety of opinions concerning the cause of the disease called compound poisoning, but there are also a number of different methods by which an attempt has been made to remove all bacteria and other foreign matter from the oil, that is likely to be responsible for the trouble.

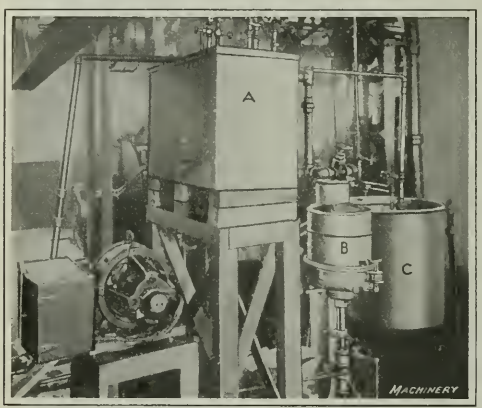


Fig. 1. Original Plant installed in Ford Factory for Cleansing Cutting Oils by Pasteurization and Filtration

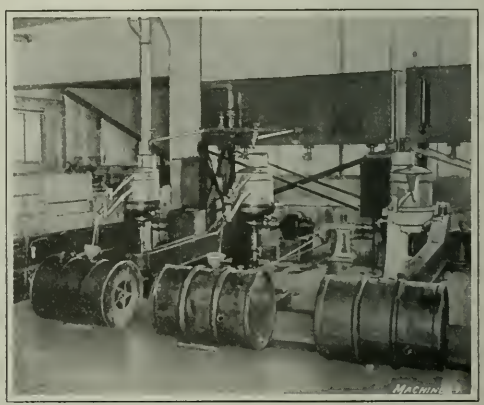


Fig 2. Oil Cleansing Plant of Improved Design, which operates on the Same General Principle as that shown in Fig. 1

A Departure from Established Practice in Sterilization

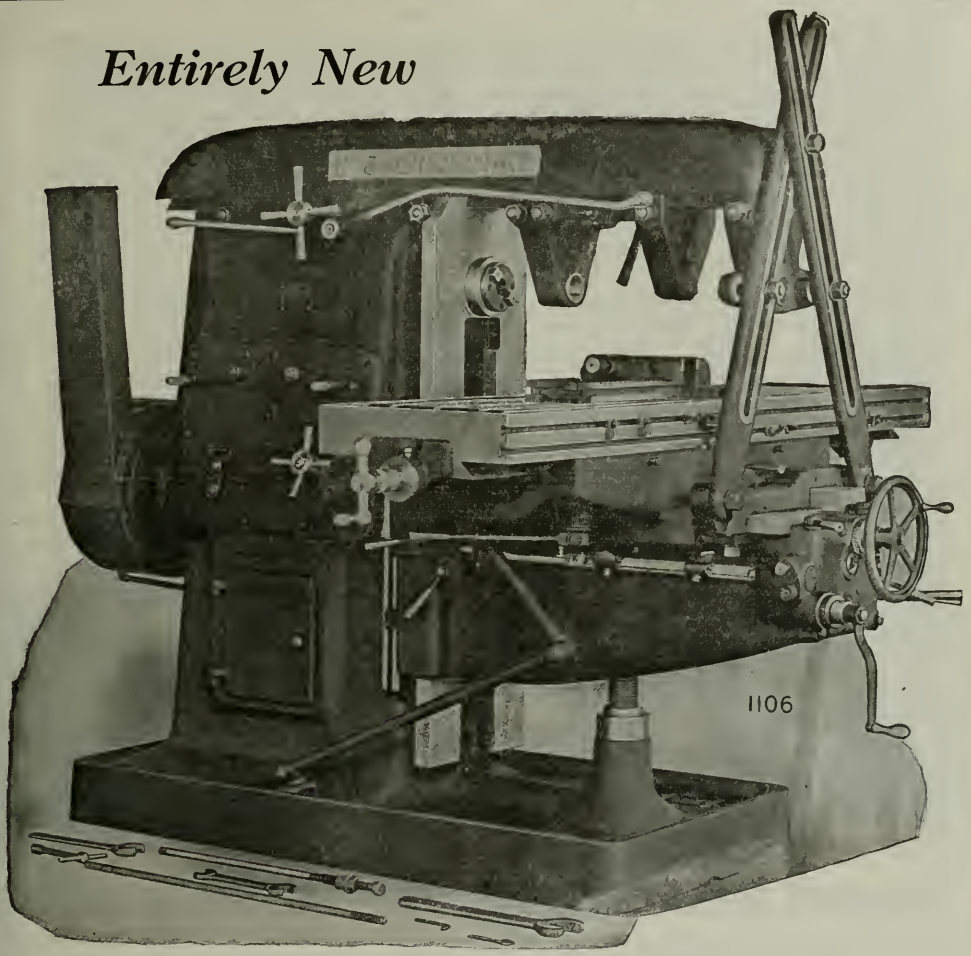
Two general methods have been employed for the removal of bacteria from oils and cutting compounds: First by the addition of a germicide such as carbolic acid or creosote to the oil; and second, through employing a process of sterilization by heating the oil. But neither of these methods has been developed to a point where definite assurance may be given that oil so treated will not cause cases of skin disease among operators of machines on which the oil is used. An interesting discovery of the assistance given by a centrifugal separator in helping to remove bacteria from oil was made by James W. Ramsdell, in connection with his inspection of working conditions at the plant of the Ford Motor Co. in Detroit, Mich. After trying various methods for the purification of coolants used on metal-cutting tools in this factory, a practice was finally adopted of first subjecting the oil to pasteurization in an equipment so arranged that the fluid could be raised to any temperature up to 212 degrees F. After receiving this treatment, and before the oil was allowed sufficient time to cool, it was removed from the pasteurizing apparatus and placed in a centrifugal cream separator, with the idea of removing suspended foreign matter. Centrifugal separation of the hot oil was more effective than where it was treated at a normal temperature, because the hot oil is less viscous. Tests were made of the number of bacteria present in the oil before and after receiving this centrifugal treatment, and it was found that the oil passed through the separator was free from bacteria, while samples taken after the process of pasteurization were still quite heavily contaminated. This fact has been definitely determined, although the way in which the bacteria are removed is still a matter of hypothesis. It is suggested that the bacteria may gather into groups possessing sufficient weight so that centrifugal force is able to act upon them.

Mr. Ramsdell has also reached the conclusion that cases of compound poisoning which develop among machine operators are not due solely to the presence of bacteria in the oil, although these are an important factor. It is his belief that there are two other contributory causes, namely, a poor physical condition of the operator, and the tendency of hydrocarbon oils to dissolve fats from the skin. Removal of the fatty matter from the skin leaves it dry and liable to crack; and then the bacteria in the oil find their way through these abrasions and, assisted by the poor physical condition of the operator, they are able to cause localized blood-poisoning.

Method Developed for the Treatment of Oils and Cutting Compounds

Fig. 1 shows the first experimental plant which was installed at the Ford Motor Co.'s plant, for applying a combination of the principles of pasteurization and filtration for cleansing oil. Sixteen gear-cutting machines which are partially shown in the background of this illustration were supplied with cleansed and sterilized oil, treated in this purification plant. The results obtained from the gear-cutting machines demonstrated that not only were the operators kept free from infection, but that a better grade of workmanship could also be produced; and the average production obtained from each of the rotary gear-cutting tools be-

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fore grinding became necessary, was forty more gears with the purified oil than where dirty oil was employed.

In Fig. 1, the pasteurizer is shown at *A*. This part of the apparatus was equipped with steam coils capable of raising the temperature of the oil as high as 212 degrees. From the pasteurizer, the oil is discharged into a DeLaval centrifugal cream separator shown at *B*, which not only removes suspended foreign matter from the oil, but also has a tendency to remove bacteria in the manner previously described. After passing through separator *B*, the oil is delivered to a cooling tank *C*, in which its temperature is reduced to normal, after which the oil is ready to be returned to the gear-cutting machines for subsequent use.

One of the chief reasons why the oil is able to give so much better service after being treated in this way, is that all particles of metal have been removed, so that their abrasive action on the edge of the cutting tool is eliminated. Some authorities claim that the removal of such impurities is also a factor in improving sanitary conditions, because the metal particles are believed to have a tendency to abrade the skin and cause openings, which either admit bacteria or allow the irritating properties of the oil to become effective in causing sores to form on the machine operator's hands and arms.

Fig. 2 shows a better organized oil cleansing plant that is now used at the Ford factory. In the background of this illustration there will be seen an elevated tank to which the dirty oil is returned and subjected to a temperature suitable

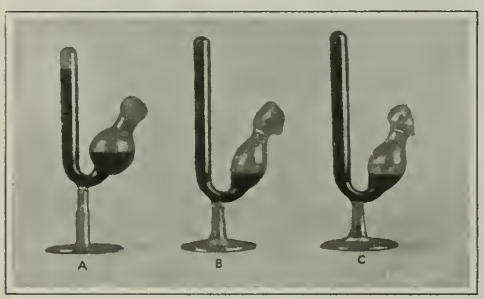


Fig. 3. Three Fermentation Tubes used for determining Presence of Bacteria in Cutting Oils. Untreated Oil at A contains Bacteria; there are no Bacteria in the Treated Samples B and C

for pasteurization, by means of steam coils provided in the tank for that purpose. The oil can be drawn off by gravity into the centrifugal separators which are mounted at a level midway between the bottom of the pasteurizing tank and the floor. The equipment shown in this illustration had not been completed at the time that the photograph was taken. In the illustration the oil is shown flowing from the centrifugal separators into funnels placed in steel barrels that receive the clean oil; but it is the intention to have this clean oil delivered into a cooling tank, from which it will be pumped back through piping to the various machines on which the oil is used. There seems to be no limit to the possibility of rejuvenating oil. By this process of sterilization and filtration, the oil is said to be brought back to 100 per cent efficiency after each treatment, so that the expense of lubricating or cutting oils is reduced to the cost of labor for operating the cleansing plant plus the value of the slight amount of oil which is lost by spattering on the floor, etc. The saving made possible at the plant of the Ford Motor Co. by treating cutting oils and compounds in this way, is estimated at from $200 to $300 a day, in addition to a substantial improvement in the quality of the work.

Testing Oil to Ascertain Its Freedom from Bacteria

Those who have any knowledge of bacteriology know that one of the causes of a case of infection that arises through the presence of bacteria in the system is the extreme rapidity with which many of the disease-producing species of bacteria increase. As a case in point, let us consider what happens if a dangerous form of germ finds its way into an abrasion on the skin of a workman's hand. In a very short time, this single germ may have developed into an incredibly large number of bacteria which are able to cause a bad case of compound poisoning.

This tendency for bacteria to increase rapidly under favorable conditions is utilized by bacteriologists in determining the presence of bacteria in cutting oil, or in other substances under test, or the freedom of the oil from bacteria. The method of procedure is to make what is known as a "culture," which is simply a medium that is favorable to the growth of bacteria. Many different kinds of cultures are used, among which mention may be made of ox bile sweetened with lactose. Fig. 3 shows three fermentation tubes that are used in the present instance for determining the presence of a form of bacteria in the oil which has the tendency to produce fermentation when placed in a lactose-bile culture; and its presence is made evident in a culture contained in a fermentation tube by the presence of gas, which results from fermentation of the culture in the closed end of the tube. At *A*, Fig. 3, there is shown a culture in which this form of bacteria is present, while at *B*, no gas has formed in the fermentation tube, and so it is reasonable to assume that this culture has not developed any of the bacteria for which the test was made.

In making a culture, great care must be taken to have the fermentation tube or other vessel in which it is placed, care-

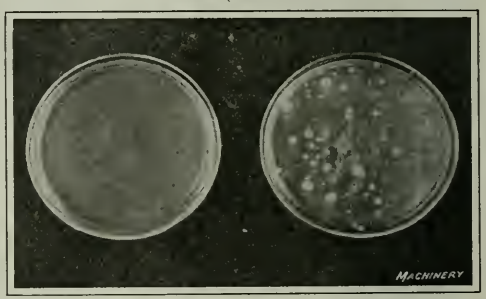
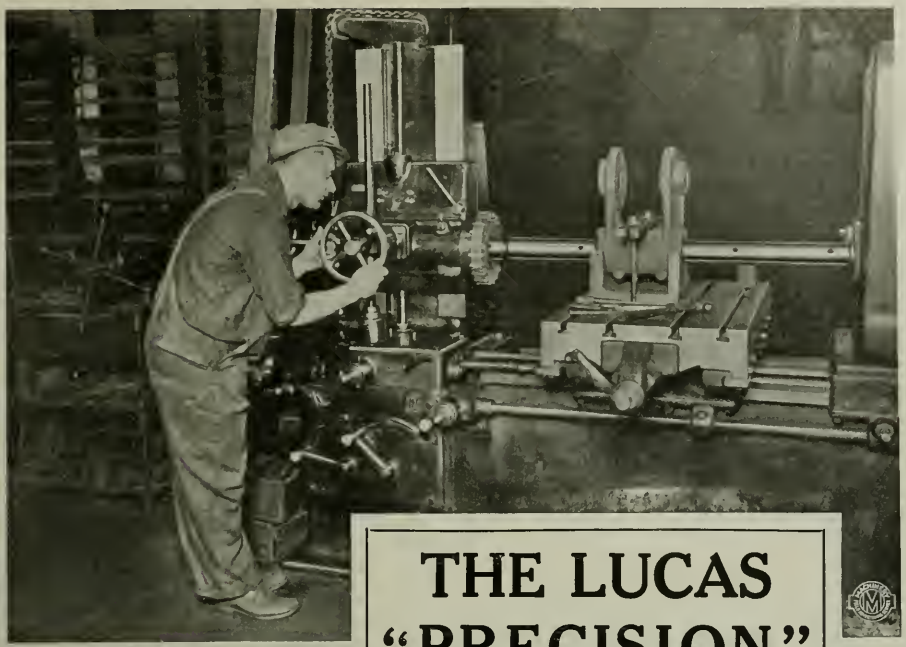


Fig. 4. Method of testing Oil to determine the Number of Bacteria which are contained. The Result of the Test is expressed as a Number of Bacteria per Cubic Centimeter

fully sterilized, so that it is perfectly free from bacteria. The culture medium is then placed in the container, and a test for the presence of bacteria in the oil is conducted by dipping a sterilized platinum wire into the oil to bring out a single drop of the oil, which is put in the culture. After this has been done, the culture is placed in an incubator, where the temperature is maintained at a degree most favorable for the development of the type of bacteria for which the test is being made. At *A*, Fig. 3, there is shown a culture which was inoculated with unpasteurized oil, and the culture at *B* was inoculated with pasteurized oil. As gas is developed in the fermentation tube *A*, and no gas in the tube at *B*, it can be assumed that all of the bacteria that were present in the uncleansed oil were eliminated by the treatment to which it was subjected.

Determining the Number of Bacteria Present in Oil

Determinations of the number of bacteria which are present in an oil or any other fluid under test, are usually expressed in a specified number of bacteria per cubic centimeter of the fluid. Determinations of this kind are made by a process known as "plating out." For this purpose, a gelatin culture is made in a sterilized dish of the form shown in Fig. 4. Each of these dishes is provided with a close-fitting cover, which excludes air and avoids the possibility of bacteria carried by air finding their way into the culture. When the cultures have been prepared, the oil to be tested is placed in a pipette, which is graduated to provide for delivering



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exactly one cubic centimeter of oil into each culture; and care is taken to see that the oil is uniformly distributed over the entire surface of the gelatin.

By leaving the culture in an incubator for a period of twenty-four hours, any bacteria carried by the oil are given an opportunity to develop, each individual germ producing a colony which can be readily seen on the surface of the gelatin. In Fig. 4, it will be evident that the surface of the gelatin in the right-hand dish is covered with white spots, each of which is a colony of bacteria that has developed from a single germ which was deposited on the gelatin from the one cubic centimeter of oil placed in the dish. The bacteriologist counts these colonies which have developed on the gelatin, and this number represents the bacteria per cubic centimeter that were in the oil at the time the test sample was taken. The dish at the left-hand side has no bacteria present in it. E. K. H.

* * *

CRANK-HANDLE DRILLING FIXTURE

Various sizes of cast-iron crank-handles are required for use on the line of gasoline-measuring pumps and similar garage equipments which are manufactured by S. F. Bowser & Co., Inc., of Fort Wayne, Ind. Extreme accuracy is not necessary in making these parts, but it is of importance to

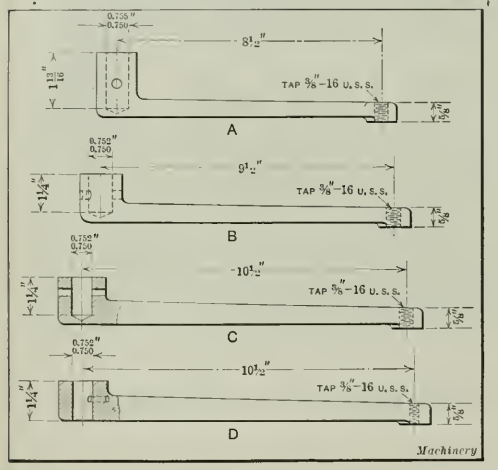


Fig. 1. Four Sizes of Crank Handles to be drilled

reduce production costs in machining them just as far as possible. With this idea in mind, a multiple indexing drill jig was developed, which is adapted for drilling and reaming the holes in opposite ends of these crank-handles. Either four or five handles are drilled and reamed simultaneously on a multiple-spindle drilling machine equipped with one of these jigs, the number of pieces drilled at a time being dependent upon the size of the crank-handles that are to be machined.

Fig. 1 shows four different styles of crank-handles which are drilled and reamed in the indexing jig illustrated in Fig. 2. It will be seen that these handles are 8½, 9½, and 10½ inches in length, respectively. To adapt the same jig for holding pieces of these different sizes, use is made of the three different filler blocks shown in Fig. 3, which are marked *A*, *B*, and *C* and *D*, to coincide with the marking of the corresponding sizes of crank-handles shown in Fig. 1. It will be evident that these filler blocks are of the same design, except that block *A*, which is adapted for holding the 8½-inch handles, is made to project 2 inches further out from the center of rotation of the jig than the filler block marked *C* and *D*, which holds the two longest handles. Block *B* is an intermediate size.

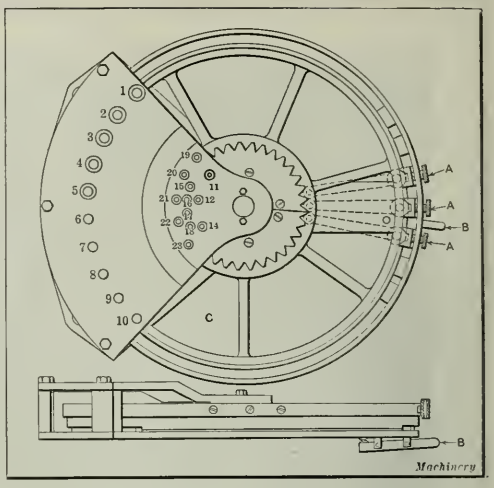


Fig. 2. Indexing Jig designed to drill and ream Four Sizes of Handles

For performing drilling and reaming operations in this indexing jig, thirty-five, twenty-eight, or twenty-one crank-handles are set up, according to their size, these pieces being held at their inner end by means of V-notches in the filler blocks and at their outer end by means of knurled-head cap-screws *A*. The reason for drilling smaller numbers of the longer handles at a time, is that the inner ends of these handles come so close to the center of the jig, that it would be impossible to set up thirty-five of them in position for drilling. This is why only twenty-one of the 10½-inch handles or twenty-eight of the 9½-inch handles can be set up; but 75 per cent of the handles drilled are 8½ inches long, and for that reason it was not felt desirable to make a jig large enough to enable thirty-five of the medium and largest sized handles to be set up at a time.

Reference to Fig. 1 will show that three of the types of crank-handles to be machined have blind holes at their large end, although handle *D* has the ¾-inch hole going all of the way through. It will be evident that after ¹⁷⁄₃₂-inch holes have been drilled in handles *A*, *B*, and *C*, these blind holes act as cups which retain the chips. Obviously it will be impossible to ream these holes with the chips in them, because a reamer often has difficulty in clearing its

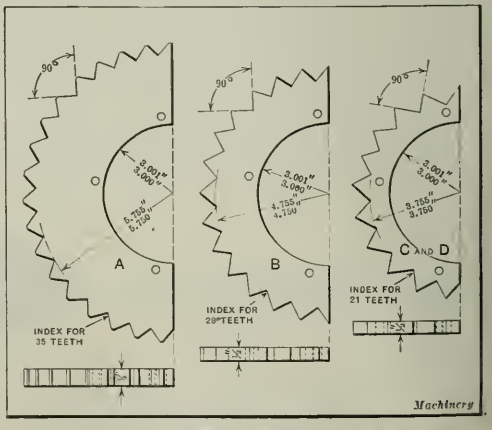


Fig. 3. Filler Blocks used on Jig shown in Fig. 2, to locate Different Sizes of Handles

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own chips, without being hampered by the presence of a lot of coarse drill chips. To overcome trouble which would be experienced if the drill chips were left in the holes, the jig was designed to carry an odd number of groups of castings to be drilled, that is to say, seven groups, respectively, of five 8½-inch handles, four 9½-inch handles and three 10½-inch handles. In operation, the jig carrying the handles with blind holes is indexed through a number of spaces equal to twice the number of castings that are drilled in a group, thus bringing the handles that have just had the $\frac{21}{64}$-inch holes drilled in them, out to a position indicated at *C* in Fig. 2, so that they are clear of the reamers. While in this position, the operator takes an air hose and blows the chips out of the drilled holes; then he removes the pieces of work that have been both drilled and reamed, replaces these with a group of undrilled castings, and indexes the fixture to the next position.

Indexing of the fixture according to this method brings the castings that were drilled at the previous rotation of the jig under the reamers, while making their second trip around the circle. In this way the work is reamed and is ready to be removed from the fixture after it is indexed to bring the work clear of the plate in which the reamer holes are drilled. If there were not an odd number of groups of castings to be machined, the work would not come under the reamers at the second revolution of the jig. It will be evident that as many handles are drilled and reamed in a specified period of time by this method as would be the case if the fixture were only indexed through half as many spaces, the only difference being that the operator is required to blow away the chips after the holes have been drilled. No time is actually lost by having the work make two revolutions after it has been set up in the fixture. When this method of drilling was first employed, the removal of chips from the blind holes gave a great deal of trouble; but after the idea of using an odd number of groups of work, and of indexing the work through the number of spaces occupied by two groups of pieces was employed, this difficulty was effectually overcome.

For drilling crank-handles of the form shown at *A* in Fig. 1, the $\frac{21}{64}$-inch holes in five handles are drilled through bushings 1, 2, 3, 4, and 5, Fig. 2, while three $\frac{7}{16}$-inch holes are drilled at the same operation through bushings 19, 20, and 21. After this has been done, lever *B* is depressed in order to withdraw the locking pin, so that the jig may be indexed through successive intervals of ten spaces. When the jig has made a complete revolution, the next downward stroke of the drilling machine reams the drilled $\frac{21}{64}$-inch hole in each of the five handles to a diameter of $\frac{3}{4}$-inch, the reamers working through holes 6, 7, 8, 9, and 10. At the same time the $\frac{7}{16}$-inch holes in the two remaining crank-handles are drilled through bushings 22 and 23. The reason for drilling the smaller holes in two successive positions is to allow a space between the drill bushings greater than the minimum center distance on which the drilling machine spindles can be located.

For drilling the size of crank-handle shown at *B*, four castings can be drilled and reamed simultaneously. The four $\frac{21}{64}$-inch holes are drilled through bushings 1, 2, 3, and 4, and at the same time two of the $\frac{7}{16}$-inch holes are drilled through bushings 15 and 16. After this has been done, the jig is indexed through successive intervals of eight spaces; and on the next revolution of the jig the four $\frac{21}{64}$-inch holes are reamed to a diameter of $\frac{3}{4}$-inch through holes 6, 7, 8, and 9; and at the same time two $\frac{7}{16}$-inch holes in the opposite end of the other two handles are drilled through bushings 17 and 18. It will be apparent that in this case, one of the large drill bushings and one of the corresponding reamer holes are skipped.

For drilling the sizes of crank-handle shown at *C* and *D*, in Fig. 1, the method of procedure is essentially the same as for handle *B*. The three $\frac{21}{64}$-inch holes are drilled through bushings 1, 3, and 5, and two $\frac{7}{16}$-inch holes are drilled at the opposite ends of two handles, bushings 11 and 12 being used. Then the jig is indexed and after it has made a complete revolution, the work has advanced five spaces, so that the three $\frac{21}{64}$-inch holes can be reamed to a diameter of $\frac{3}{4}$ inch through holes 6, 8, and 10; and at the same time, the $\frac{7}{16}$-inch hole at the opposite end of the third handle is drilled through bushing 14. As in the preceding case, drill bushings 2 and 4 and reamer holes 7 and 9 are not used in this set-up.

Any of these four drilling and reaming operations is performed with the same jig set up on a cluster type of multiple-spindle drilling machine, on which at least fifteen spindles are available, so that while machining crank-handles of the type shown at *A*, the holes at both ends of five handles are drilled and reamed each time the fixture is indexed. As in the case of all indexing jigs or fixtures of this type, a high rate of production may be obtained, because the operator is able to remove finished pieces and substitute other castings in their places, while the drilling and reaming operations are being performed on castings at the opposite side of the jig. E. K. H.

* * *

STATEMENT OF THE OWNERSHIP, MANAGEMENT, ETC., REQUIRED BY THE ACT OF CONGRESS OF AUGUST 24, 1912

of MACHINERY, published monthly at New York, N. Y., for October 1, 1919.

State of New York } ss.
County of New York }

Before me, a Notary Public in and for the state and county aforesaid, personally appeared Matthew J. O'Neill, who, having been duly sworn according to law, deposes and says that he is the General Manager of The Industrial Press, Publishers of MACHINERY, and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management, etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 443, Postal Laws and Regulations, printed on the reverse of this form, to wit:

1. That the names and addresses of the publisher, editor, managing editor, and business managers are:

Publisher, The Industrial Press 140-148 Lafayette St., New York
Editor, Erik Oberg " " " " "
Managing Editor, None
Business Managers:
Alexander Luchars, President " " " " "
Matthew J. O'Neill, Treasurer and General Manager " " " " "

2. That the owners of 1 per cent or more of the total amount of stock are:

The Industrial Press 140-148 Lafayette St., New York
Alexander Luchars " " " " "
Matthew J. O'Neill " " " " "
Louis Pelletier " " " " "
Erik Oberg " " " " "
H. L. Ketchum " " " " "
E. Y. Urban " " " " "

3. That there are no bondholders, mortgagees, or other security holders.

4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

MATTHEW J. O'NEILL, General Manager.

Sworn to and subscribed before me this 30th day of September, 1919.

WILLIAM E. BACON,
(SEAL) Notary Public, New York County, No. 12.
New York Register, No. 10196.
(My commission expires March 30, 1920.)

PERSONALS

J. R. PEARSEN, formerly vice-president and general manager of the Acme Machine Tool Co. of Cincinnati, severed his connection with this concern November 1.

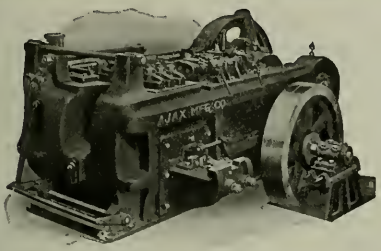
JAMES SPRING, former superintendent of the Independent Pneumatic Tool Co.'s Chicago plant, is now works manager of the Superior Motors Co., also of Chicago.

CAPTAIN JOSEPH R. GREENWOOD, having recently received his discharge from the Army, has renewed his association with the firm of Charles H. Higgins, architects and engineers, 19 W. 44th St., New York City.

CHARLES F. SCRIBNER, formerly industrial engineer with the Colt's Patent Fire Arms Mfg. Co., Hartford, Conn., and

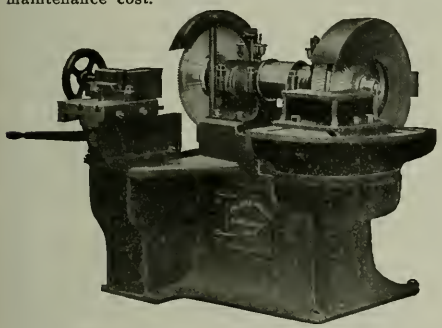
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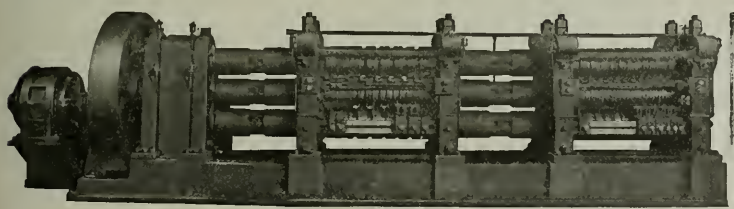
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more recently consulting engineer for L. V. Estes, Inc., Chicago, Ill., has become associated with the Business Service Corporation of America, Chicago, Ill., in the capacity of vice-president and chief engineer.

GEORGE R. WETTEN, who until recently was with the Cyclops Steel Co., of Titusville, Pa., has taken a position with the Hess Steel Corporation, Baltimore, Md. While with the Cyclops Steel Co., Mr. Wetten designed a new 12-inch mill for rolling carbon and high-speed tool steels, and he will do similar work for the Hess Steel Corporation.

D. B. CLARK is now in charge of the Cleveland Milling Machine Co.'s Indianapolis district and will handle it through the Chicago office. The Indianapolis office has been discontinued, owing to the death of W. P. Sparks, the former representative.

OSCAR WODACK, for several years Chicago representative for the James Clark Jr., Electric Co., Inc., Louisville, Ky., has resigned his position and organized the Wodack Electric Tool Corporation, 23-27 S. Jefferson St., Chicago, Ill. This concern will manufacture portable electrically driven drills and grinders.

ARVID E. NISSEN is now assistant superintendent of the melting shop at the plant of the Hess Steel Corporation, Baltimore, Md. Mr. Nissen was formerly with the Taylor-Wharton Iron & Steel Co., Highbridge, N. J., as assistant metallurgist and prior to that was in the open-hearth department of the Illinois Steel Co., Gary, Ind.

PAUL M. LINCOLN, for many years commercial engineer of the Westinghouse Co., has resigned from that organization to enter the consulting engineering field, and in that capacity will have active charge of motor application engineering for the Lincoln Electric Co. The work which Mr. Lincoln will take up with the Lincoln Electric Co. involves the entire problem of motor drives for machinery and more especially the determination of the proper type, characteristics, and size of motors best adapted for direct connection to various sizes and types of machinery.

RUSSELL W. STOVEL, who recently returned from France as Lieutenant-Colonel of Engineers, having served there as Chief of the Terminal Facilities Division of the Army Transport Service, has been appointed a consulting engineer of Westinghouse, Church, Kerr & Co., Inc., and will devote his entire time to the company's electrical and mechanical work. Mr. Stovel has had an unusually comprehensive experience in the electrical and mechanical problems connected with central power station and steam railroad electrification work—from the fundamental economics involved, to design, construction, equipment and operation—together with a valuable experience in mechanical handling at docks and terminals. Mr. Stovel received high commendation from the military authorities for his "splendid administrative abilities, to which are due the excellent results obtained by the Terminal Facilities Division of the Army Transport Service."

COMING EVENTS

January 6-8—Annual meeting of the Society of Automotive Engineers, Inc., in New York City, at the Engineering Societies Building, 29 W. 39th St.

January 8-15—First aeronautical exposition in the Coliseum in Chicago, Ill., given by the Manufacturers' Aircraft Association, Inc., 501 Fifth Ave., New York City.

February 2-6—First annual mechanical inspection equipment exposition and convention of the American Society of Mechanical Inspectors at the Hotel Astor, New York City. Secretary, Henry F. Winter, 35 W. 39th St., New York City.

May 15-20—Seventh national foreign trade convention in San Francisco, Cal. Secretary of the National Foreign Trade Council, O. K. Davis, 1 Hanover Square, New York City.

NEW CATALOGUES AND CIRCULARS

Lakeside Forge Co., Erie, Pa. Catalogue P, listing the complete line of drop-forged wrenches, adjustable wrenches, and pliers made by this company.

Davis-Bournonville Co., Jersey City, N. J. Circular briefly reviewing autogenous welding, the opportunities for oxy-acetylene welders and cutters, and including the terms of instruction in the Davis-Bournonville Institute.

General Metals Co., 895 Greenwood Ave., Detroit, Mich. Booklet dealing with the construction and operation of the Trundle automatic multiple-spindle thread milling machine, which is a double-spindle machine designed for a high rate of production.

Edgemont Machine Co., Inc., Dayton, O. Catalogue G of friction clutches, extended sleeves, cut-off couplings, clutch pulleys, and countershafts. The standard dimensions of various clutches and couplings are given in tabular form.

Bausch & Lomb Optical Co., Rochester, N. Y. Illustrated 112-page catalogue of microscopes in which several new models and features are presented. In addition to the common types there are binocular, metallurgical, chemical, and other special types.

Independent Pneumatic Tool Co., Chicago, Ill. Illustrated circular describing a line of "Thor" portable electric drills ranging from the No. 000 size which has a 1/4-inch drilling capacity, to the No. 1 size which has a 9/16-inch drilling capacity.

Barrett-Cravens Co., 171 N. Ann St., Chicago, Ill. Circular descriptive of the Barrett lift-trucks equipped as trailers. The lift-truck is especially designed for use as a trailer behind a power unit, but it can also be employed as an ordinary lift-truck, operated manually whenever required.

Bearings Co. of America, Lancaster, Pa. Revised edition of the load and data sheets issued by this company, in which several additions have been incorporated. Copies will be sent to all interested, either from the main office at Lancaster or from the Detroit sales office at 1012 Ford Bldg.

Medart Patent Pulley Co., Inc., St. Louis, Mo. A sixteen-page booklet entitled, "The Clutch that Clutches." Various types of friction clutches and cutting-off couplings made by this company are illustrated and described. The advantages of the Medart V-groove friction clutch are especially emphasized.

Universal Machine & Tool Co., 601 Mahoning Road, N. E., Canton, Ohio. Leaflet descriptive of a special vise designed for use on planing, milling, shaping, drilling, and slotting machines in place of ordinary vises. The vise jaws are mounted upon angular ways to give an inward and downward clamping action.

Landau Machine & Drill Press Co., Inc., 19-25 W. 44th St., New York City. Circular on the Landau combination drill chuck and tapping machine consisting of a combination head, housing four independent spindles which can be quickly used for either drilling, tapping, reaming, or countersinking operations.

Garrison Machine Works, Dayton, Ohio. Catalogue of Johnson gear chucks of the pitch-line control type for chucking gears true with the pitch diameter. These chucks include designs for spur, helical, internal and bevel gears and sprockets. Illustrations are used to show the various applications of these chucks.

P. W. V. Automatic Machine Corporation, Fitchburg, Mass. Booklet entitled "The Index to Radical Construction," which precedes a new catalogue and which shows by an interesting series of photographs, the successive stages in the construction of the Radical automatic screw machine, the object being to show by this series of views the simplicity of construction.

Taft-Peirce Mfg. Co., Woonsocket, R. I. Bulletin devoted to various forms of production and inspection tools such as are used in connection with precision work. These tools include taper test-gages, sine bars, V-blocks, parallels, straightedges, angle-irons, bench plates, indicators, precision squares, and boring equipment for milling machines.

Lima Drill Press Co., Lima, Ohio. Booklet descriptive of the main features and advantages of the new multiple-spindle upright drill press which has sixteen spindles, each of which can be quickly brought into the working position by turning the magazine, thus making it possible to perform sixteen different operations by equipping the spindles with the proper sizes of drills, reamers, countersinks, etc.

Cutler-Hammer Mfg. Co., Milwaukee, Wis. Pamphlet emphasizing the numerous applications of electrical heat by means of flat standardized C-H space heaters which are 2 feet long, 3/16 inch thick and 1½ inches wide. Typical applications are in crane and hoist cab, meter houses, valve houses, and low-temperature ovens. Another booklet is entitled, "Electrical Operation of Gate Valves" and contains a reprint of an address by Peter Payne Dean given before the Metropolitan Section of the American Society of Mechanical Engineers.

Ingersoll-Rand Co., 11 Broadway, New York City. Booklet 8707 superseding 8606 and featuring "Little David" pneumatic drills, grinders and saws; booklet 5106 superseding 5006 on Type 47 "Radialaxe" coal cutter; leaflet 954 descriptive of the air lift method of pumping; booklet 963 explaining the various uses and advantages of compressed air in saw mills; leaflet 945 entitled "'Tis a Good Investment," illustrating ER and FR compressors in small machine shops, power houses, garages, etc.; booklet 9020, a pictorial products catalogue illustrating and describing practically the entire line of products manufactured by this company.

TRADE NOTES

Superior Machine Tool Co., Kokomo, Ind., manufacturer of upright drilling machines, has erected a new office building adjoining the factory.

Gairing Tool Co., Inc., Detroit, Mich., is the new name of the firm previously known as the Gairing Needham Tool Co., Mr. Needham having severed his connection.

Business Service Corporation of America, engineers and accountants, have opened an office at 29 S. LaSalle St., Chicago, Ill. Charles F. Scribner is vice-president.

Richardson-Phenix Co., Milwaukee, Wis., lubrication engineers and manufacturers, have again opened a Philadelphia office which is located in the Bailey Building and is in charge of George F. Fenno.

American Forge & Machine Co., Canton, Ohio, has recently added another steam hydraulic forging press to its forge shop. This enables the company to take care of a wide range of forging work, with facilities for rough-machining and heat-treating.

Rivett Lathe & Grinder Co., Brighton District, Boston, Mass., has let a contract for the construction of a three-story building, 200 by 60 feet. The building, which is to be of reinforced concrete, will be used for manufacturing, and will cost approximately $100,000.

Torrington Mfg. Co., Torrington, Conn., has let a contract for the design and construction of a new manufacturing building to the Aberthaw Construction Co. of Boston, Mass., at a cost of approximately $100,000. The new building will be 60 by 180 feet, two stories high, of reinforced concrete, and is expected to be ready for occupancy about the middle of February.

Wodack Electric Tool Corporation, 23-27 S. Jefferson St., Chicago, Ill., has been organized by Oscar Wodack, formerly Chicago representative for the James Clark Jr. Electric Co., Inc., Louisville, Ky., for the manufacture of electric drills, hammers, and grinders. Oscar P. Wodack is president and treasurer; A. K. Wodack, vice-president; and Albert T. Lochner, secretary and superintendent. They expect to have tools ready for the market about January 1, 1920.

Urban Machine & Tool Co., Inc., has been formed to take over the business of the Ohio Tool & Machine Co., at 2424 St. Clair Ave., Cleveland, Ohio. The product of the company is machine tools, and for the present it will specialize on an improved type of bench lathe. The company is incorporated for $100,000 and the officers are F. Urban, president; C. S. Sprigade, vice-president; K. L. Hayes, treasurer, and W. E. Keough, secretary.

Hammond Steel Co., Inc., Syracuse, N. Y., is completing extensive additions to its mills at Solvay, N. Y. The extensions include 16- and 10-inch rolling mills, straightening machinery, turning equipment, new electric furnaces, and annealing plants. The erection of a plant for cold-drawing will follow the completion of this work. The company will devote its efforts to the production of high-grade hammered and rolled tool and alloy steels, die-blocks, and special forgings.

National Automatic Tool Co., Richmond, Ind., manufacturer of multi-drillers, has placed a contract for a new addition to the plant which will be of steel and brick construction and will be equipped with modern machinery. It has been only three years since the plant capacity was doubled, but the increased demand for multi-drillers, both domestic and foreign, necessitates this additional building, which will enable the company to again double its capacity.

Swan & Finch Co., 165 Broadway, New York City, announces the purchase of the **Cataract Refining & Mfg. Co.** of Buffalo. The latter concern operates large lubricant plants at Buffalo and Chicago and has given particular attention to the development of specialties in grease lubricants, such as cutting compounds, drawing compounds, and practically every form of lubricating grease. The Swan & Finch Co. has been one of the leading oil and grease producers, so that this new acquisition will result in large and diversified production. Henry Fletcher, former president of the Swan & Finch Co., is chairman of the board of directors, and W. G. Monerief, former president of the Cataract Refining & Mfg. Co., is president of the Swan & Finch Co.

General Motors Corporation is to build what is virtually a new plant at Meriden, Conn., for one of the subsidiaries, the New Departure Mfg. Co. The work includes the erection of four new buildings at Meriden and the remodeling of an old building, together with the construction of one new building at the West Hartford plant. Reinforced concrete will be used throughout. The Meriden plant will cover a total floor area of 340,000 square feet and consists of two new three-story and basement buildings, 302 by 82 feet, and two one-story and basement buildings, 67 by 202 feet. The old building, which is to be remodeled, is a three-story structure, 305 by 58 feet. At West Hartford, the work consists of one two-story building, with basement and sub-basement.

Syracuse Alloy Steel Co., Inc., Syracuse, N. Y., has reincorporated, the new company assuming the name of the old one. Property has been purchased in the eastern part of Syracuse and a plant is now being erected. This plant will be equipped with additional hammers and rolls sufficient to care for the rapidly growing business. The company, in addition to making high-speed steel in the standard forms of annealed bars, hardened tool bits, etc., is also manufacturing forged milling cutter blanks of standard types such as blanks for side milling cutters, end-mill cutters, etc., and is also manufacturing forged cutter blanks for special shapes of cutters as required by individual customers. It is anticipated that the new plant will be in operation early in 1920.

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JANUARY, 1920

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Principal Articles to Appear in February MACHINERY

MAKING SEAMLESS COPPER AND BRASS TUBING ..... *Edward K. Hammond*

CAR AXLE DESIGN....*A. L. Nichols*

SPECIAL TYPES OF DRILLING MACHINES .....*F. E. Johnson*

STIMULATING COOPERATION BETWEEN EMPLOYER AND EMPLOYEE

Circulation for December, 1919, 25,750 Copies

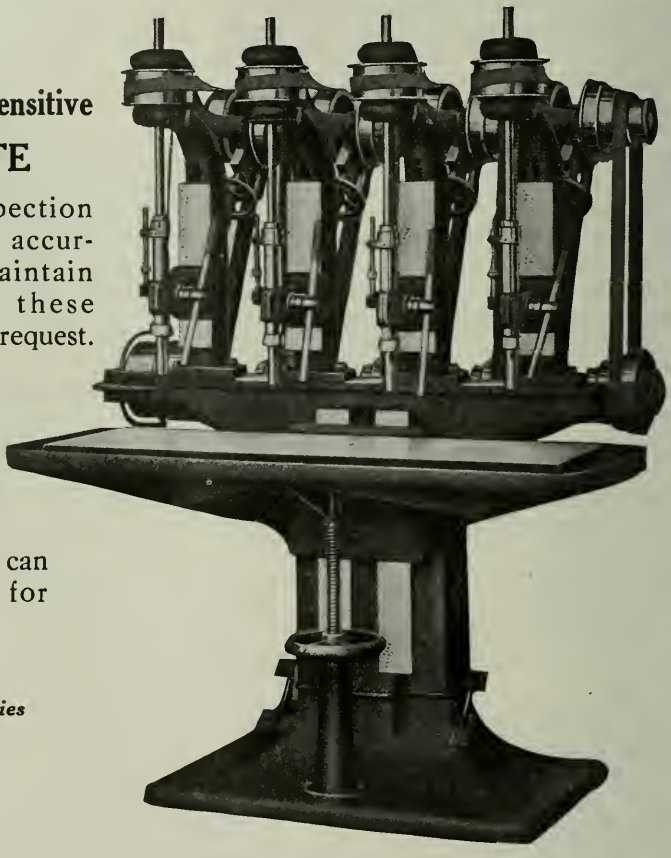
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Carburizing and Casehardening

By S. P. ROCKWELL, Metallurgist, Weekes-Hoffman Co., Syracuse, N. Y.

First of a series of articles on the latest practice in carburizing and casehardening, covering different classes of carburizers, their selection and characteristics; steels suitable for carburizing; carburizing pots and methods of packing and sealing them; temperatures required for carburizing; treatment after carburizing; cyanide hardening; various kinds of quenching mediums, furnaces and fuels; valuable cost data; and many other subjects of importance.

CARBURIZING and casehardening have developed rapidly during the last ten years, due primarily, to the rapid advance of the automobile industry. In view of these developments, a complete record of the present state of the art has been deemed necessary, and it is the author's object, in the following articles, to deal with the various materials, equipment, and methods used in carburizing and casehardening. It has been the author's aim to write these articles so that they will be understood by men who are not versed in the theory of metallography, but who are engaged entirely in the practical work of heat-treatment. Hence, everyday terms have been used as far as possible and technical phrases, in general, have been avoided.

Briefly defined, casehardening is the process of increasing the carbon content of the surface of steel. The steels so treated are generally low in carbon, and the object is to raise the carbon content of the surface until it may be hardened by the usual method of heating to a hardening temperature and quenching in a cooling bath. Hence, the term "casehardening" implies the hardening of the surfaces or skin of a part made from steel. The process of increasing the carbon content of the surface is known as "carburizing" and the actual hardening process is known as "casehardening." The carbon content is increased by heating the steel in the presence of materials high in carbon, so that the latter element which has a great affinity for iron, has an opportunity to combine with it in the surface of the steel. The materials used for carburizing steel are known as "carburizers."

Carburizing material in general is a carbonaceous material, which gives off as its chief ingredient carbon monoxide gas. Other gases given off are really impurities. Charcoal, coke, or anything which burns to charcoal or coke when burned with a minimum amount of air is really a carburizer. Alone, however, these materials are not suited for all cases of carburizing inasmuch as the carbon monoxide gas is not controllable in its volume given off and its intensity. Usually chemicals or a catalytic agent is added to the carburizer, or the coke or charcoal product, which is known as the generator, and this chemical or catalytic agent has been termed an energizer. The energizer, therefore, is some product which regulates the volume and intensity of the gas given off by the generator, but which in itself does not take a definite part in the actual carburizing operation.

Types of Carburizers

There are, strictly speaking, but four standard types of carburizers; they are classed by their physical form as follows: (1) Powder materials, in which the generator and the energizer are in a powder form and are thus mixed together. (2) Pill materials, in which the generator and the energizer are in a powder form, but are held together by a binder which in itself may be either a generator or an energizer. (3) Pellet materials, in which the generator is a granule of solid carbonaceous material coated with an energizer by the help of a binder. (4) Pellet and powder materials, in which the generator is a granule of solid carbonaceous material, and the energizer is in the form of a powder. A certain per cent of the powder may also be a generator. Different combinations of the above four forms may be found, but no great value should be attached to claims for their importance.

Two other mediums are still used to some extent for carburizing, namely, bone and leather. Bone is classed as a pellet material, with the exception that the energizer is contained in the bone in the form of ammonium carbonate. The ammonia fumes are quite noticeable when water is poured on red hot bone. Leather is classed as a powder material due to its being so easily powdered. The energizer is in the form of cyanogen and is contained within the leather.

Charcoal, coke and coal should not be classed as carburizers, as they are nothing more than generators. Alone, they are not easily controlled as regards penetration and percentages of carbon entering the steel to form the case. There are a great number of commercial carburizers on the market in which the materials used as the generator may be hard and soft wood charcoal, animal charcoal, coke, coal, beans and nuts, bone and leather, or various combinations of these. The energizers may be barium, cyanogen, and ammonium compounds, various salts, soda ash, or lime and oil hydrocarbons. There are no secrets concerning these compounds. In the selection of a carburizer, the main points to be taken into consideration are whether the material of-

fered is best fitted for the work in hand, whether it contains impurities making it useless for the work, and whether the company manufacturing it has had sufficient experience so that a uniform product can be had at all times.

Experiences of Firms Manufacturing Carburizers for their Own Use

The compounds sold on the market could be manufactured by the user, but he should take into account the following points: (1) Are his purchasing requirements as great for the ingredients making up the carburizer as the manufacturer's who specializes in making carburizers? (2) Will he save enough to pay for the cost of labor, mixing machinery, and tanks? (3) Can he be assured that all his raw materials will be uniform? (4) Can he rely on obtaining a constant mixture and strength of finished material at all times?

The following experiences show the errors into which concerns making their own carburizer sometimes allow themselves to be led. A certain concern which manufactured spring shackle bolts used leather for a carburizer. It bought raw leather for $12 per ton. This leather had to be charred in order to use for carburizing, and to do this 112 pounds, worth 67 cents, was packed in pots. A furnace was then given up for the charring. The cost of charring including fuel, power, depreciation, labor, and pot loss was $2, taking no account of the possible holding up of further production. The total cost for the operation was then $2.67. While charring, the shrinkage in volume and weight was so great that only forty pounds of leather was left. The cost per ton of carburizer ready to use was then $133.50, or about $2.50 per cubic foot. This material could be used twice, so that the cost per useful ton was therefore $66.75 and the cost per useful cubic foot, $1.25. The cost per useful ton of the commercial carburizer later used in place of this, was only $11, while the cost per useful cubic foot was only 14 cents.

In another instance, a concern bought soft charcoal for $25 per ton. This was powdered at a power and labor cost of $3.50 per ton. To a ton of this charcoal were added twenty pounds of fine salt worth $1. The whole was then dampened with seven gallons of coal oil costing 70 cents, which brought the cost to more than $30 per ton. As this material caused soft spots on the work after the first heat, it was not used more than once. The cost per useful ton was then $30 and the cost per useful cubic foot was 75 cents. The cost of a commercial carburizer for this class of work was only $10 per useful ton or 20 cents per useful cubic foot.

In a third case, bone was used for carburizing. The cost of good quality shin bone was $60 per ton uncharred or about $1.33 per cubic foot. This material was used three times before discarding, by mixing one-third unused with two-thirds used, after each heat; so the cost per useful ton was $20 and the cost per useful cubic foot 44 cents. The market price of a good commercial carburizer was $11.25 per useful ton, or 15 cents per useful cubic foot.

Selection of a Carburizer

The selection of a carburizer should be governed by the desired quality of the finished product. When manufacturing high-class products, impurities in the carburizer that might affect the proper results should be carefully considered. Sulphur and phosphorus are the two impurities that cause the greatest trouble in carburizing and are therefore the greatest drawbacks. Hydrogen sulphide in some of its forms is sometimes used as an energizer, and water sprinkled on such an energized material will cause fumes to be given off. Materials having coke and coal as the base or energizer are rich in both sulphur and phosphorus. Bone and leather also contain them, the residue of bone being calcium phosphate, while leather is often tanned with chemicals containing these elements. Just what proportions of these elements are necessary in order to be harmful to the steel is a question. It stands to reason, however, that it is unwise to subject the steel to these impurities when the steel maker is trying to hold the sulphur and phosphorus contents as low as possible. Supposedly, sulphur enters the case and combines with the manganese to form manganese sulphide. Extreme brittleness is often due to sulphur infusion.

Chemicals are sometimes used in a carburizer in order to hasten the penetration. They may or may not be impurities as regards the internal effect on the steel. When manufacturing parts which merely require a surface hardness and on which strength and wearing qualities are minor considerations, it is not necessary to pay an excessive price for the carburizer. Such work will probably not be endangered by impurities, and a carburizer consisting of nearly any generator and energizer can be used, provided it is economical from other standpoints. Such cases, however, are few, as



Fig. 1. Carburizing Department of a Large Ball Bearing Manufacturing Plant

nearly all carburized work must withstand wear or shock. A concern engaged in manufacturing set-screws of large size formerly used a carburizer which had been recommended by a manufacturer of ball bearing parts. This material gave excellent results, but at a fairly high cost. The set-screws required a hard surface for a depth of only a few thousandths of an inch and the depth of this case was so small in proportion to the size of the screw that it did not affect the strength of the screw. Results meeting all the specifications were later obtained with a material of a cheaper quality at about half the former cost.

Rate and Depth of Carbon Penetration

For parts requiring an excessive depth of case, a carburizing material should be used that has the necessary lasting qualities and endurance. Ball bearing parts of the larger sizes are carburized to a depth of ½ inch. Plug gages are also deeply carburized so that they may be ground to a smaller size after being worn. A long time is required to carburize such parts, and the carburizer must be capable of evolving sufficient gas during the operation to take care of the steel at all times. Bone, if used for such work, would soon lose its carburizing qualities and would start to decarburize the pieces. Oil hydrocarbon energized materials of a fine mesh seem to answer this purpose better than barium energized compounds of a coarse mesh. It also appears from experiments on work which was deeply carburized that the gas evolved must decrease slowly as the penetration increases, because the greater the depth of carbon penetration, the slower the action.

The chart in Fig. 3 shows the penetration and time curves of a barium energized carburizer while Fig. 4 shows those of an oil hydrocarbon energized carburizer. It will be noted that the set of curves in Fig. 3 shows faster penetration than the set of curves in Fig. 4, whereas the latter do not fall off in their rate of penetration as rapidly as the former. The curves represent the rate of penetration on samples taken from the same pot at the same time. Curve 1 represents a cold-rolled rod where the depth examination was made by means of a rough fracture, while Curve 2 represents a similar rod on which the examination was made by polishing and etching with nitric acid. Curve 3 represents the concave surface of a ball-bearing raceway, and the apparent depth of penetration is less than on the first two curves. This misleading phenomenon will be taken up in a later article. The parts treated by the barium energized carburizer were subjected to 14½ working or carburizing hours and were in the furnace a total of 19 hours, while the parts treated by the oil hydrocarbon energized carburizer were subjected to 11 carburizing hours and were in the furnace for 13¾ hours. The temperature of the furnaces in both instances was 1700 degrees F.

The process of carbon absorption is retarded both by the high percentage of carbon and the increase in the thickness of the layer. If allowance is not made for this, the carbon will pile up on the surface, showing freckled edges, free cementite, and pigging or carbon thrown out of solution, as may be seen in the magnified view shown in Fig. 6.

Mesh of Carburizer Dependent on Work

The mesh of the carburizer should be governed largely by the size of the individual work. In no case should the granules of the carburizer be larger than the greatest dimension of the individual pieces. Powder carburizer is often used for work of large size on the assumption that the carburizing process is a contact process and not a gas process. It is, however, a good point to have small holes filled up with the carburizer as this will prevent dead air or gas pockets and will cause a better circulation of the gas over the whole of the exposed surfaces. A powder carburizer is more dense and as a rule will shrink less than a pellet or pill form of carburizer. On the other hand, such a carburizer, being denser, will have less volume per ton and consequently will cost more per cubic foot. Powder carburizers will not heat through to the center of the pot as readily as an open form of carburizer and the carburizing of the steel will not start as soon—pot, work, and furnace conditions being equal. The explanation of this is that with the open form, the heat conducted through the outside of the pot first heats up the carburizer in contact, which emits gases. These gases then move by thermo-syphon action, carrying their own heat both upward and toward the center of the pot, heating the whole more uniformly than with the powder carburizer, whose gases are restricted to more of an upward movement.



Fig. 2. Another View of Large Carburizing Department in Ball Bearing Plant

Instances where Carburizers Containing Excessive Chemicals Should be Avoided

When work is protected by copper plating for local carburizing, a material with excessive chemicals should be avoided. Even with the best of copper plating, it is found that few chemical carburizers can be used. Barium, ammonium and similarly energized carburizers will apparently break down the copper and allow the carbon to penetrate. Bone is the only exception to this rule that is known. Bone black and charcoal base carburizers with oil hydrocarbon energizers are apparently the most satisfactory materials to use for copper-plated work.

In an experiment in making a carburizer for copper-plated work on ball bearing races, a base of charcoal and sugar bone was used. The specifications on the work called for a depth of from 3/64 to 1/8 inch, and in each case an analysis of 0.005 inch thickness of the surface was required to show a carbon content of 0.9 to 1 per cent. Alone this material could not be depended on to give a carbon percentage of over 0.8, and it was therefore necessary to use an energizer. For this purpose a water solution of sal-ammoniac was added and it was found that when enough had been added to start to increase the carbon percentage and likewise the rate of penetration, the copper broke down completely.

Excessive chemicals should also be avoided where the finished article is not ground but is buffed and must have a highly finished surface free from pit marks, because certain energizers leave the surface of the steel in a pitted condition. This may take place during the carburizing operation or may be a chemical or rusting action even before the heat is applied and while the work is in contact with the carburizer. Sometimes the action may cause a scale to be formed on the work during heating, and on cooling or during some range of temperature this scale is reduced. The result is a skin that adheres irregularly to the surface of the work.

A concern which carburizes gears changed its customary carburizer for one in which the energizer was a strong combination of ammonia and cyanogen compounds. The gears, after hardening, were covered with a thin pliable dull silver skin. In buffing and scratch brushing, most of this film was removed and in such areas a bright surface resulted, but small particles of this film defied the scratch brush and adhered to the steel. These particles caused a slight elevation on the surface of the teeth and a discoloration. It was claimed that these elevations caused noise in the gear action. If it had been possible to grind the gears they would have been all right from other standpoints. A similar condition was experienced by a firm that manufactured skates. The carburizer which was a charcoal base material having a sodium carbonate energizer left a black soot on the finished product which was harmful only in that it filled up the buffing wheels and slowed up production. Alkali washes or pickling would not remove this condition. The carburizer used in the preceding case was then tried with the same

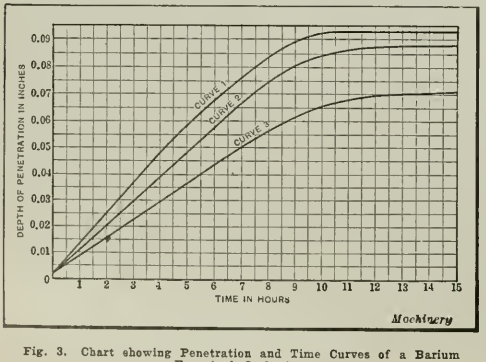


Fig. 3. Chart showing Penetration and Time Curves of a Barium Energized Carburizer

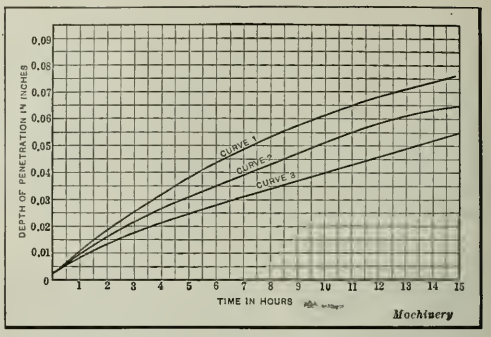


Fig. 4. Chart showing Penetration and Time Curves of an Oil Hydrocarbon Energized Carburizer

results as found in that experience. A charcoal generator material with a barium carbonate energizer was next tried with excellent results, this carburizer leaving the surface in a clean condition, free from soot, pits, or films.

Life of a Carburizer

The life of a carburizer is an important consideration if both slight and great depth work is to be handled. In such an instance it might be economical to have two forms of carburizers. The great depth carburizers are usually a little slower in penetration than the slight depth materials. A certain manufacturing concern used a charcoal generator material with barium carbonate as an energizer for work requiring heats of from 4 to 15 hours, the average heat being about 10 hours. They added, after each heat and after screening, an average of 1/8 new material to 7/8 of the used, which gave one volume of the material a life of about 80 hours. In carburizing some ball bearing parts to great depth it was found that after using this material from 25 to 30 hours, it ceased to penetrate any further and started to decarburize the work. It is interesting to note that such an energizer in a carburizer will lose its power on heat application, but if not carried too far will absorb carbon monoxide from the air when exposed to it and will be thus recharged to a considerable extent. The difficulty in carburizing these parts was eliminated by using a material of medium mesh consisting of a charcoal generator and either an oil hydrocarbon or cyanogen compound energizer. It was also found that if the cyanogen energized material was given a short initial heat at a temperature of approximately 1600 degrees F. before use, the initial shrinkage was removed and satisfactory heats of over 100 hours were obtainable.

Shrinkage of a Carburizer

Shrinkage of a carburizer is desirable to some extent, but too much is liable to expose the work in the pots to the scaling effect of air and furnace gases. On the other hand, too little usually denotes that either an excessive filler is used or that the proper evolution or release of gases is not taking place. Results cannot be obtained except at the expense of solid matter being gasified. A perfect carburizer is one that will be completely gasified, leaving no residue, and at the same time give off gas of a constant composition and in only sufficient volume for the steel to absorb. It is, of course, impossible to obtain such a carburizer. Bone is one of the carburizing mediums that does not shrink to any great extent but leaves a large and wasteful residue and is of little value for great depth work. Shrinkage of a carburizer is largely governed by the method of sealing the pots and the style of pot used. Many users of bone do not seal the pots and for this reason, when commercial types of carburizers have been tried in competition, the pots have not been sealed, with the result that the carburizers have greatly shrunk and on this account are disqualified. It is because of the poor sealing of pots that commercial carbur-

izers are mixed with a certain percentage of inert filler. If the sealing of pots was uniform and of such a quality that only enough gas was released to keep the pot from blowing up or blowing out its seal, then a carburizer containing about 95 per cent gasifiable matter could be used and with the greatest economy. This is more nearly possible with the use of inverted pots and with the nichrome pots that will be described later.

A concern which used a bone carburizer tried out a number of commercial carburizers without success. Upon investigation it was found that they were only covering the pots with a loose piece of sheet iron, and that there was a space of from one to two inches around this iron where the furnace gases could consume the material. The hardener was adverse to changing his methods of sealing and so a special carburizer was made up containing about 65 per cent inert material. With such an amount, the shrinkage was no more than the bone shrinkage had been. Less weight per cubic foot, and equally good penetration and length of life gave the hardener confidence in this material and, on further promises of economy, he agreed to seal his pots by luting the cover with clay. As soon as this was done a standard carburizer containing but little inert filler was submitted and excellent results were obtained. It was interesting to note in experiments made at the time, that the life of the bone was increased 30 per cent by sealing.

Effects of Fast Penetration

It is to be regretted that the sales argument of fast penetration has been used so much. Rate of penetration is governed by the proportions of the gases given off and the degree of heat. Claims for a wonderful degree of penetration should not be given great consideration as tests of 75 per cent of the commercial carburizers showed that the rate of penetration for the first 1/32 inch was equal. From this point on, some showed more rapidity. The advantages of too rapid penetration are often annulled by excess chemicals, lack of endurance from quick spending of themselves and lack of proper gaging of depths on small parts. A fast penetration is sometimes caused by internal combustion within the pot and in such a case the temperature of the work may be slightly higher than the furnace temperature with the obvious disadvantages.

A coke generator with a complex energizer has been largely advertised as a very rapid penetrator. At least three concerns, in the knowledge of the writer, have had the experience of having the work melt in the pot while the outside of the pot showed no signs of overheating. At one of these concerns the writer saw the entire heat and can vouch that the furnace temperature did not at any time exceed 1750 degrees and that the burner flame did not touch the pots.

Purchasing and Comparing Carburizers

As carburizers are bought by the ton but are used by the cubic foot, the makers of these materials try to supply a material light in weight which will at the same time fulfill the requirements pertaining to life, such as shrinkage, etc. Bone at $60 a ton is more expensive than another carburizer at $100 per ton, if the latter contains 75 cubic feet and all other conditions are equal. Carburizers vary in volume from 40 to 100 cubic feet per ton and the cost per cubic foot should be a guide in the selection of a carburizer not forgetting, however, to take into consideration the other points brought up in this article.

The question often arises as to the proper method of comparing a carburizing material with other carburizing materials. Table 1 shows the method used by one of the concerns previously mentioned, in comparing three different carburizers. The various materials are represented by *A*, *B* and *C*, *A* and *B* representing the materials compared with *C*, which was unsatisfactory.

The materials are first compared with respect to their cost and volume, then to their shrinkage and life, and finally, to their actual cost, which is based on the number of times that the material can be used. The first and second heats each lasted five hours, the temperature being 1650 and 1600 degrees F., respectively. It will be noted that the shrinkage of material *A* for the first heat was 37.5 per cent; for the second heat, 10.4 per cent; and for the third heat, 7.5 per cent. These percentages are based on the shrinkage of the total contents in the pot both before and after the first heat, which means that the percentage of shrinkage of the new material added in preparing for each successive heat is not equivalent to the shrinkage of the material in the first heat. This is due to the fact that the shrinkage is not uniform throughout the pot, its maximum point being at the top of the pot. The new material is mixed well with the old before each heat, which does not shrink nearly so great after the first heat as it did during that heat.

From tests conducted on twenty-two well-known commercial carburizers it has been ascertained that the shrinkage percentage practically remains constant after the third heat, and it is therefore unnecessary to conduct further tests. On this basis it can be readily calculated that the several materials could be used the following number of times, *A*, 9; *B*, 7; and *C*, 6. With slight variations this method of comparing can be applied to all carburizers of a pellet or granular nature.

TABLE 1. COMPARISON OF COSTS AND LASTING QUALITIES OF SEVERAL CARBURIZERS

Various Comparisons	Carburizers		
	A	B	C
Cost per ton in dollars	90	90	90
Cost per pound in cents	4.5	3	3
Weight of 231 cubic inches in pounds	5	4.25	4.375
Number of unit volumes in 231 cubic inches	8	8	8
Cubic feet per ton	53.2	62.8	61.1
Cost per cubic foot in dollars	1.69	0.955	0.982
Number of unit volumes per pot	24	24	24
Number of unit volumes in pot after first heat	15	14	14
Number of unit volumes lost in first heat	9	10	10
Percentage of loss in first heat	37.5	41.7	41.7
Number of unit volumes added to pot for second heat	9	10	10
Number of unit volumes in pot after second heat	21.5	21	20
Number of unit volumes lost in second heat	2.5	3	4
Percentage of loss in second heat	10.4	12.5	16.6
Percentage of loss in third heat	7.5	9	10.7
Life of material; number of heats	9	7	6
Cost per useful ton in dollars, based on number of times material can be used	10	8.55	10
Cubic feet of material per pot	0.4	0.4	0.4
Cost per pot for all heats, in cents	67.6	38.2	39.28
Cost per pot for each heat, in cents	7.51	5.45	6.55
Cost of loss in material per pot, first heat, in cents	25.35	15.93	16.38
Cost of loss of material per pot, second heat, in cents	7.03	4.78	6.52
Cost of loss in material per pot, third heat, in cents	5.07	3.44	4.20

Machinery

The physical properties of the work after the first and second heats are given in Tables 2 and 3, respectively. By referring to Table 2, it will be noted that in the first heat, *A* gave fair results; *B*, very good; and *C*, poor. The results obtained by using the various materials in the second heat were on a par, except that a few pieces of work treated with *C* had soot on the surface which would not come off in the soda bath. The work could be buffed all right, but no doubt this practice would have been detrimental to the buffing wheel if continued. It is obvious that *B* was superior to *C* and *A* for work where a clean surface was desired; where the depth of penetration was slight, especially on the first heat; and where the cost was considered. In subsequent heats *A* gave the toughest core and became slightly more economical, while the cleanness of the parts became more equal. Carburizer *B* also became more economical than *C*.

Selecting Steel for Carburizing

In selecting the steel to be carburized, a knowledge of the requirements of the finished product is of first importance, as the carburizing process will not improve the quality of

the steel. The length of time that the steel is of necessity exposed to high heat will distort the grain. The great value of the carburizing process is the fact that a low-carbon steel, which would not harden under ordinary heat-treatment and which on the other hand can be readily machined, is, by carburizing, given sufficient surface hardness and approximate strength to meet the conditions met by a similar steel of higher carbon content. Again, the value of carburizing lies in the ability of hardening certain parts of the work, which is known as local hardening. Furthermore low-carbon steels are more readily forged than a higher carbon steel and are safer from a standpoint of final strength. The quality of the finished carburized and heat-treated work in comparison with a similar steel of original carbon content depends upon the skill of the hardener and the method of heat-treatment after the carburizing process.

Steels are principally divided into two classes, straight carbon steels and alloy steels, of which the straight carbon steels are by far the simplest to handle. Alloy steels, on the other hand, are being carburized more and more, due to the desire to get greater strength out of a lesser cross-section. Alloy steels are better for certain classes of work which are not carburized than straight carbon steels, and alloy steels, when carburized, compare similarly with straight carbon carburized steels.

Effects of the Various Elements in Steel

The common elements found in steel are carbon, manganese, silicon, sulphur and phosphorus. Steels containing only these elements in addition to pure iron, are known as straight carbon steels. The addition of one or more element such as nickel, chromium, vanadium, molybdenum, tungsten, etc., designates the steel as an alloy steel.

Carbon is the principal element in all steels which gives it the power of attaining hardness on heat-treatment. Each 0.1 per cent of carbon will increase the ultimate strength of the product from 6000 to 8000 pounds per square inch and the ductility, 5 or 6 per cent. File hardness does not occur until the carbon percentage is close to from 0.45 to 0.70 and then only when quenched in water, though a 0.40 per cent carbon gives considerable hardness if in very thin sections. Under general carburizing conditions, the case is from 0.9 to 1.1 per cent carbon and such an amount gives the necessary exterior hardness. Brittleness, however, accompanies this and it is therefore necessary to depend on the core of the work for the toughness. This toughness is maintained only by obtaining a steel having only a sufficient percentage of carbon that it will not harden in the sense of file hardness. It must have sufficient carbon, however, to stiffen

TABLE 2. COMPARISON OF PHYSICAL PROPERTIES OF THE WORK AFTER THE FIRST HEAT

Various Physical Properties of Work	Carburizers		
	A	B	C
Relative depth of case	3	1	2
Appearance when pot was quenched	Clean	Very clean	Dirty
Appearance when pot was cooled	Dull white	Mottled gray	Sooty
Relative appearance when buffed	2	1	3
Relative toughness	1	1	2
Relative hardness	1	2	1

Machinery

under heat-treatment, so that pressure on the case will not cause the case to fall in. Too high a carbon content will cause more difficulty in machining and forging the steel, but, on the other hand, if the carbon content is too low the steel will be too soft to machine without tearing. Too high a carbon steel will not progress so fast in the carburizing operation, though no difference can be detected commercially for less than 1/32 inch in depth. High carbon acts as a check valve; this is upheld by the experience of getting greater depth in one sixteen-hour heat than in two eight-hour heats. Thirty per cent should, in the majority of cases, be the limit of carbon in steel to be casehardened. Higher carbon steels are often treated like a carburized product, but this should be classed under pack-hardening.

Manganese, when in excessive quantities, gives very erratic results, but this condition need not be discussed, as the ordinary commercial steels do not contain excessive amounts. In a way, manganese is like carbon, as from 0.06 to 0.07 per cent of manganese is equivalent to 0.01 per cent of carbon in hardening. It has the valuable property of decreasing the liability of the steel warping in heat-treatment and also allows it to be heated to a slightly higher degree in relation to the increasing amount of manganese. From 0.3 to 0.8 per cent of manganese is generally adopted in carburizing steels. In carburizing, manganese slightly decreases the depths of penetration per unit of time.

TABLE 3. COMPARISON OF PHYSICAL PROPERTIES OF THE WORK AFTER THE SECOND HEAT

Various Physical Properties of Work	Carburizers		
	A	B	C
Relative depth of case	1	1	1
Appearance when pot was quenched	Very clean	Very clean	Clean (Some soot)
Relative appearance when buffed	1	1	2
Relative toughness	1	2	2
Relative hardness	1	1	1

Machinery

Silicon is the least important of the elements in connection with carburizing steels. It rarely occurs above 0.2 per cent. Too high a silicon content will increase the time of carburizing.

Sulphur should never be present in great quantities, but a very low content causes poor machining qualities. If the content is held under 0.05 per cent or preferably under 0.035 per cent, no harm is done to the steel for carburizing purposes. An excessive sulphur content causes a condition of brittleness which is often laid to faulty carburizing. Sulphur has an affinity for manganese, and together they form manganese sulphide streaks in steel which cause lack of strength and start cracks. Sulphur does not affect the rate of penetration in carburizing.

Phosphorus reduces the shock-resisting qualities of carburized work, and if in an excessive amount, causes a coarse grain which is difficult to refine by heat-treatment. The phosphorus content should not exceed 0.045 per cent. Phosphorus also does not affect the rate of penetration in carburizing.

Nickel increases the strength, ductility, and toughness of steel and allows it to stand shocks to a better degree. This element causes the grain to become fibrous or woody. The heat-treatment temperatures are lowered with the increase in the percentage of nickel, and are about 15 degrees lower for steel containing 1 per cent nickel than for a straight carbon steel. Low-carbon nickel steel carburized is on a par with straight high-carbon steel. The commercial steels contain from 0.5 to 5 per cent nickel. To get the best results from this steel, careful treatment after carburizing is necessary. It is particularly adapted for axles, shafts, gears, etc.

Chromium increases the elasticity of steel, and also the hardness, resistance to shock, and resistance to rupture by twisting. It makes the steel closer grained and homogeneous. When used in combination with nickel or vanadium, greater shock-resisting qualities are obtained, such as are required in armor plate. The use of chromium alone gives the steel poor machining qualities, but, when used with nickel, vanadium, or molybdenum, the steel becomes more readily machinable. Chrome steels are not so easily forged as steels containing other alloying elements. The rate of penetration in carburizing is increased per unit of time and the allowable heat variation is increased in both carburizing and hardening. Carburized chrome steels are particularly easy to harden and give satisfactory results. Chrome steels used in carburizing usually contain from 0.65 to 0.85 per cent chromium. When combined with nickel, the

chromium content is as follows: When nickel is from 1 to 1.5 per cent, chromium is from 0.45 to 0.75 per cent; when nickel is from 1.5 to 2 per cent, chromium is from 0.90 to 1.25 per cent; when nickel is from 2.75 to 3.25 per cent, chromium is from 0.60 to 0.95 per cent; when nickel is from 3.25 to 3.75 per cent, chromium is from 1.25 to 1.75 per cent. When used in combination with vanadium, the chromium content is usually from 0.8 to 1.1 per cent and the vanadium content from 0.15 to 0.20 per cent. Lower amounts of chromium of from 0.60 to 0.80 per cent are used with smaller amounts of vanadium, but then the vanadium acts more as a cleanser for the steel. Chromium steels are particularly adapted for ball and roller bearings, engine shafts, etc.

Vanadium is seldom used alone in steels. Its greatest value is in being combined with nickel and chromium. When used alone in straight carbon steels or in other alloyed steels it acts as a cleanser, as it has a strong affinity for oxygen, the removal of which causes the structure of the steel to become denser. Vanadium increases the rate of penetration in carburizing, per unit time.



Fig. 5. Enfoliation of a Ball Bearing Part due, primarily, to being cooled too slowly after being carburized

Molybdenum, tungsten, titanium, etc., are lately being introduced in carburizing steels, formerly being used only in high-speed steels; these elements give greater shock-resisting qualities to the steel, tend to retain the shape in quenching, and raise the hardening points.

Material from which Carburizing Pots are Made

Perhaps cast iron is the most common material from which carburizing pots are made, possibly because it is available on short notice and the first cost is low. Malleable iron pots, however, have considerable more life but the first cost is slightly more. Other materials used for pots are, alloy steel, cast steel, puddled iron and wrought iron. The following list shows the results of tests on pots made of these various metals.

Material	Life, Hours	Pot Cost Per Hour, Cents
Malleable iron	465	0.85
Malleable iron	415	0.82
Alloy steel	517	1.68
Cast steel	552	0.77
Cast steel	460	0.87
Puddled iron	475	0.97
Wrought iron	386	2.75
Cast iron	169	1.38
Cast iron	75	4.77

These tests were all made from the same size pot, which was 9 inches in diameter, and 10 inches deep, having walls ¾ inch thick, and will serve as a comparison of the final cost of these pots.

There is a material on the market, known as nichrome, which is high in first cost, being approximately $1.25 per pound; the final cost however, is considerably less than the other materials mentioned in the above. The writer has had personal experience with pots of this material which have shown a life of over 25,000 heat hours and has used the same metal for pyrometer protection tubes in the furnaces where it lasted for five years. The life of this material makes it possible to reduce the wall thickness of the pot, thereby cutting down the weight and cost of the pot and making it easier to handle.

Clay and black-lead crucibles are occasionally used for pack-hardening, but due to the usual rough handling in the hardening shop, they are not practical. Some hardeners prefer to have a firebrick pot permanently installed within their furnaces, which is packed and unpacked in its original position, in which their carburizing is done. They claim that by this method they get a greater uniformity of heat throughout, and likewise, greater uniformity of case. The method is good, but it is a question whether it could be used satisfactorily and economically on a large scale. Ordinary pipe is often used in carburizing and gives a very good life, being also very satisfactory from other standpoints.

Unsatisfactory Results Obtained by Using too Large Pots

The general rule of using a pot only slightly larger than the work is a safe one, but there is no great advantage in commercial work of using pots less than 5½ inches square by 5½ inches deep. Parts such as graphaphone needles are usually carburized in tubes from 2 to 3 inches in diameter and from 8 to 12 inches high, which are placed in a furnace vertically. Watch screws, etc., are carburized in retainers or pots from 2 to 4 inches in diameter and from 2 to 3 inches high.

There are three disadvantages in using a large pot which are as follows:

1. Difficulty in handling.

2. Length of time required to heat the pot and the lack of uniformity of heat from the outside to the center, which means a lack of uniformity of penetration. This is especially important for work requiring a slight depth of case, because if the entire pot is not brought to an even heat, there is danger of carburizing the work near the outside of the pot deeper than at the center. As mentioned previously, a fine mesh carburizer causes more lagging of heat between the inside and outside of the pot than a coarse mesh carburizer. As an example of this disadvantage: In a certain case gun triggers were carburized in pots 12 inches long, 8 inches wide and 6 inches high, and after they were removed from the pots great unevenness of depth was noticed. Marked samples from the outside of the pot were carburized to too great a depth while samples at the center remained uncarburized and would not harden.

3. Likelihood of too slow cooling when the work is pot-cooled. This danger results in a tendency of the carbon in the carburized case to separate into layers on slow cooling, each layer containing a different percentage of carbon. Often an inner layer of medium carbon has approximately from 0.6 to 0.8 per cent carbon, and an outer layer of high carbon has 1 per cent. There is no cohesion between these two layers or zones, and when the work is hardened, a weakness and separation result between these layers which will develop when the work is strained or subjected to wear. The final effect of this condition will be a shelling away of the outer zone as shown in Fig. 5. The name for this is "liquation" or "enfoliation." Pot-cooling will always cause this phenomenon to a greater or lesser degree depending on the rate of cooling, but if the effect is not too pronounced it can be eliminated readily by heat-treatment.



Fig. 6. Magnified View of Work having Carbon piled on Surface due to Retardation of Absorption

The following experience shows that when the pot is too large so that the work cools too slowly, there is not only enfoliation or separation of zones but also a decarburizing effect of the carburizer in close vicinity of the steel, on the steel, because the carbon in the former overbalances the carbon in the steel. A large manufacturing plant making air compressors experienced trouble in carburizing parts made of nickel-chromium steel which were carburized up to a depth of 1/16 inch. On attempting to harden these parts

a softness of skin was found. Fractures of these parts showed that this skin was spread on a hardened surface beneath, and close examination by a microscope showed that there were three distinct layers of metal before the core was reached. The outer layer was practically pure iron; the next layer was extremely high in carbon; and the layer adjacent to the core was of about 0.7 to 0.9 per cent carbon. The trouble was first laid to the carburizing material, and initial tests to determine the truth of this were conducted in small pots with especially prepared test samples, but the conditions of the trouble were not found. About the time that the trouble started, this company had commenced using extremely large pots for the carburizing operation, some of them being 3 or 4 feet in diameter. After thorough investigation it was found that the extreme slow cooling of the work in these pots, after carburizing, caused these separations of the zones and the surface softening. This trouble was eliminated by quenching direct from the pot and then rehardening as if it had been cooled in the pot. In this way the work was produced at a faster rate and at the same time the cooling from the pot gave nearly the same conditions as a reheating for refinement of the core.

Design of Pots

Pots should always be of sufficient size to allow from ½ to 1 inch of carburizer between any part of the work and the pot, slight depths requiring the lesser amount. For large work where the smallest dimension of the piece is greater than 6 inches, it will be found that one piece of work to a pot probably will be better than a number of pieces. This depends, however, on the depth and quality of case desired on the work. It is sometimes advantageous to use a flue through the center of round pots to allow furnace heat to circulate up and through. When the pot is made in this way, large pieces would be packed around this flue.

The height and length of pots is not important except that they must meet furnace conditions and be of such a size that they can be readily handled. The width is the most important dimension since it takes but very little more time to heat a pot 6 inches wide and 2 feet long than it does one 6 inches wide and 1 foot long. The design of the pot is governed to a great extent by the class of work desired. A round pot heats through more evenly than a rectangular pot and is particularly adapted to disks, gears, bearings, etc. A rectangular pot is more economical for other classes of work from a standpoint of inside space. The round pot warps less and does not need warpage cleats, a heavy upper rim being sufficient. When the proper equipment is provided, it will be found that it can be as readily handled as the rectangular pot.

The warpage cleats on rectangular pots depend on the material and the size of the pots. Experience is the best guide for placing warpage cleats. Cast-iron pots warp more than malleable, and both of these more than steel pots; nichrome pots do not warp to any appreciable extent; while rectangular pots usually bulge on the sides, the ends and upper rims falling in. Cast-iron and malleable pots should have a slight taper from the top to the bottom, the bottom being from 1 to 1½ inches less in width or diameter than the top, for every 12 inches in height. This will help to prevent warpage and will allow the contents to be dumped easier, especially when a fine mesh carburizer is used. The wall thickness should be from ⅝ to ¾ inch, the smaller pots requiring the lesser thickness. Greater thicknesses would stand the heat a greater length of time but would most likely have to be discarded on account of warpage before any benefit could be derived from the added thickness.

All pots should have legs or cleats, to hold them off the hearth. The cleats are the more substantial, and their height should be from 1 to 2 inches. By thus allowing a complete circulation of furnace gases around the pot an even heating is insured. For the same reason, pots, especially rectangular ones, should not be allowed to touch one another in the furnace, and there should be at least 2 inches of space between them in all directions.



Fig. 7. Method of packing Nichrome Pots. Note the Beveled Surfaces on the Pots and Covers

Methods of Packing Carburizing Pots

There are in use a number of methods of packing carburizing pots. Some carburizing materials require tamping down, while others require merely a shake or rapping on the outside of the pot. A powder material should be tamped, but a granular material is best settled by shaking or rapping. It has been found that a granular carburizing material, which has been tamped down in the pot, is liable to become crushed into a powder form, and on later sifting, too much is wasted. It is also found that if granular material is tamped down to a certain level and then shaken, it will drop still more.

At least ¾ inch of carburizing material should cover the bottom of the pot and this material should be leveled off fairly smooth. The work may then be placed on this layer, allowing approximately ¼ inch between the surfaces of the various pieces of work, depending upon the required depths of carburization. Corners of the work may be disregarded and brought very close together. It is always best to have at least from ½ to ¾ inch between the work and the wall of the pot. The reason for this is that pots absorb some carbon and are liable to take away some of the strength of the carbonaceous gases, thereby lowering the carbon carrying properties of the gas that comes in contact with the work. After a layer of work has been placed on the layer of carburizer, from ½ to ¾ inch of the carburizing material should be placed over this layer of work and leveled off, after which the former procedure should be continued. After each layer of carburizer has been placed, it is well to tamp the carburizer or rap the pot before adding the next layer of work, so as to insure a perfect settling of the contents. The reason for a greater amount of material between each layer of the work than between each piece of each layer, is because all materials shrink on heat application and as soon as they have reached the heat will begin to settle, so that at the end of the heat, the distance between the work will be found to have closed up to some extent. Due to the shape of the work it is not always possible to pack in layers, but it

is good practice to follow out the above plan as nearly as possible. At least 2 or 3 inches of material should cover the top layer of work when granular material is used and when the material is new. From 1 to 2 inches is sufficient for powder material under the same conditions. After the material has been used and has come to its constant rate of shrinkage, from 1 to 1½ inches is all that should be required with either a granular or powder material.

Various Methods of Sealing the Pots

It is best to seal the pots in order to retain as much of the carburizing gas within the pot as possible. This will increase the pressure which, in turn, increases the rate of carburizing and likewise protects the carburizing material from undue exposure to the air and keeps it from burning and losing its strength. There are various methods of sealing pots. Common fireclay and salt mixed together are used for this purpose. The salt keeps the fireclay from being chipped and glazed by the furnace heat. The mixture is spread over the surface of the pot and trowelled down. Sometimes steel and cast-iron chips are mixed with this clay, which help to form a non-cracking cover. Cast-iron or steel plate covers which fit loosely over the top of the box are also used, the corners being sealed with clay. In some vicinities, ordinary red brick clay is satisfactory for this purpose and is much cheaper than fireclay. In fact, as clays have different fusing temperatures, it is sometimes found that the ordinary clay is more satisfactory than fireclay, due to the fact that heat causes them to fuse and fill up any cracks that may be developed by the pressure of escaping gases. Cast-iron or steel chips alone are a good seal and when placed on the top of a steel or cast-iron cover make an excellent method of covering. The steel or cast-iron chips should not, however, be allowed to get into the carburizer to any great extent.

A concern making chain parts experienced trouble with silica deposits on carburized bushings. The shape of these bushings caused considerable cost in cleaning them and the silica deposits dulled the reamers and other tools. Investigation showed that if the carburizer was not sifted, a magnet placed in the carburizer came out covered with iron filings, chips, etc., and an examination of these chips showed that they were from some other source than pot seals. It was found that clay mixed with sand was used for sealing purposes. This sand was waste foundry sand and contained 2 or 3 per cent of iron. The silicon and the finely divided iron in the sand, and the sodium carbonate in the carburizer, formed silica or glass deposits on the work. By taking clean steel and painting a design on it with the sand and packing with new carburizing material, the design was produced in glass on the steel by the carburizing operation. Elimination of the sand and a thorough sifting of the carburizer relieved this trouble. In conjunction with this, it is interesting to note that alloys in the steel will cause these silicon deposits to take on various colors. With the nichrome pots previously referred to, as they neither warp nor scale, it is found that by grinding the surface of the inside of the pot near the opening to a bevel, and having covers which fit this bevel made of the same material, no luting or other covering is necessary. (See Fig. 7).

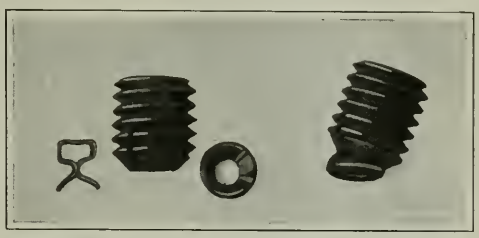
Many concerns do not seal their pots at all and claim that such a procedure is unnecessary for their class of work. Satisfactory work cannot be done, however, without sealing, except perhaps for work having a slight depth of case. For great depth work, uniform results can be obtained only with the best methods of sealing. Non-sealing results in the burning of the carburizing material by air and furnace gases, exposure of the work, scale decarburization, and the escape of the carburizing gas before the steel has received the greater benefit that it would get if these gases were somewhat confined.

In packing, it is well to determine whether it is advantageous to the work from standpoints of desired hardness, grain structure, and strength, to cool the work in the pot or quench from the pot. If it is desired to quench from the pot, in most cases, this can easily be accomplished by wiring or stringing the work to rods before packing. A number of parts can be wired together, and there can be one or several sets to the pot. The ends of the wires should be brought to the under side of the cover where they can be easily grasped by tongs for removal and quenching. In the case of gear pinions, the pinions can be threaded on bolts sufficiently long to reach to the top of the pot. Where the work can be quenched by tipping the pot and contents into a quenching bath or a sieve, stringing is not necessary unless the rough handling mars the work or if warpage is liable when the work is quenched in this manner.

* * *

SELF-ALIGNING AND SELF-LOCKING SET-SCREW

A self-aligning and self-locking safety set-screw is being manufactured by the Bofors Co., Sweden, and is the invention of M. Weibull of that company. This set-screw, which is here illustrated, is an improvement over the well-known safety set-screw having a hollow conical point. The ordinary hollow set-screw loses much of its holding power when it is at an angle with the shaft. Since the efficiency of the screw is due largely to the holding power of the two semicircular incisions which the hollow point makes in the shaft, it is evident that the maximum holding power is obtained when the set-screw is at right angles to the



Ball-point Hollow Set-screw which is both Self-aligning and Self-locking

shaft. It is frequently necessary to incline the set-screw, as in the case of a gear having a short hub, in which a hole cannot be drilled at right angles to the shaft.

The improved set-screw which is designed to overcome this condition consists of three parts; a regular hollow set-screw slotted across the point as shown, a semi-spherical loose point, and a holding wire for assembling the two parts together. It will be apparent from the illustration that the wire fits into one of the slots in the set-screw and that the bent ends are the means of supporting the point, and are shaped to conform to the curvature of the inside of the loose point. This loose point has a sharp circular edge like the regular set-screw point, and its spherical surface fits the point of the set-screw and acts like a universal joint. It will be evident that by this means a full bearing of the loose point against the shaft will always be had. Continued pressure on the loose point when tightening the screw will expand the slotted end and lock the screw in the hole. This latter feature makes the set-screw self-locking.

* * *

Among the exhibits of special interest at the Shipping, Engineering, and Machinery Exhibition at Olympia, London, might be mentioned friction linings. There is on display a fabric manufactured by a London firm that is said to meet the serious braking problems of the underground railways of London and Paris and that was used by the British and allied engineers on the clutches and brakes of war tanks. There are in all, thirty-one varieties of friction linings exhibited, each kind intended to perform a special function with loads up to 10,000 pounds per square inch.

Dies for Automobile Muffler Housings

By J. BINGHAM, President, The B. J. Stamping Co., Toledo, Ohio

THE dies used to make the two shells which form the housing for a certain type of automobile muffler are described in the following. The illustrations show the dies and the housing part or shell as it appears after each operation. The corresponding parts of the various dies have the same reference letters throughout the description. The functions of the various die parts that are shown in Fig. 1 will be described, but only those features of the other dies which are incorporated for the purpose of performing some special operation will be described. The blanks from which the housings are made are sheet steel, 0.0375 inch thick and 6¾ inches in diameter.

The combination die shown in Fig. 1 forms the shell to the shape shown in the lower part of the illustration. The taper on this shell is started at the very beginning of the forming operation. The design of the die provides for employing the familiar punch press construction, with rubber

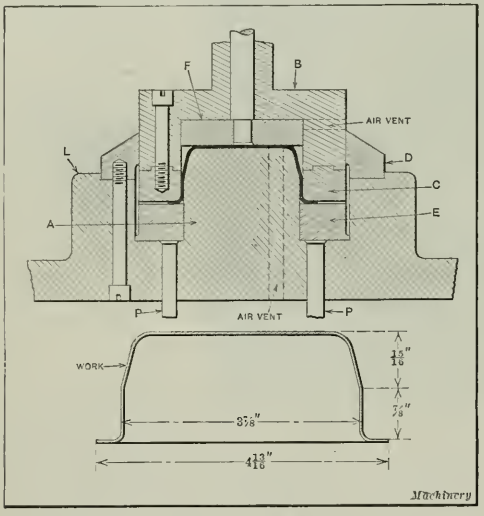


Fig. 1. Combination Die which cuts the Blank and performs the First Drawing Operation

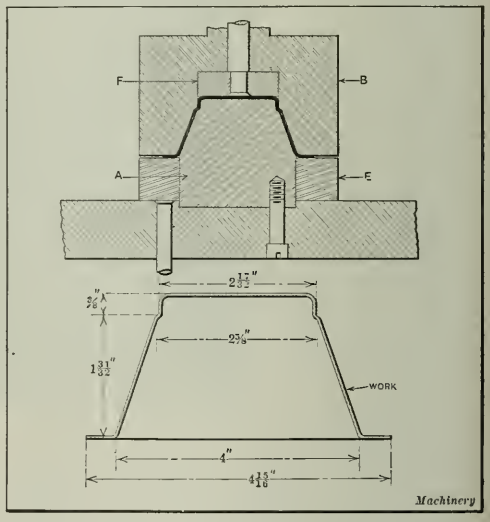


Fig. 2. Die for forming the Tapered Part of the Shell and for the Preparatory Forming of the Small End

buffer attachment and supporting plates for pins *P*. The forming die *A* is an integral part of the cast-iron holder, the construction being found very efficient for a preliminary operation of this kind. The punch *B* is also made of cast iron and has a tool-steel ring *C* fitted to its bottom face. The cutting ring *D* is inserted in a recess in the cast-iron die-holder *L*. The flange of the shell is formed and held firmly between the ring *C* and the drawing ring *E* at the completion of the drawing operation. Knock-out pad *F* is used to eject the shell from punch *B* upon the upward stroke of the press.

The die illustrated in Fig. 2 forms the main or tapered part of the shell and also forms the small end of the shell preparatory to performing the next operation. In its normal position, the ring *E* is raised on the buffer-plate pins sufficiently to allow the flange of the shell to rest upon its top surface, and when in this position the shell is concentric with the forming die *A*. The rubber buffers are screwed up fairly tight during this operation so that when punch *B* descends, the gripping action on the flange will hold the shell securely between punch *B* and the ring *E*, and the shell will not be distorted or changed during the operation of the press. The top part of the shell becomes contracted and the lower part expanded to the shape of the forming die as the punch completes its descent. This method has proved very satisfactory for shaping tapered shells of this type.

The die shown in Fig. 5 is known as a hole and flange die. The forming die *A* has a cutting edge on its inside diameter. The locating ring *G* conforms to the taper of the shell, and is so shaped as to furnish a seat for the flange, the shell thus being located concentrically with the punch. In operation, the cutting punch *H* comes in contact with the shell a trifle ahead of punch *B*, and cuts a hole in its center as it passes the cutting edge of *A*. As *H* continues to descend into the hole in *A*, punch *B* comes into contact with the shell and turns or edges up the shell as shown. This operation completes the small end of the shell.

The blanking die shown in Fig. 3 operates on a rubber buffer, the same as the combination die shown in Fig. 1, and is used for trimming the flange of the shell concentric with the shell itself, which is very essential in work of this type. The pad *J* holds the work and locates it properly in relation to the cutting edge of punch *B*, and also lifts the shell out of the die on the return stroke of the press. It will be noted that there is a space provided between the lower surface of the cutting ring *D* and the pad, which allows sufficient movement of the pad to permit the shell to be readily removed from it. There is another die used in making the muffler housing which is not illustrated, but which is similar in construction to the one shown in Fig. 3. This die is employed to trim the shell flange on one half of the housing ¼ inch smaller in diameter, the purpose of which will be apparent later. Fig. 4 shows a die that turns or edges up the flange of the other half of the housing. The ring *K* is recessed at *R* to suit the diameter of the flange, thus locating the shell properly. The punch *B* descends upon the shell and edges up the flange by pushing it clear through ring *K*, after which the shell drops off the punch and through a hole in the die.

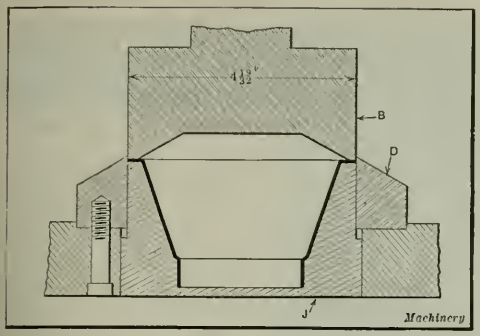


Fig. 3. Blanking Die used for trimming the Shell Flange

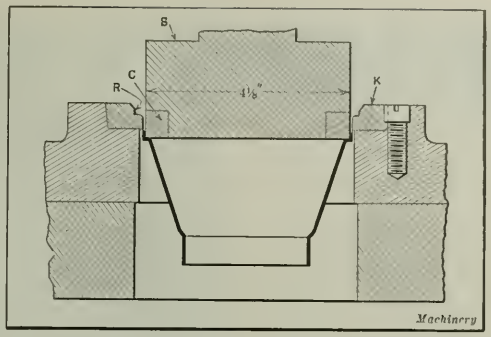


Fig. 4. Push-through Die for turning up the Shell Flange

In the operation illustrated in Fig. 6, one of the shells, which has had the diameter of its flange trimmed ¼ inch smaller than shown in Fig. 3, is placed within the turned-up flange of the other shell which is placed in holder *L*. This die is a plain closing die which is employed to fold the edge on the lower shell over the flange of the upper shell to produce the complete muffler housing. The cast-iron punch *B* has a tool-steel ring or face *C* attached as shown, and is also equipped with a knock-out pad *F*. The tool-steel ring *K* is inserted in the holder *L*, both rings *C* and *K* being hardened and ground to their proper shapes. Dies of this type work very well if properly made, the correct method being to make the inside diameter of ring *C* where it comes in contact with *K*, the same as the inside diameter of the ring *K* in Fig. 4, and the ring *K* in Fig. 6 should be made to fit ring *C* very closely.

* * *

BELGIAN-AMERICAN CHAMBER OF COMMERCE

The Belgian-American Chamber of Commerce, originally organized about twenty years ago, but interrupted in its activities during the war, has just been reorganized, and the secretary, René L. J. De Wael, may be addressed at 4 Montagne du Parc, Brussels. The membership at the present time consists of 60 Americans and 200 Belgians, and the chamber is a member of the Chamber of Commerce of the United States, at Washington. The services rendered by the Belgian-American Chamber of Commerce are being considerably extended and are at the disposal of American firms interested in establishing connections with Belgium.

SALE OF MACHINE TOOLS TO BELGIUM

The War Department has authorized publication of the following statement from the office of the Director of sales: The War Department has entered into a contract with La Construction Metallique, a cooperative society composed of the heads of approximately five hundred industrial organizations of Belgium, for the sale of a quantity of surplus machine tools held by the War Department. The Belgian Government has arranged through American banking interests, for a credit of $50,000,000 in the United States, and La Construction Metallique has been authorized by the Belgian Government to make purchases of machine tools against this credit to the extent of 25,000,000 francs. To date, La Construction Metallique has purchased from the War Department approximately 2500 machine tools. The contract with La Construction Metallique was made by C. W. Hare, Director of Sales, during his recent visit to Europe. La Construction Metallique recently sent to the United States a commission headed by Lieutenant Jean Jean, the Director General of the Cooperative Society, to make a general survey of the mechanical equipment which the bureaus of the War Department hold as surplus. The machine tools sold to La Construction Metallique are now being selected from the several districts of the Ordnance Department, the Air Service, and the Purchase and Storage Service, and are being put in transit to Belgium as rapidly as they can be prepared for shipment. More complete information on earlier Belgian transactions by the Government will be found in the November number, page 226.

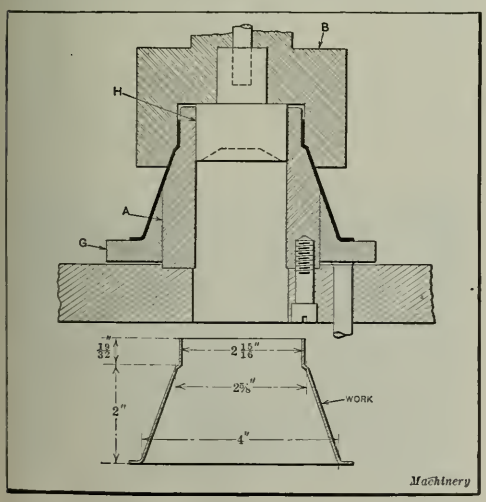


Fig. 5. Hole and Flange Die which cuts a Hole in the Small End of the Shell and turns up the Edge

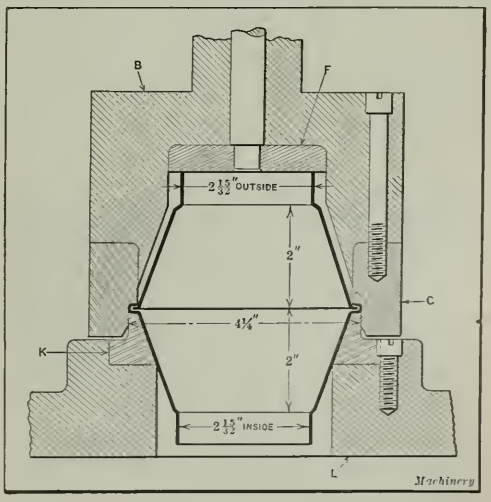
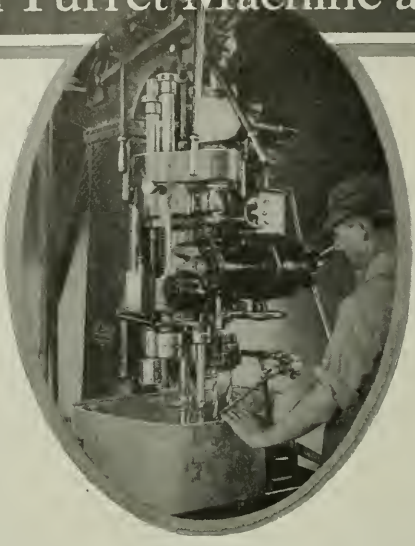


Fig. 6. Closing Die which secures the Two Shells together, producing a Complete Muffler Housing

The Vertical Turret Machine and Its Work



Uses of the Turner Vertical Turret Machine on Quantity Production Work Including a Description of the Equipment Used on Various Machining Operations

By FRED R. DANIELS

MODERN requirements in interchangeable manufacturing necessitate that as much as possible of the work should be performed on one machine and in a single setting of the tooling equipment; otherwise the resulting loss of time caused by changing the set-up and the expense of extra machines will make economical production impossible. Forged and machine steel parts which can readily be handled on automatic chucking machines and turret lathes offer no perplexing problems in this regard, but when such parts are of irregular shape, requiring surfaces to be finished which are not located from a common center line, or axis of rotation, difficulties arise when attempting to machine these parts without excessive handling. In fact, it is generally conceded that for such work special holding fixtures must be employed for machining differently located surfaces. Many such parts are used on automobiles and airplanes, in the manufacture of which, a great variety of bolts, knuckles, and other similar small forgings are required to be machined.

The vertical turret boring and chucking machine is especially adapted to this type of work; and the steel forging shown in Fig. 4, finished in one setting, furnishes a good example of what can be accomplished. With this machine the problem resolves itself into designing a ruggedly constructed indexing fixture and selecting an operator of average ability. The most recent model of the vertical turret machine referred to in this article, known as the Model F Turner vertical boring and chucking machine, is the product of the Turner Machine Co., Danbury, Conn. It is the purpose of this article to deal more especially with the uses of this machine on various classes of work rather than with the construction of the machine itself, except as it may be referred to, incidentally, in order to more clearly describe the machining operations.

The turret of the machine revolves automatically from right to left in a horizontal plane, after each tool has been withdrawn from the work. The turret is gear-driven (see Fig. 1), and provision is made whereby, by means of minor gear changes, the spindles may be independently driven by gears *A*, at different speeds so that no attention need be paid to speeds after the job has once been set up.

The hanger bolt shown in detail in Fig. 4 is typical of the class of work for which the vertical boring and chucking machine is especially fitted. It is a steel forging, 0.30 to 0.40 per cent carbon content, and is machined complete on the turret machine without change of tools. The operations performed on the forging are as follows: Drill one 11/16-inch and one $\frac{5}{8}$-inch hole through 1 7/16 inches of metal; rough-turn shank $2\frac{1}{4}$ inches long and face shoulder; rough-turn shank 1 inch; finish-turn shank $2\frac{1}{4}$ inches long; thread $\frac{5}{8}$-inch diameter, 18 threads per inch; countersink one side of $\frac{5}{8}$-inch hole and face adjacent surface. The production time on this job with an operator of only average ability is 5 minutes per piece. One workman can easily operate two machines at a time, taking care of the threading and hollow-milling operations on one machine while the second machine is engaged in drilling the two holes automatically.

Mechanisms for Indexing the Turret

A description of a machine which is similar to that employed in performing the work described in this article was published in the February, 1918, number of MACHINERY. This machine, however, did not possess many of the features incorporated in the more recent model illustrated herewith. In describing the various operations performed on this machine it may be well to refer briefly to the several mechanisms of recent application which are employed to actuate the indexing movement. A toothed clutch on the hub of the foot spider *B*, Fig. 1, operates the vertical traverse of the spindles so that by raising the spindle that is in the operative position, a tapered roller bearing friction clutch *C* is engaged to index the turret *K*, advancing the second spindle into the operating station. The advantage of this means of transmission of power will presently be apparent. Before the turret can be revolved, however, the steel detent, or locking member *H*, must be withdrawn. This is accomplished just before the clutch is engaged, by means of a ratchet and pawl arrangement which is also operated by the upward travel of the spindle. As a result of this device, lever *F* (see also Fig. 8), engages an extending finger *G* and ejects the detent. The details of the clutch and the device employed to support it when disengaged are illustrated in Fig. 3.

The tool steel inner member *A* of the clutch is attached to a bronze sleeve *B*. Three springs interposed between these two members permit a flexible movement and allow the clutch to readily align itself when being thrown into engagement. This inner member has a 3-degree taper and fits into the turret pinion *D* to which is attached a bronze retainer *C* which carries the tapered rollers in suitable conical slots. The double driving gear *E* is attached to the vertical shaft of the machine (see also Fig. 1), and has a tapered chamber, within which the clutch rollers operate, revolving the turret to the next operating station as soon as the clutch sleeve is raised. The action of the driving gear will cause the tapered rollers to immediately roll themselves free from engagement, after the supporting device (shown assembled in the lower right-hand corner of the illustration), has been automatically released. However, the employment of tapered rollers in the clutch and their arrangement in the retainer slots, in combination with the yielding construction of the clutch sleeve, permits the turret pinion *D* (see also Fig. 1), to remain in mesh with the turret gear *J* even when the clutch is disengaged.

The supporting device, except when employed to raise the clutch, is inoperative and supports the clutch by means

of a hook *F*, Fig. 3, which hangs from the inside wall of the turret case. It is actuated by a lug on the upper end of the spindle which is to be indexed. This lug engages the under side of the swinging cam *G* directly after the locking detent has been withdrawn. The turret being now unlocked, the friction clutch is free to act as soon as the spindle has been raised sufficiently to force the cam *G* against latch *H*, so that hook *F* will swing free as the clutch is brought into engagement. As soon as this movement occurs, the swinging cam, by means of the now revolving turret, forces the hook into its upright position and the entire supporting device drops down to normal again, suspended by hook *F*. The part *K* in this illustration is the bronze index-control cam which carries a steel detent socket *L* in which the detent engages to lock the turret. The lug *M* on these cams performs a very important function in the cycle of movements connected with indexing the turret. These cams are spaced around the periphery on the under side of the turret, the location and quantity corresponding to the number of spindles in the turret. The arrangement is quite plainly shown in Fig. 2, in which the cam and the lug are designated by the same reference letters that are employed in Fig. 3.

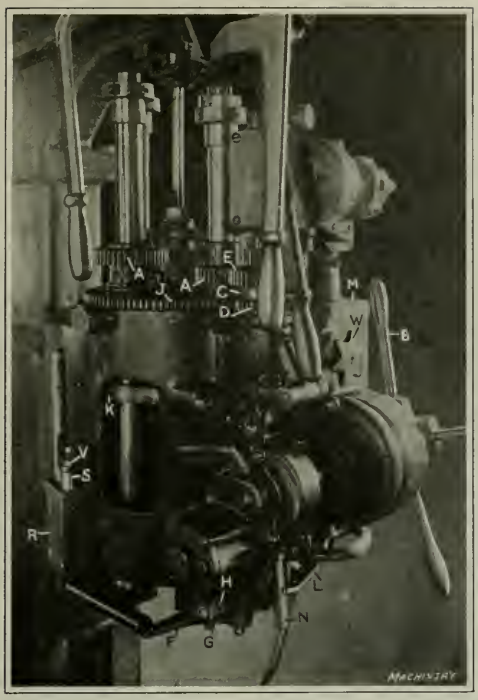


Fig. 1. Vertical Turret with Top Gear Guard removed showing Indexing Gears and Clutch Drive

Referring to Fig. 1, the opposite end of the lever *L* (which might be termed an escapement lever), is swung outward as soon as the friction clutch has started to revolve the turret, through the agency of the lug on the particular index-cam that is located nearest the advancing spindle. This results in operating lever *N*, releasing a catch and allowing the detent to spring into its socket in the bronze cam. Ordinarily a rather severe shock would attend the action of this indexing mechanism if some form of check were not provided to absorb this shock. Accordingly, the Turner turret Model F machine is equipped with an oil-pressure hydraulic brake, or shock absorber *R*, Figs. 1 and 2. The plunger *S* carries a shoe *T* at its lower extremity, which is operated against the hydraulic pressure by the lug on the index-control cam which is located near the receding spindle, that is, near the spindle which has just left the operative position. The operation of the shock absorber is so timed by its location in relation to the cams, that the stopping of the heavy turret is accomplished without severe shock to the machine. The oil pressure is regulated by means of valve *V*. The machine is also equipped with a feed mechanism, automatically regulated which may be engaged or disengaged while the machine is in operation. The feed-gears provide four feed changes without regard to the spindle speeds and are enclosed within case *M*, Fig 1. Change of feeds is accomplished by adjusting hand-wheel *W*.

With the foregoing brief description of the construction of those devices which concern the actual indexing of the turret, a better conception can be had of the use and manipulation of the machine when employed on quantity production. A few representative examples of vertical turret machine work will now be described in detail.

Machining a Front Spring Hanger Bolt for Automobiles

In discussing the performance of work required to machine the automobile hanger bolt shown in Fig. 4, attention is called to the tooling lay-out shown in this illustration which furnishes a graphic presentation of all data necessary to enable the reader to readily understand the arrangement of the set-ups and the sequence of operations. Fig. 8 shows the piece clamped in the fixture preparatory to performing the first operation—that of drilling the two large holes. After the fixture has been indexed 180 degrees, the turret is indexed to No. 1 spindle, bringing the duplex drill head into the operating position. Fig. 9 shows the operation in the course of completion.

After these two holes have been drilled, the work is indexed 90 degrees and the turret indexed to No. 2 spindle where the second operation, which consists of rough-turning the large diameter and facing the shoulder, is performed. The tool used for this operation is an ordinary hollow-mill (see Fig. 10). Following this operation, the turret is in-

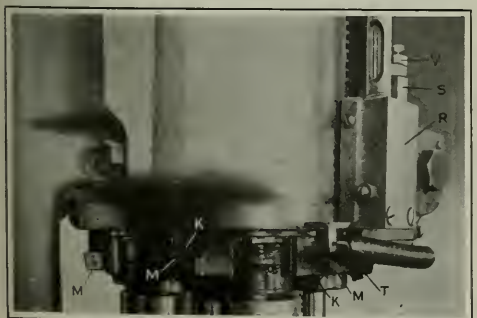


Fig. 2. Arrangement of Index-control Cams on Under Side of Turret

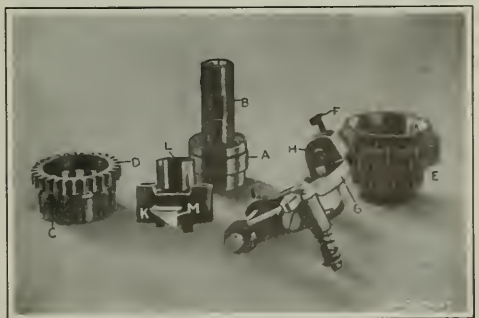


Fig. 3. Clutch Parts and Index-control Cam with Detent Socket

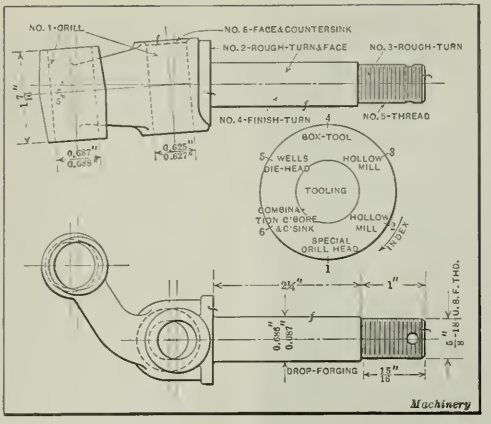


Fig. 4. Detail of Front Spring Hanger Bolt for Automobiles, and Tooling Lay-out

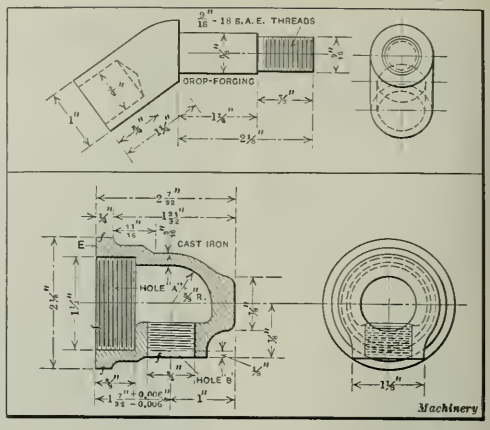


Fig. 5. Additional Examples of Vertical Turret Machine Work, and Operations performed on Each

dexed to No. 3 spindle where the 5/8 inch diameter is rough hollow-milled to a length of 1 inch. Operation 4 consists of finish-turning the large diameter to the dimension shown in the illustration after the turret has been indexed to No. 4 spindle. This operation is illustrated in Fig. 11 from which it will be seen that a box-tool of the usual type is employed. The next operation, the fifth, which is shown in Fig. 12 consists of threading the 5/8-inch diameter end of the forging, 18 threads per inch, and is performed on spindle No. 5 with a Wells self-opening die-head, the opening cam or yoke trip *A* being located on the center post *B*. The arrangement may also be clearly seen by referring to Fig. 7 which shows the position of the die in engagement with the opening cam *A* after the completion of the threading operation. The sixth and last operation is performed on spindle No. 6 after the fixture has been indexed another 90 degrees. This brings the work into the starting position, shown in Fig. 8, where the surface around the 5/8-inch hole is faced and the hole countersunk, the tool used being a combination counterbore and countersink. This completes the work and the finished forging is removed from the fixture, another clamped in place, and the fixture indexed 180 degrees before again indexing the turret. It will be noticed that a cotter-pin hole is drilled through the threaded end of the bolt. This is done by the operator on a small drilling machine located near the turret machine, during the time the large drills are feeding through the next piece; thus the idle time of the operator is greatly reduced. For the drilling operation, a special duplex drill head is employed, the detailed construction of which is shown in section in Fig. 7. The head, which is a very simple design, consists essentially of an auxiliary spindle *B* driven by gears from the main spindle *C* (see plan section view through gear head). Both spindles, as will be clearly seen in the illustration are provided with ball thrust bearings. The case *D* which encloses the head has a removable cover *E* and a radial arm *F* which connects with a center post—a provision for counterbalancing the overhanging weight of the drill head, preventing sag and consequent inaccuracy.

The work-holding fixture used on this job is illustrated in Fig. 6. Its principal feature, which is also common to all jigs used in vertical turret machine practice, is that it is of a very rugged and simple construction. The fixtures must be rugged in order to permit positive clamping and indexing arrangements for firmly holding the work under the severe strains which are commonly produced in this general type of machine operations. The outer jaw *A* of the fixture is turned to fit a bearing in the base *B*, and extends far enough beyond the bearing to allow a thrust collar *C* and a handwheel *D* to be assembled. The opposite end of this jaw has a journal by means of which it is mounted in the block *E*, on the base. The inner jaw *F* is the movable member and functions through a hole in the outer jaw, being closed on the work through the medium of the cam lever *G* operating the cam *H*. This cam compresses spring *J* so that when released by the cam lever, it will force the jaw

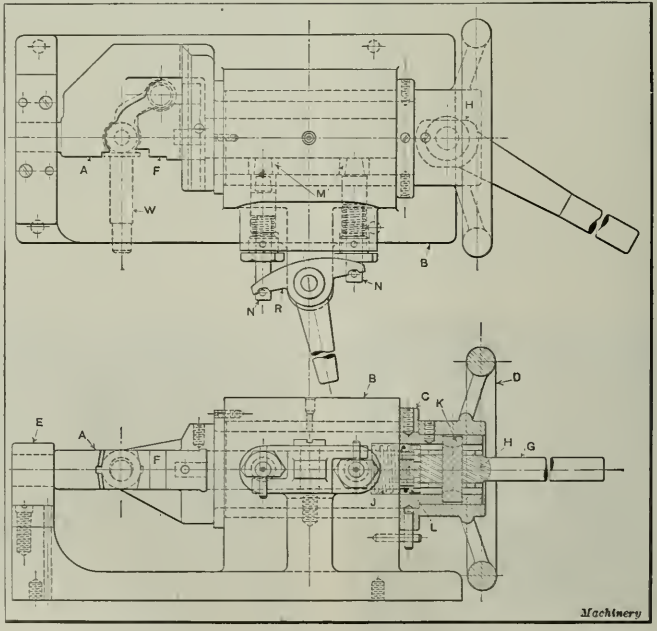


Fig. 6. Fixture for holding Automobile Hanger Bolt when machining on the Vertical Turret Machine

open and permit the work *W* to be removed. It will be seen that the cam is hung on a pin *K* within the bore in the end of the outer jaw, and that when it is in engagement with head *L* of the inner jaw, the entire clamping arrangement and the work may be revolved by turning handwheel *D*. The proportions of the lever *G* are such as to enable it to be used to advantage when revolving the fixture by producing greater leverage than could be obtained with the handwheel alone. Bushed index holes *M* in the outer jaw bearing permit the fixture to be indexed in the desired position by means of spring-actuated detents *N* operated by the rocker arm *R*. The two detents shown in this illustration, permit the use of the fixture for either right- or left-hand hanger bolts.

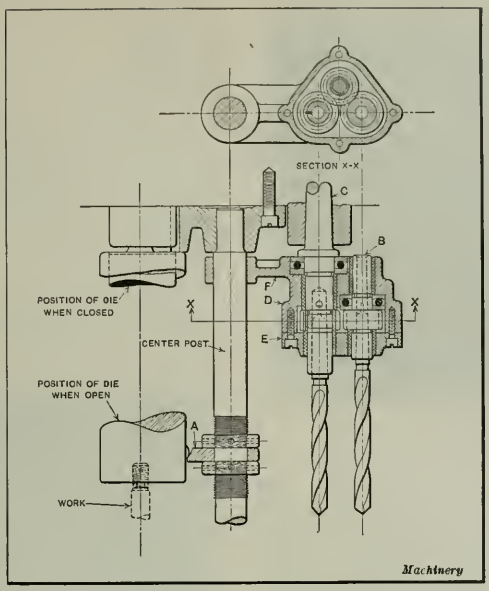


Fig. 7. Duplex Drill Head with Sectional View through Gears. This Illustration also shows Position of Die-head when in Engagement with Opening Cam

Since the general character of the work performed on the vertical turret machine and the methods and tools employed in the performance of the operations should be well understood from the foregoing description, only a comparatively brief description will be given of additional examples of work which may be advantageously handled on this machine. In the upper half of Fig. 5, there is shown a working drawing of a small drop-forging which is machined in four operations on a four-spindle machine. It will be remembered that the operations performed on the hanger bolt, previously described, were handled on a six-spindle machine. A ¾-inch hole is first drilled to a depth of ¾ inch. The fixture is then indexed so as to bring the part of the piece which is to be turned into an upright position, after which the turret is indexed to No. 2 spindle for hollow-milling the ⅝ inch diameter and then to No. 3 spindle for hollow-milling the 9/16 inch diameter. The fourth operation on the forging consists of threading the 9/16 inch diameter, 18 S. A. E. standard threads per inch on the No. 4 spindle. The total time for finishing the piece is 3½ minutes. Since the tooling arrangement does not involve the use of special equipment, no further information other than that contained on the illustration should be necessary.

The cast-iron fitting shown in the lower part of Fig. 5 is finished in two settings of the turret machine. The operations performed in the first setting are: (1) Bore hole *A* ⅝ inch deep; (2) face end *E* of casting using a pilot counterbore; (3) turn 2⅛-inch flange, with a box-tool; and (4) tap hole *A* 10 threads per inch (collapsible tap). The second series of operations concerns the machining of hole *B* in the following sequence: (1) bore; (2) face (counterbore); (3) counterbore ¾ inch diameter, ⅛ inch deep; and (4) tap hole *B*, 14 threads per inch. The total time for both series of operations is 5 minutes, 3 minutes for the first setting and 2 minutes for the second setting.

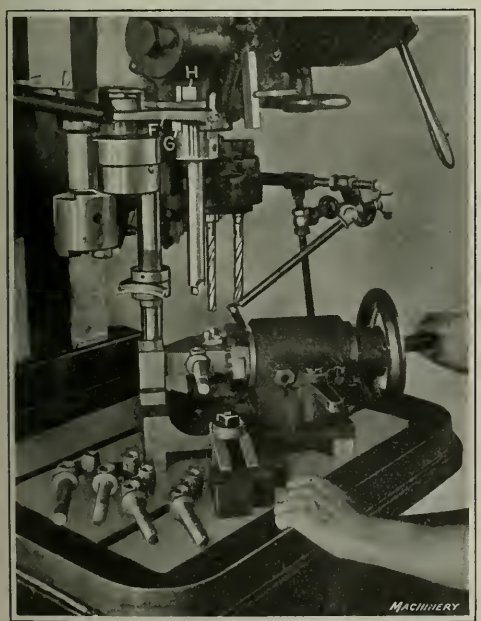


Fig. 8. Hanger Bolt clamped in Fixture before indexing Either Fixture or Turret

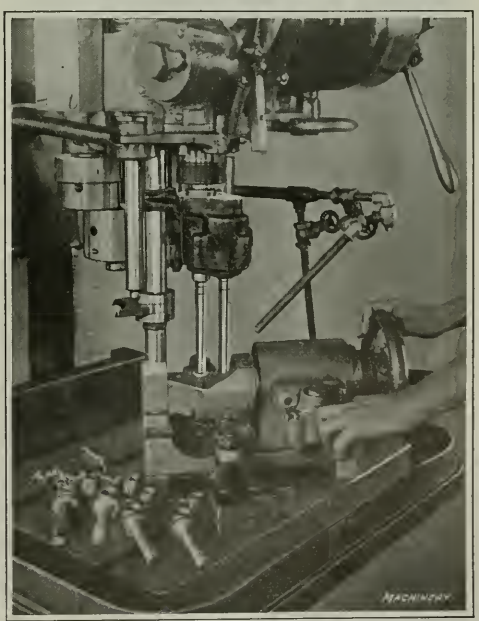


Fig. 9. After indexing Fixture and Turret. Drill Head at Work on First Operation

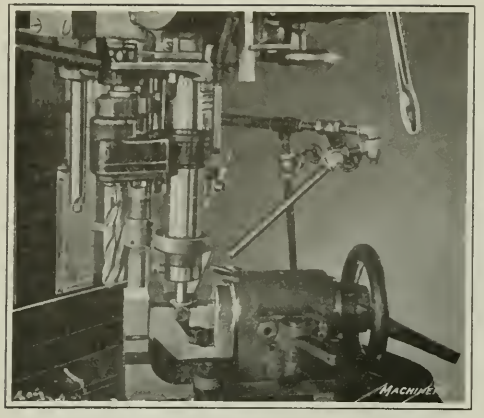


Fig. 10. Second Operation consists of rough-turning Large Diameter of Body and facing Shoulder with Hollow-mill

Machining Automobile Steering Knuckles

Another automobile part, large quantities of which have been entirely machined on the Turner vertical turret machine, is shown in detail in Fig. 14. The part is a forged steel steering knuckle for automobiles, the machining of which was performed on a four-spindle, instead of a six-spindle machine. Consequently, and also on account of the large number of operations required to finish the part, it was found necessary in this case to make three separate set-ups in the completion of the job. The tooling lay-out for each of these set-ups is presented in diagrammatic form in Fig. 15. The 43/64-inch hole is first drilled half way through the forging and the end faced, as shown. This requires the use of the first two spindles, after which the work is revolved 180 degrees and the third and fourth operations performed in a similar manner on the opposite end.

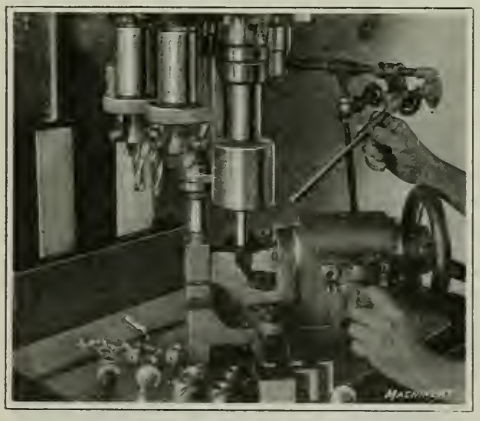


Fig. 11. Performing the Fourth Operation which consists of finish-turning the Large Diameter of Hanger Bolt Body using a Box-tool

This last facing operation establishes the 4$\frac{3}{4}$-inch length of the bearing end of the knuckle. On account of the length of this hole, more accurate results are obtained by drilling in from each end to the center line than could be had by running the drill entirely through, which would probably result in the drill running out considerably before finally breaking through at the opposite end. The second series of operations performed on the knuckle, consists of drilling and reaming the $\frac{3}{4}$-inch hole; facing both sides of the boss through which this hole is drilled; and finally countersinking the hole $\frac{1}{8}$ inch deep.

The operations performed during the third set-up, as will be seen by inspecting Fig. 14, are those confined to the shafting part of the forging, on which the front wheel of the automobile is assembled. The first operation consists of hollow-milling the threaded end to a length of 2 inches and to a diameter of 0.749 inch. Operation 2 is also a hollow-milling operation, the large diameter being turned to a dimension of 1.1875 inches. The third operation consists of removing the burr formed in the first operation at the intersection of the tapered section with the straight turned end. A chamfering tool is employed for this operation. The work is finally completed on the fourth spindle by threading the $\frac{3}{4}$-inch end, 16 threads per inch, (S.A.E. standard). The production time for the three settings is 5$\frac{1}{2}$ minutes.

If a six-spindle machine had been used on this job in connection with an indexing fixture, it would have been a simple matter to arrange the work so that the eight operations included in set-ups Nos. 1 and 3, Fig. 15, could have

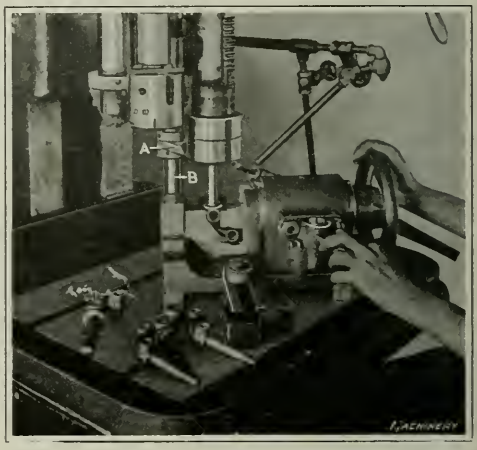


Fig. 12. Operation 5—Threading the End of Body with Wells Self-opening Die-head

been performed in one setting of the tools. This would permit the performance of those operations now included in the second set-up, to have been done on another machine during the time required to drill the 43/64-inch hole, thereby somewhat reducing the production time, although tying up two machines on the job in so doing. It is safe to state, that to the average mechanic the machining of this forging would doubtless present difficulties, the solution of which might require the design of elaborate fixtures, or in any event, the use of two or more machines, the employment of more than one operator, and a considerably increased amount of handling, which, of course, means a decreased production rate.

In connection with the reference to quantity production, it may be well to emphasize the need for a machine of the

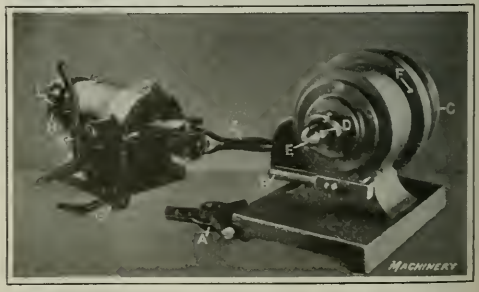


Fig. 13. Typical Work-holding Fixtures used on Vertical Turning and Boring Operations

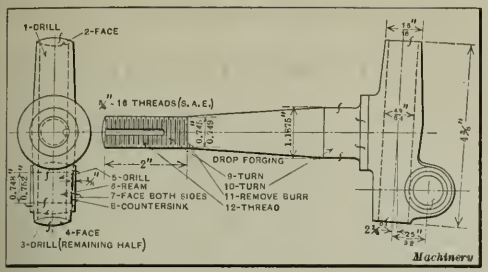


Fig. 14. Working Drawing of Automobile Steering Knuckle showing Various Operations

vertical turret type containing gang or multiple turrets, after the general design of the multiple-spindle vertical drilling machines. Such a machine, equipped with two or even three turrets, would be the means of greatly augmenting the present high productivity of vertical turret machines without employing additional operators. An arrangement of this kind is altogether feasible and offers an opportunity for spindle arrangement and timing for each turret whereby continuous production could be maintained. In view of the fact that continuous output is obtained by the adaptation of this principle in such shop tools as drilling and milling machines, this suggestion is only a natural conclusion and is, no doubt, within the limitations of the adaptability of vertical turret machines.

Fixtures Used on Vertical Turret Turning and Boring Operations

Emphasis has already been laid upon the fact that the principal features of the fixtures and jigs employed in the vertical turning and boring practice are simplicity in design and ruggedness of construction. These two characteristics are apparent from the illustration, Fig. 13, which shows two fixtures that have been used on the Turner turret machine for quantity-production work. The fixture at the right in this illustration is used in machining the differential spider shown at *A*. Three turning operations are performed on each of the three arms of the spider, consequently an indexing plunger or detent is employed to lock the work-holding fixture, at every 120-degree revolution of the work. This detent is operated by means of handle *B*, and the fixture is revolved by handwheel *C*, which when the fixture is locked, also operates a draw-in chuck, by means of which the work is secured in place. One of the three index-holes in which the detent fits when indexing the fixture is shown at *F*. The forging is slipped on the split sleeve or collet *D* which normally is a loose fit within the hole in the spider hub; then by turning the handwheel the tapered pin *E* within the collet is drawn in, thereby expanding the collet and securely clamping the work. The time required to perform the nine operations on the spider including indexing, is five minutes.

The other jig shown in the illustration is employed to hold the small drop-forged arm *G* during the various operations performed on the stem, hole, and hub of the piece.

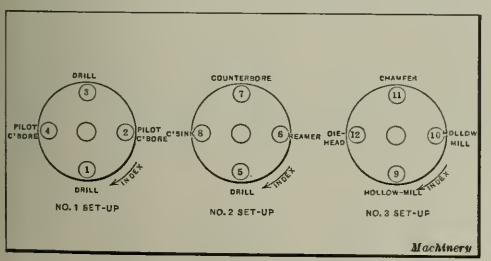


Fig. 15. Tooling Lay-out for Forging shown in Fig. 14, illustrating diagrammatically, the Sequence of Operations

The work is held between two jaws, the outer one of which *H* has a groove *L* shaped to conform to the offset of the arm. The jaw is operated by a toggle-jointed handle *J*, which also, by means of this joint, produces a positive clamping action. This fixture is also indexed 90 degrees after machining the stem, bringing it in position for finishing the hub and hole. The index plunger is controlled by handle *K*.

It will be observed that owing to the design of those parts which are especially suitable for finishing on the vertical turret machine, that an indexing device is, in nearly every case, employed in the fixture as a means of presenting the various surfaces of the work to the tool without removing the piece from the fixture. The advantage of employing indexing fixtures to eliminate repeated handling of the work, makes vertical turning and boring practice distinctly a quantity production method of machining.

* * *

A LIVE-WIRE MACHINE-SETTER

By J. J. BORKENHAGEN

In changing over a small automatic screw machine department from a day-rate basis to a premium system, a premium rate was set for all pieces over and above 85 per cent production, the other 15 per cent being an allowance for stocking up the machine. On the basis by which the rates were set, the operators could, by obtaining 100 per cent production, make approximately 40 per cent over the regular day rating. Under this arrangement the machine-setter's share of the premium earned was 30 per cent; the two operators' share, 25 per cent each; and the share for the helper, 20 per cent. The machine-setter took full advantage of the possibility presented in the arrangement, and after the system had been in use for a few days, it was noticed that he was timing each machine with a time-study watch. Upon being asked the reason for using the watch, he replied that he was going to make the machine "talk 100 per cent to me." He had observed that a slipping belt, or an incorrectly adjusted part, such as a feed-cam, was retarding his production and beating him out of his premium money. This was the reason for using the watch, and explained why he had gone to the expense of buying it with his own money. It is needless to say that this man and the operators under him always made premium wages. The machine-setter also used a card system, showing the feed, speed, cams, rate of production, actual time in seconds per piece, and such other data as might enter into the problem of obtaining 100 per cent production.

* * *

THE CALIPER AS A CHECK FOR MICROMETER MEASUREMENTS

By DONALD A. HAMPSON

For experimental and maintenance work in which only a few pieces of a kind are required at a time, limit gages are not usually supplied. Mistakes in reading the micrometer are of quite frequent occurrence on such work, and invariably these mistakes are not errors in reading the graduations on the thimble, but rather in reading from the wrong 0.025 line. In the effort to make a close fit, workmen are likely to pay more attention to the graduations on the thimble between which they must work, than to the lines indicating the number of turns of the thimble. From this it will be apparent that the caliper serves as a good check for obviating an occurrence of this sort. The micrometer cannot, of course, be safely used on work that is revolving in the lathe, nor is it the proper instrument for measuring roughing cuts. It is not difficult for mechanics to work within a hundreth of an inch, using the scale and caliper, and it is without doubt the quickest method for ordinary machine work and for roughing.

Future of Machine Trade with South America

A GREAT deal has been said about the possibilities for future trade with South America, as regards both machine tools and woodworking machinery. An analysis of the past trade with the South American countries, therefore, will prove of interest, and the accompanying tables have been abstracted from reports published by the Bureau of Foreign and Domestic Commerce, Washington, D. C., in order to show the amount of the trade in machine tools and woodworking machinery previous to and during the war. Table 2 gives the amount of metal-working machinery, including machine tools, exported annually from the United States to South American countries, from 1909 to 1918, inclusive. Table 1 gives the amount of machine tools exported during 1918, which is the first year during which machine tools were separately classified in the government statistics. Table 3 shows the amount of woodworking machinery exported annually from 1912 to 1918, not including sawmill machinery, while Table 4 gives figures for sawmill machinery.

Previous to the war, a large proportion of the metal-working machinery imported to South American countries came from England and Germany. The total amount of metal-working machinery exported annually during 1912, 1913, and 1914 from the United States to the South American countries averaged about half a million dollars. During the same three years our exports to France alone averaged more than three times that amount, and our exports to Belgium alone averaged over 30 per cent more than our total exports in metal-working machinery to all the South American countries combined. This would indicate that the South American market had considerable limitations as compared with the markets of the European countries. In 1912, our South American trade in metal-working machinery was less than 5 per cent of our total exports. In 1913, it was not much more than 3 per cent, and in 1914, less than 3 per cent of our total exports.

During the two last years of the war, however, the value of the exports of metal-working machinery to the South American countries increased considerably, as will be noted from the tables, but the increase was not proportionate to the increase of our foreign trade elsewhere. In 1917, for example, our South American trade in metal-working machinery was not quite 1 per cent of our total foreign trade in that line, and in 1918, when our exports to the European countries were considerably curtailed on account of the United States having entered the war, while at the same time our South American trade almost doubled, the South American buying still amounted to only a little over 5 per cent of our total exports, and to less than ½ per cent of our estimated production of machine tools alone in that year.

Attention is called to these facts merely in order to indicate that as yet the South American market in machine tools and metal-working machinery is an insignificant one as compared with the big markets of Europe, and that while it is a market not to be ignored, it is not one on which big hopes can be built for immediate results.

TABLE 1. MACHINE TOOLS EXPORTED TO SOUTH AMERICAN COUNTRIES DURING 1918—VALUE IN DOLLARS

Exported to	All Classes of Machine Tools	Lathes Only	Grinding Machines Only
Argentina	93,227	29,228	9,397
Bolivia	11,437	5,672	252
Brazil	94,590	53,939	7,099
Chile	232,974	125,940	17,920
Colombia	9,276	3,748	1,213
Ecuador	12,992	1,070	294
Guiana, British	9,071	7,394	182
Guiana, Dutch	446		76
Paraguay	13,767	86	8,844
Peru	55,110	29,980	5,911
Uruguay	8,175	1,306	702
Venezuela	11,466	7,091	419
Total	552,531	265,454	52,309

Machinery

Woodworking Machinery

With regard to woodworking machinery, the conditions are somewhat different. During 1912, 1913, and 1914, the average exports of woodworking machinery, exclusive of sawmill machinery, into the South American countries averaged slightly over $140,000 a year, which was about 9 per cent of our total exports of this class of machinery during these years. In sawmill machinery, a large bulk of our exports went to the South American countries, or nearly 25 per cent in 1912, 15 per cent in 1913, and over 10 per cent in 1914, indicating that our market in South America for this line of machinery is doubtless better than for metal-working machinery. The machine industries in the South American countries are not highly developed, the main uses for machine tools being in repair and railway shops.

It has also been pointed out that while many native industries exist in the South American countries, most of the industrial and commercial enterprises in the mechanical lines are under the control of foreigners, Europeans of many nationalities having colonized in South America, while the Americans there are few and scattered. It is but natural that concerns of European origin purchase their supplies

TABLE 2. METAL-WORKING MACHINERY EXPORTED ANNUALLY FROM THE UNITED STATES TO SOUTH AMERICAN COUNTRIES, 1909-1918—VALUE GIVEN IN DOLLARS

Exported to	1909	1910	1911	1912	1913	1914	1915	1916	1917	1918
Argentina	72,871	237,123	88,155	117,061	112,747	109,836	25,700	142,907	154,581	166,041
Bolivia	61			5,937	187	9,896	291	56	1,725	15,679
Brazil	23,063	19,657	128,454	331,422	346,187	115,974	55,106	29,606	55,409	164,587
Chile	112	29,302	24,649	59,662	43,930	85,168	28,430	58,447	426,980	792,882
Colombia	3,462	1,240	7,795	1,939	8,967	16,838	11,572	9,488	20,859	17,087
Ecuador	815	2,006	1,054	13,659	510	5,077	3,567	2,972	16,700	14,307
Guiana, British	89	1,316	1,668	242	206	61	163	367	3,191	12,602
Guiana, Dutch			700						916	446
Guiana, French	991	72								
Paraguay						237				14,036
Peru		2,399	6,926	15,073	40,651	35,294	31,631	30,151	71,477	77,964
Uruguay		11,193	5,515	19,305	13,828	20,612	1,845	5,382	27,162	29,281
Venezuela	11,909	761	4,100	2,941	4,706	4,950	6,975	7,080	17,365	25,581
Total	113,373	305,069	269,016	567,241	571,919	403,943	165,280	286,456	796,365	1,330,493

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and machinery in and through their home countries, and for that reason there will be a tendency for a large share of the trade to revert to Europe as soon as the trade channels are again opened and conditions become normal.

At the same time it must be remembered that the South American countries, and particularly the Argentine Republic, are at the present time heavy exporters of food stuffs to Europe, which builds up a favorable balance in their favor with the financial institutions there. Argentine is the only country in the world where the exchange is above normal compared with the value of the currency of all other nations, and this naturally will influence the tendency toward importation of machinery from Europe. Hence any development of the South American market will require exceedingly hard, conscientious and careful work, and it is not a market that will come to us without effort, nor one where great immediate results may be expected.

TABLE 3. WOODWORKING MACHINERY EXCLUSIVE OF SAWMILL MACHINERY EXPORTED ANNUALLY TO SOUTH AMERICAN COUNTRIES, FROM 1912 TO 1918, INCLUSIVE—VALUE IN DOLLARS

Exported to	1912	1913	1914	1915	1916	1917	1918
Argentina	15,515	24,477	14,430	5,074	6,405	37,596	46,979
Bolivia	375	464	950	471	27		5,612
Brazil	72,593	58,526	19,544	8,328	4,159	12,573	8,715
Chile	53,993	39,799	28,049	7,321	5,159	6,970	31,947
Colombia	7,855	1,172	2,061	4,437	1,737	4,868	3,519
Ecuador	64	1,737	2,047	531	2,376	2,250	7,713
Guiana, British	1,451	283	402		12	1,806	1,357
Guiana, Dutch				379		22	
Paraguay			342		429		6,612
Peru	12,203	6,133	30,286	5,069	5,809	6,811	3,466
Uruguay	12,279	6,590	2,528	882	787	165	2,235
Venezuela	5,077	4,947	1,909	581	4,580	13,379	1,311
Total	181,405	144,128	102,548	33,073	31,480	86,440	119,466

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CANADIAN ENGINEERING STANDARDS ASSOCIATION

An association for furthering standardization in the engineering trades has been formed in Canada, known as the Canadian Engineering Standards Association. This association has been formed with the object of carrying out in Canada, for the benefit of Canadian industries, work similar to that done in England by the British Engineering Standards Association, and recently begun in the United States by the Engineering Standards Committee formed under the auspices of the large national engineering societies. The Canadian association is supported by contributions from various engineering and industrial societies, as well as from individual firms, and also receives an appropriation from the Canadian government.

The method in which the work is carried out is as follows: When a request or suggestion is received from some responsible firm or person to the effect that the formulation or revision of a Canadian standard is desirable, the association confers with the various interests likely to be affected by the establishment of such a standard, and arranges for the organization of a committee to consider the matter. This committee includes representatives of both the producers and users of the standard in question, together with such technical advisers as may be considered desirable. The committee so formed recommends the adoption or modification of a standard, and its findings are reviewed by the association, the main committee of which must be thoroughly satisfied that full consideration has been given to the subject before it authorizes publication by the association. The actual discussions as regards technical details are thus carried out by specially chosen representatives of the manufacturers and purchasers, and the various interests, whether of the producer, the user, or the engineer, are safeguarded, since all these parties have a voice in the decisions reached. In this way it is clear that before a report defining a Canadian standard is issued or modified, the effective approval of all concerned will have been obtained.

TABLE 4. SAWMILL MACHINERY EXPORTED ANNUALLY TO SOUTH AMERICAN COUNTRIES, FROM 1912 TO 1918, INCLUSIVE—VALUE IN DOLLARS

Exported to	1912	1913	1914	1915	1916	1917	1918
Argentina	4,405	4,663	3,707	192	1,414	4,366	343
Bolivia	15				23	35	1,600
Brazil	44,168	62,370	14,576	4,748	20,289	4,100	15,462
Chile	125,731	37,099	24,147	2,040	3,757	2,845	5,001
Colombia	9,083	2,893	7,138	5,190	3,688	5,251	1,599
Ecuador	1,234	247	1,702	655	1,827	999	351
Guiana, British	231	45	2,259	2,596	1,394	1,707	1,629
Guiana, Dutch						3,345	
Guiana, French				78			
Peru	3,587	6,336	3,155	286	2,893	6,756	2,787
Uruguay			471	506		38	445
Venezuela	20,594	9,010	11,829	1,231	3,994	7,876	3,834
Total	209,048	122,663	68,984	17,522	39,279	37,318	33,051

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PRACTICE IN MAKING ENAMELED CAST-IRON WARES

The Bureau of Standards has published a report dealing with the materials and methods used in the manufacture of enameled cast-iron wares. It is the first publication dealing fully with this subject in any language. It deals particularly with the coating of cast iron with white vitreous enamels by the American or dry-powder process. In this method of manufacture, the thoroughly cleaned castings are painted with a suspension in water of powdered glass, clay, and other materials. This suspension is known as the ground coat. The castings are then heated until the ground coat is thoroughly fused, forming an extremely thin layer of transparent glass on the castings. The ware is then withdrawn from the furnace and immediately coated by means of long-handled sieves with a layer of white, opaque, powdered glass, known as the cover coat enamel. Next the castings are returned to the furnace, and in a couple of minutes the cover coat enamel fuses to a smooth layer. Two such layers of cover coat enamel are usually applied, giving a total thickness of from 1/32 to 1/16 inch. The treatise does not discuss the enameling of cast iron with wet coat cover enamels.

Several sections are devoted to a discussion of the preparation and testing of the various chemicals and minerals used in compounding enamels and to the effect each of these has on the physical and chemical properties of enamels. The methods employed in making and cleaning the castings are described in detail, beginning with construction of patterns and ending with sand-blasting and polishing. The methods and equipment, including furnaces, used in preparing enamels and applying them to castings are covered in two sections. Sections are also devoted to the control of the luster of enamels, and to the methods to be used in avoiding blisters, pin holes and other minor defects. Typical formulas are given for ground coat enamels, cover coat enamels containing oxide of tin, and for those containing antimony compounds as the opacifying agent. The calculations that are involved in arriving at each form of expression are explained in detail in the treatise.

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INCREASED PRODUCTION A NECESSITY

The abnormal decline in foreign exchange, especially with England, France, and the Scandinavian countries, will shortly exert a profound influence upon the trade of the world. With the value of the pound sterling 20 per cent below normal, the franc worth about 9 cents, and Scandinavian money depreciated 25 per cent, it will evidently become increasingly difficult to sell our products in those countries. European economists and manufacturers are quick to see and to utilize the advantage these conditions create for them. If the present abnormal exchange rates continue in effect for an appreciable period there will be a reversal of the trade currents. Already French and English makers of high-speed and tool steels are planning to sell their products in the United States on a larger scale than formerly, and one large English machine tool builder has entered the American market with the intention of permanently establishing a business here. Scandinavian manufacturers of various products and accessories are making plans to enter our markets, and doubtless this competition will be felt in certain lines within a few months.

Some think the easiest way to meet this competition is by increased tariffs; but while this will be helpful, it is only a temporary and artificial remedy. Increased production is the fundamental necessity. The workers of the United States should realize that if they persist in shortening the working day and decreasing production, all our industries will suffer, our foreign trade in manufactured products will disappear, and masses of workers will find themselves out of employment. If they want hard times, shorter hours and increased pay under present conditions will bring them. Prices cannot be reduced except by increased production or diminished consumption, and unless they are reduced we shall be unable to hold our own in either foreign or domestic markets. Unless the workers recognize the necessity for increased production they will seriously endanger our whole industrial structure and create an era of unemployment during which they will be the greatest sufferers.

Close observation of industrial conditions in European countries has shown that in general our workmen, accustomed to the use of labor-saving machinery, are the most capable and economical producers in the world, and therefore entitled to high wages. But even with this advantage there is a point where our production costs pass those of European manufacturers, and that point we have reached in many lines.

* * *

PIONEER WORK BY THE BIG INDUSTRIES

Much credit is due to our larger industrial concerns for what they accomplish through research and experimental work. Many of our big manufacturers appropriate considerable money for developing industrial processes and for improving and originating mechanical and electrical equipment. Progress in engineering, chemistry, and along scientific lines generally, must be preceded by costly experiments and tests which usually require special apparatus. This work cannot be done by small manufacturers for, however enterprising, they lack the necessary resources. It is chiefly in the physical and chemical laboratories of firms doing business on a large scale that this invaluable and often very costly work is carried on. There the idea is tested by men whose aim is practical results achieved by direct, practical means. As in all such work not the least valuable feature of it is the immense amount of data evolved which represent ideas rejected. All achievement involves the arrival at results through learning what not to do.

While the primary object of these laboratory investigations and pioneer work is to benefit a particular business either by the improvement of manufacturing processes or the acquisition of definite, reliable knowledge of unexplored subjects, the fact remains that these discoveries which are continually being made, ultimately prove to be a national asset. Small manufacturers, inventors, and men who are born investigators have, of course, done much toward industrial development, but many important discoveries and improvements may be traced directly to the experimental laboratories of large establishments. In numerous instances, this knowledge would doubtless remain hidden indefinitely were it not for the special efforts and resources of progressive industrial organizations which operate on a scale large enough to warrant the expense of maintaining costly research departments.

* * *

THE TRAINING OF THE SPECIALIST

There are many erroneous ideas in regard to the training required by an expert or specialist in one particular line of machine manufacture or design. It is believed by some that the essential requirements for success in this capacity are a narrow and one-sided training and long experience on the specific line of work involved. As a matter of fact, such a specialist should have an extended knowledge of mechanics in general, because the more he knows about manufacturing problems in varied lines of machine shop practice, the better can he work out any special mechanical problem.

The machine designer, for example, who specializes on one particular kind of machine tool, let it be a planer, a milling machine, or an automatic screw machine, will be all the more successful in his work if he has a general knowledge not only of machine tool design, but also of machine design in general. The more thorough his mechanical knowledge in a wide field, the more efficiently can he apply this knowledge to a specific field and become a specialist of the highest order.

The same principle applies to specialists in shop management and production. The broader their general knowledge, the more valuable and successful they become when they apply this broader knowledge to the one particular line of manufacture in which they are engaged.

Annual Convention of the A. S. M. E.

THE annual convention of the American Society of Mechanical Engineers, held in New York City, December 2 to 5, was the fortieth annual convention of the society. The sessions of the meeting were opened by the presidential address of Professor M. E. Cooley, the president for the past year. In his address Professor Cooley outlined the great scope of the society, its organization, and the functioning of its council and committees. At the same meeting honorary memberships were conferred upon Charles de Freminville, consulting engineer, Creusot Works, France, and Auguste C. E. Rateau, of steam turbine fame, and chairman, board of directors, Rateau, Battu & Smooth Co., France.

Fred J. Miller, the New President of the Society

At the opening meeting announcement was also made of the election of Fred J. Miller as president of the society for the coming year. Mr. Miller was born in Ohio in 1857. He had a common and high school education, supplemented by personal study and speclal instruction. He served an apprenticeship of four years in the machinist trade, and for a number of years worked in various capacities in machine shops. He became a contributor to mechanical journals and finally a member of the editorial staff of the *American Machinist* on which he served for twenty years, the last ten years of which he was editor-in-chief. During this time he acquired an extensive acquaintance with machinery-building establishments in Europe as well as in America.

After retiring from journalism, Mr. Miller was for nine years general manager of a group of typewriter factories, and was then commissioned Major of Ordnance in the U. S. Army, being stationed during most of his service at the Rock Island Arsenal, where he organized and was at the head of the Civilian Service Division of the Arsenal. Afterward he was attached to the office of the Director of Arsenals in Washington, being assigned to duty at the Bethlehem Steel Works, and was then attached to the office of the Secretary of War. He is now a member of the Technical Advisory Committee of the War Claims Board at Washington.

Mr. Miller became a member of the society in 1890, and has always taken an active interest in its affairs, having served on a number of important committees, and as a member of the council from 1904 to 1907, inclusive. He also served two terms as the society's representative on the board of the United Engineering Societies, where he was chairman of three successive committees entrusted with the work of reorganizing and perfecting the Founder Societies' business affairs and finances. He was a member of the council at the time the *Journal* of the society was started, and has always been consulted on questions relating to its development, having recently devoted considerable time to the study of the society's publishing problems and its office methods and organization.



Fred J. Miller, Newly Elected President of the A. S. M. E.

The professional sessions offered much of interest to the members, no matter in which branch of engineering engaged. The meeting was divided into sections, many of which held simultaneous sessions. At the appraisal and valuations section meeting the following papers were read: "Ice-plant Depreciation", by George E. Wells; "Depreciation of Insulation", by John E. Starr; "Appraisal and Valuation Methods", by David H. Ray; "Fundamental Principles of Rational Valuation", by James Rowland Bibbins; "The Construction Period", by H. C. Anderson; "Price Levels and Value", by Cecil Elmes; and "Original Costs and Normal Values", by R. H. Nexsen. All papers were followed by discussions.

At the gas power section meeting the following papers were read: "The Hvid Engine and its Relation to the Fuel Problem", by E. B. Blakely; "Kerosene as a Fuel for High-speed Engines", by L. F. Seaton; "Combustion of Heavier Fuels in Engines of Constant-volume Type and Super-induction Type Engines", by Leon Cammen; and "Oil Pipe Lines", by S. A. Sulentic.

At the industrial relations section meeting the following papers were read: "The Causes of Industrial Unrest and the Remedy", by Frederick P. Fish; "Wage Payment", by A. L. De Leeuw; "Systems for Mutual Control of Industry", by William L. Leiserson; and "What May We Expect of Profit Sharing in Industry?" by Ralph E. Heilman.

At the machine design section meeting the following papers were read: "Reliability of Materials and Mechanism of Fractures", by Charles de Freminville; "Tests on Dredging Pumps Used in Inner Harbor Navigation Canal, New Orleans", by W. J. White; "A Perfected High-pressure Rotary Compressor", by C. B. Lord; "Turbo-compressor Calculations", by A. H. Blaisdell; and "A New Type of Hydraulic-turbine Runner", by Forrest Nagler. On power machinery the following papers were read: "Emergency Fleet Corporation Water-tube Boilers for Wood Ships", by F. W. Dean and Henry Kreisinger; "Flow of Water Through Condenser Tubes," by William L. DeBaufre and Milton C. Stuart; "Air Pumps for Condensing Equipment", by Frank R. Wheeler; and "Thermal Conductivity of Insulating and Other Materials", by T. S. Taylor.

The sub-committee on textiles arranged for a topical discussion on teaching and training textile mill employes, with contributions from various textile schools and manufacturing plants. A paper was also read on "The Economical Use of Steam in Textile Plants", by George H. Perkins. On the subject of transportation, papers were read on "Scientific Development of the Steam Locomotive", by John E. Muhlfeld, and "Motor-transport Vehicles for the United States Army," by John Younger.

The machine shop practice section contributed the following papers to the meeting: "Common Errors in Designing and Machining Bearings", by C. H. Bierbaum; "Lubrication

of Ball Bearings", by H. R. Trotter; "Thread Forms for Worms and Hobs", by B. F. Waterman; and "Illustrated Talk on Electric Arc Welding", by H. L. Unland. The following papers on general subjects were also presented at the convention: "Octoval Notation and the Measurement of Binary Inch Fractions", by Alfred Watkins; "Modern Electric Furnace Practice as Related to Foundries in Particular", by W. E. Moore; "An Investigation of Strains in the Rolling of Metal", by Alfred Musso; and "Slow-speed and Other Tests of Kingsbury Thrust Bearings", by H. A. S. Howarth.

General Features of the Convention

The main feature of the convention, outside of the professional sessions, was the DeLamater-Ericsson commemoration meeting held on the evening of December 3 to commemorate the eightieth anniversary of the beginning of Captain John Ericsson's work in America and the thirtieth anniversary of the death of Captain Ericsson and of Cornelius H. DeLamater, founder of the DeLamater Iron Works, where Captain Ericsson's most important work was executed. At this meeting an illustrated historical review of the DeLamater Iron Works and of Ericsson's inventions was given by H. F. J. Porter, and addresses were made on Ericsson's contributions to engineering and to civilization by Rear-Admiral Bradley A. Fiske and W. A. F Ekengren, minister from Sweden to the United States. Rear-Admiral Fiske particularly called attention to the world-wide consequences of John Ericsson's inventions and paid a very high tribute to his remarkable engineering genius, the greatness of which the world did not fully appreciate until after his death.

On Thursday evening two lectures were given, one on the future of aviation by Colonel E. A. Deeds, Dayton, Ohio, Chief of Equipment Division of Air Service during the early development of the air program of the war. The Liberty engine was developed under the personal direction of Colonel Deeds. The other paper was on "Present Development of the Military Airplane" by Colonel Thurman H. Bane, Chief of Engineering Division of Air Service and commanding officer of McCook Field. The lecture hy Colonel Bane was illustrated by slides and moving pictures released by the War Department for this lecture for the first time.

Abstract of Important Papers

Reprints of the important papers presented before the society may be obtained hy non-members for a nominal fee by addressing the society at its headquarters, 29 W. 39th St., New York City. In the following, a brief review is given of some of the papers that are most important to the machine-building field.

Thread Forms for Worms and Hobs

The use of worm-gearing is steadily increasing, and accompanying this increase—perhaps the cause of it—is a corresponding increase in efficiency and durability, which is the result of a better understanding of both the theoretical and mechanical problems. This paper points out some of the problems involved and some of the mechanical difficulties in the use of worm-gearing. Failure to take these problems and difficulties into consideration in the past has often led to the discrediting of this form of drive. Methods for bringing about a uniform and satisfactory practice in worm-gearing are also suggested.

The Lubrication of Ball Bearings

Ball-bearing lubrication is a subject of which little is known, chiefly because there is no accepted method of determining the lubricating value of an oil or grease. As a step toward the development of a satisfactory method, the author has devised an instrument for such a purpose, a brief description of which is given in this paper. The operating characteristics of a ball bearing as related to the problem of lubrication are also discussed, and the specifications for a satisfactory oil are given. The use of grease and graphite as a lubricant is next presented, and the paper concludes with a suggested procedure for the analysis of lime-soap greases.

Common Errors in Designing and Machining Bearings

After presenting ten principles relating to the design, construction, and operation of journal bearings, based on what is now known concerning the laws of lubrication, the author discusses among other things oil-grooves and their proper distribution, the disadvantages of tight-fitting bushings, proper methods of finishing brasses to provide for expansion when running, and proper methods of clamping bearings during tooling. He then takes up the matter of the tools employed in machining bearings and shows by numerous photomicrographs of finished surfaces the importance of using sharp tools with the proper rake in order that the crystalline structure of the surface material of the bearing may not be so crushed and compacted that it will fail to function as a normal bearing alloy.

Slow Speed and Other Tests of Kingsbury Thrust Bearings

This paper presents operating and experimental data which show the wide range of application of the Kingsbury thrust bearing, and the author gives particulars of typical installations which have been in successful operation since 1911. These bearings have been applied to vertical and horizontal hydro-electric units as well as to horizontal steam turbines and centrifugal pumps, and to determine some of the service conditions a series of slow-speed tests was recently made on a bearing having a total area of 76 square inches on its four shoes and a load of 10,000 pounds. Details of these tests are given and the results obtained indicate that the lower the speed at which the bearing is run continuously, the better the conditions of the bearing surfaces. Speeds as low as 0.38 revolution per minute have thus far been employed, using, however, only a light oil.

An Investigation of Strains in the Rolling of Metal

In every manufacturing process, while raw stock is being transformed into a finished article, a certain amount of material is incidentally wasted, and the minimizing of such waste constitutes one of the most important problems to be solved by the operating engineer. Rolling-mill operations are no exception to the general rule, and the problem may be specifically set forth as follows: What is the most convenient length and width of the piece of metal to be rolled, in order to produce a finished article of certain definite dimensions, so that the waste of material may be reduced to a minimum? A complete answer to this complex question depends on data of various natures resulting from actual investigation. We may, however, group these data into two classes: To the first class belong all data of a general character obtained through mechanical investigation; and to the second, data obtained through investigation of the special condition under which the manufacturing takes place. The scope of this paper is the exposition of some fundamental principles leading to data of the first class.

Modern Electric Furnace Practice as Related to Foundries in Particular

Since 1913 the number of electric furnaces employed in the steel industry in the United States and Canada has risen from 19 to 335, practically all of which are of the arc type. After first giving particulars regarding the operation of acid and basic furnaces, the author enumerates the superior properties which have created the present demand for electric steel. He then points out the advantages of the electric furnace over the open-hearth furnaces in steel melting and states the features of the various classes of arc furnaces which have made that type practically supreme in its field. Following this the crucible and converter processes are briefly described and it is shown how the acid type of furnace is the best for foundry work. Comparative operating costs of producing liquid steel by the converter and electric-furnace processes are then given, which bring out the marked economy of the latter. The paper concludes with notes on the employment of the electric furnace in malleable-iron foundries and on the selection of the most suitable types.

French Industrial Conditions

By A. L. VALENTINE, Works Manager, Societe des Usines Curial, Paris

In this article, the author gives an interesting inside view of French industrial conditions. Mr. Valentine was until recently connected with a well-known maker of small tools in the United States, and came to France last summer as works manager of Societe des Usines Curial in Paris, which firm is now also building a large plant outside of Paris for the manufacture of small tools on a large scale. His observations are the more interesting as he sees the French conditions from an American viewpoint, at the same time being in a position to come closely in contact with the details of the present situation in France.

INDUSTRIAL conditions in France are upset, there is no doubt about that; but it may be stated that in spite of all that the newspapers have printed, there are fewer strikes there than in the United States, and when one considers how little the French manufacturer need do to satisfy the workers, it is not likely that serious labor troubles will be encountered. Generally speaking, all that the French workers ask is what they are entitled to as men and women, and what every employer in the United States has always provided as a matter of course. It may be expected, therefore, that France will shortly get back to a stable basis; and if French workmen in general are as capable and adaptable as those employed in the factory in charge of the writer, it will require but a short period of training to bring them up to the standard of the workers in the mechanical industries in the United States. French workmen appear to be fully as capable as those in the United States, and the only thing lacking to bring them up to their full efficiency is sufficient incentive to exert themselves to do more and better work, and to run the full number of machines to which each man can attend.

Lack of Modern Machinery

One of the most serious drawbacks to the rapid growth of the French industries is the lack of modern machine tools and the great difficulty of obtaining them from the United States. If it were not for the sales of machinery from war plants, I do not know what we would do for machine tools, as the sales rooms of the agents of American machine tools are practically empty. In spite of the offerings of machine tools from government factories and the American government machine tools, the facts are that the French machine tool market is bare of supplies, and that American and British machine tools cannot be obtained in sufficient quantities. Some French manufacturers, unable to obtain American machine tools, and seeing the chance for a good domestic trade, are planning to begin the manufacture of different lines, and as an example I may mention that even in our factory we are seriously thinking of manufacturing certain machinery of smaller sizes in quantity, in spite of the fact that we are not now at all in that line of business.

German Machine Tool Competition

In the reports published by Mr. Luchars, it was pointed out that the French are likely to buy machine tools from Germany, both because of the lower price and the more rapid deliveries. I can confirm this statement, for in spite of the hatred that exists between the two nations, German machinery cannot be kept out of France; because, in order to put more speed into French industry, machine tools of some make and kind must be obtained. The more rapid deliveries possible from Germany, because of its proximity to France also influences purchases.

Having visited a great number of French machine shops, and having had conferences both with their business and engineering heads, I firmly maintain that if American machine tool manufacturers could keep a plentiful supply of machines in stock in France, or ready for quick delivery, American machine tools would be used almost exclusively, because their superiority is recognized by most French engineers. They know that the German machine tools are not as good; and furthermore, they do not like to use German machinery unless absolutely forced to do so. Hence, all statements to the contrary notwithstanding, American machine tools can be sold in France, provided the exchange again recedes to eight francs to the dollar. While German machine tools are often the same in design as American, many being copies of American types, everybody recognizes that they are of decidedly inferior workmanship.

French competition need not be feared unless a machine tool industry is developed in France by the necessity of obtaining machine tools from a domestic source, foreign tools not being obtainable. Generally speaking, French manufacturers are not inclined to go into new lines of manufacture, and there will be very little competition from French makers in the machine tool field except in case of necessity; but the French certainly have remarkable push and vigor when faced by necessity.

Equipment of French Factories

A short while ago I visited the big steel mill of Jacob Holzer & Co., at St. Etienne, not far from Lyons. These works, I was told, employed about 6000 men during the war (mainly making shells), but are now employing only about 2500 men. In this factory I found nothing lacking in speed, efficiency, and manufacturing methods, even when compared with similar shops in the United States. The laboratory in these works would compare favorably with anything of the kind I know of in America. It was immense in size and equipped with instruments and machinery of the highest class. Every detail in the chemical department, the physical testing department and the photomicrographic department, was worked out minutely. As an interesting example of efficiency in heat-treatment, it may be mentioned that several solid high-speed steel cutters, 12 inches in diameter and 7 inches long, were hardened. Of course, solid cutters of this size would not be considered good practice, but it certainly is a remarkable hardening feat to heat-treat such cutters without loss.

Generally speaking, the steel made by the French mills is superior to that obtainable in the United States as regards uniformity and quality, but sizes are not as accurate and the bars are not as straight. Steel, however, is very scarce, nearly every order for the making of small tools having to be made up special, which causes long delays; in fact, deliveries of finished tools could probably be made from the United States about as quickly as they could be delivered from a French factory because of the delay in obtaining steel. The reason, of course, is that the steel companies have no inducement to carry in stock a line of sizes of high-speed or carbon steel bars such as are required for making small tools, because, as yet, there is not in the whole of France a small tool factory of any great importance, although the firm of Jacob Holzer makes twist drills on a considerable scale. This firm is quite up-to-date in its small tool manufacture, especially in the hardening department, from which even American manufacturers could learn a great deal.

Another large manufacturing plant in France that would interest American visitors, is the Etablissement Emil

Mayen, Paris. This factory, I was told, covers about 265,000 square feet of floor space, and is as up-to-date as any factory I have ever seen, probably because it was constructed by American engineers and built under American supervision during the war. This plant is said to have turned out thirty-five Hispano-Suiza airplane engines daily during the war. Most of the machine tools are of American make, and all of the machinery is kept in excellent condition. This establishment is now selling out its machine equipment, consisting very largely of automatic machines, nearly new and in excellent condition; and were it not for opportunities of this kind, the equipping of new manufacturing industries would be delayed to a great extent.

Working Conditions in France

Working conditions in France are so inferior to those provided for American workmen that they are hardly believable to a man who has been trained in the United States. The low social standing of the French factory worker as compared with his superiors, and the undesirable living conditions, are a handicap to the French industry, because men cannot attain their highest efficiency when living as the French factory workers have to live. No workers in the United States in the small tool or machine tool line would be satisfied to live in such quarters or in such surroundings as do the French workmen of the same ability and general capacity. Nevertheless, they seem happy under these conditions and more satisfied than the workmen in the same line in the United States. This being the case, very little improvement is made in their conditions either by the owners of factories or by the municipal authorities. So-called welfare work is practically unknown. If rest rooms, dining rooms, club rooms, bowling alleys, etc, were suddenly provided in French factories, I believe that the French workers would think that the end of the world had arrived and that a miracle was happening. Conditions will doubtless improve, and I am firmly convinced that as they do, the efficiency of the French worker will also rise, until he will become the equal, if not the superior, in working capacity of men of any other nationality.

* * *

FIXTURE FOR MILLING CAM GROOVES

Comparatively small-sized milling machines may often be advantageously employed for the performance of manufacturing operations on what is strictly production work. A case of this kind is shown in Fig. 1 which illustrates a No. 2 plain cone-driven miller built by the Cincinnati Milling Machine Co. of Cincinnati, Ohio, equipped with a special high-speed vertical attachment and work-holding fixture to provide for milling cam grooves in pieces of work of the form which is shown standing on end at the front of the machine.

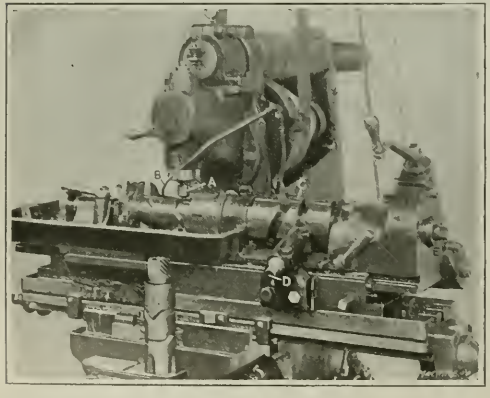


Fig. 1. No. 2 Plain Knee Type Milling Machine equipped with Fixture for milling Cam Grooves

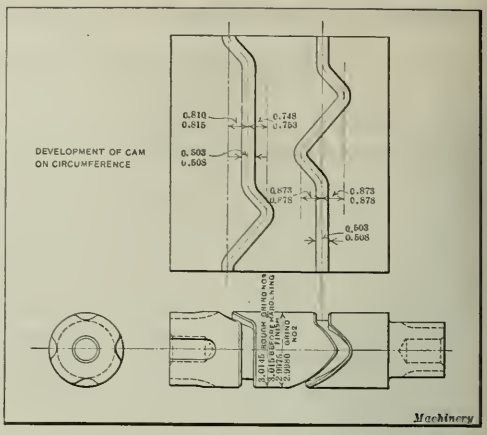


Fig. 2. Layout of the Grooves to be milled in the Cam

Reference to this illustration will enable an experienced mechanic to follow the method of handling this job without requiring more than a very brief description. It will, of course, be apparent that the milling is done by an end-mill carried in chuck *A*, and a tube *B* provides for delivering lubricant to the cutter and work. The milling cutter is of proper width for the cam groove, but provision must be made for guiding the work in order to have the cam groove of the desired form. This result is obtained by means of a master cam *C* in which there runs a roller carried at the inner end of stud *D*. The work and master cam *C* are both mounted on a horizontal shaft, the end of which is shown at *E*. This shaft is rotated by gears contained in a case clearly shown in the illustration, and as master cam *C* revolves, a reciprocating longitudinal movement is imparted to the whole fixture which is carried on a slide, while stud *D* is held in a fixed bracket. This movement of the fixture is governed by the groove in cam *C* in which the roller is held, and thus determines the form of the cam groove milled in the work.

The material of which this cam is made is a grade of steel known as hub stock. There are two cam grooves to be milled, which are ½ inch in width by 5/16 inch deep, and they extend around the entire circumference of the cam which is 3 inches in diameter. After the milling of one cam groove has been completed, the fixture is shifted over to bring the roller into the other groove in cam *C*. The second cam groove can then be milled in the work. The maximum throw of the cam grooves is 7/8 and 13/16 inch, respectively. Each groove is finished at a single revolution of the work, and the cutter used for this purpose is a single-bladed end-mill made of high-speed steel. It is driven at 1410 revolutions per minute, which corresponds to a cutting speed of 175 feet per minute. The work is fed to the cutters at a rate of 5.33 inches per minute, and the total time required to complete the operation is 34 minutes from floor to floor.

* * *

CENTRIFUGAL STEEL CASTINGS

The Bureau of Standards has made public the results of some investigations on steel castings made by the centrifugal method, which produces an ingot of hollow cylindrical form. When this method is used, the density across the section of the casting is practically constant, and blow-holes appear only in a thin section next to the inside surface. Tensile and shock tests show greater strength and elasticity, but less ductility, in the tangential than in the longitudinal direction. Very slight internal stresses are developed by this method of casting, and by proper heat-treatment it is possible to produce steel castings which compare favorably with forged materials of the same composition.

Finishing Pattern Work

By Joseph A. Shelly



THE finishing of patterns includes the application of fillets, the rounding of corners, and the final sandpapering and varnishing. The putting in of rapping plates and lifting and drawing devices, as well as the fastening of pattern letters and the final checking for errors before sending to the foundry, is also a part of this work. The final appearance of any pattern will depend largely upon the neatness with which the finishing is done. It will make but little difference how well made or assembled the different parts of a pattern may be, a poor looking pattern will result if the corners are not well rounded and if the fillets are poorly put in. Any parts that may be difficult to sandpaper after the assembly should be attended to beforehand. Core-boxes are often easier to sandpaper before they are put together or the ends or sides are put in place. All glue should be cleaned off before varnishing. The easiest way to clean the glue is while it is soft and can be taken off with a sponge or piece of waste saturated with hot water. If this has not been attended to and the glue has dried, it will have to be taken off with a scraper. Nails should be used in all glued joints and, whenever possible, in fillets. The pins in parted work should be sandpapered until the pieces part freely and skewers should be filed or scraped until they withdraw easily. Loose pieces should be carefully examined to make sure that they will draw into the pattern cavity in the mold.

Fillets

Fillets are concave connecting or corner pieces used at the intersection of surfaces. They are either "stuck" or "planted." A stuck fillet is one that is worked from the solid, and a planted fillet is one made separately and applied. Planted fillets, which are the ones commonly used, are made of wood, leather, beeswax, putty, and other plastic materials. Metal fillets have also been used to some extent, but are not very popular, as they are hard to fasten and soon work loose.

Wood fillets are used on straight work or for corners of large radii. They may be purchased, but are usually made by the patternmaker. Wood fillets are planed with a round plane (*A*, Fig. 1) in lengths to suit. These planes are made in different widths varying from ¼ inch to 2 inches. They usually come in pairs, each round or convex plane having a corresponding hollow or concave plane. The round plane, however, is the only one used by the patternmaker. Two edges of the stock are planed to slightly more than 90 degrees as at *B*, so that the edges of the fillet will lie flat when fastened in the corner. The stock is first reduced to a triangular section on the circular saw, and is then placed on the fillet board for planing with the round plane. The fillet board *C* is a board of suitable length provided with grooves of different sizes for holding the fillet while it is being planed. A projecting screw-head at the end of each groove acts as a stop for the fillet.

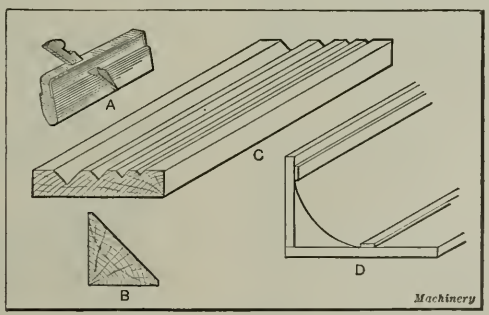


Fig. 1. (A) Round Plane for forming Fillets. (B) Section of Fillet Stock. (C) Board used for holding Fillet Stock while planing. (D) Edges of Large Fillet held down by Thin Strips while Glue is setting

Wood fillets should always be glued in place and securely nailed. A round-ended stick is handy to rub the edges flat. The applying of glue to one side of the fillet will cause the edges to curl; to counteract this, the face or concave side should be wet with water before the glue is put on. The shim or feather-edges on large fillets should be held down by tacking thin strips over them, as at *D*, Fig. 1. These are removed after the glue has set.

Leather fillets are triangular strips of leather cut in four-foot lengths. Samples are shown at *A*, Fig. 2. They come in different sizes and are in general use for fillets of one inch radius or less. The extreme pliability of leather fillets makes them easy to apply to straight or curved work or to acute or obtuse corners, as illustrated at *B*. This pliability may be increased by moistening with water. Leather fillets may be fastened with glue or thick shellac. They are rubbed in place with a spherical ended tool *D*. If glue is used, the rubbing must be done very rapidly, before it has a chance to set. Shellac is perhaps best for this purpose, as it permits more time for rubbing. The back or angled side of the fillet should be coated as well as the corner to which it is to be applied; if the shellac is thin, several coats should be put on and allowed to become sticky before rubbing into place with the spherical-ended tool.

Beeswax fillets are used on small work and applied after the first coat of varnish. The "beeswax gun" is a device for preparing wax for use as fillets. A simple form consists of a tube closed at one end, as shown at *C*, Fig. 2. A wooden piston or plunger is fitted to the open end. The tube is partly filled with beeswax and the plunger inserted; the wax is forced through the opening in the side of the tube by placing the gun in a vise and forcing the plunger against the wax. If the tube is held in hot water before squeezing, the wax will come out more easily. It will be in the form of a long string and its cross-section will be similar to the opening in the side of the tube, which is sometimes round and sometimes triangular. A hole 3/32 inch in diameter will make a beeswax string suitable for a ¼-inch fillet. Beeswax fillets are rubbed into the corners with spherical-ended fillet tools. In cold weather, these should be warmed by dipping in hot water; a little oil applied to the end of the tool will keep it from sticking.

Putty fillets are used for cheap work or for a temporary job. They are sometimes made by mixing whiting and varnish, but are not very satisfactory for standard work. Metal fillets are made of lead or white metal. They are hard to fasten securely and do not bend to curves easily.

Tools for Rounding Corners

Projecting edges on patterns, except the edges of parts that are to be machined

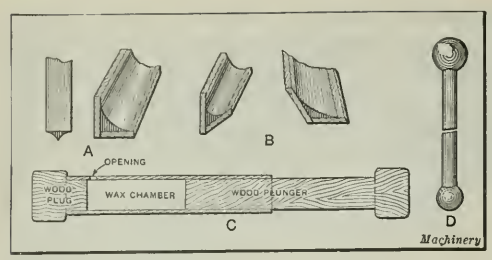


Fig. 2. (A and B) Leather Fillets. (C) Tube or "Gun" for forming Beeswax Fillets. (D) Tool for applying Leather Fillets

or to be fitted to some other piece, are finished by rounding to a quarter circle. The smaller corners up to ¼ inch may be worked off accurately enough to the eye, but even these will have to be gaged. The ordinary marking gage will not do for this purpose, as the spur makes a disfiguring line and the gage will not run freely around convex and concave curves or sharp corners. The gage shown in Fig. 3 is well adapted to this purpose; it consists of two pieces of hard wood *a* and *b*. Piece *a* is slotted and the piece *b* has a projection that fits the slot. A round-head wood-screw permits it to be clamped at any point in its travel. The marking point or spur is a pencil point.

The tools used for rounding corners include the large and small block planes, the long- and short-handled spokeshaves *A* and *B*, Fig. 4 (for both wood and metal), and a sharp knife. The spokeshaves should be in pairs with both flat and convex rounded faces. Patternmakers usually cut the long handles off short, as they are often in the way. It is a good plan, however, to be provided with both kinds. The corner-rounding tool shown at *C* makes a complete corner at one cut; it works well with the grain on straight-grained wood, but not so well across the grain. These tools are made in a number of sizes.

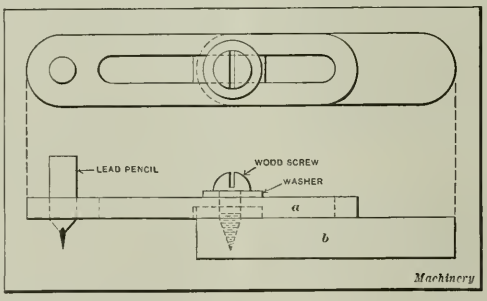


Fig. 3. Type of Gage used for marking Corners preparatory to rounding

Templets should be used for trying corners having a radius of ⅜ inch or more, while working them to shape with the tools. Cardboard templets (*C*, Fig. 5) will do very well, but for corners of 1 inch radius or larger a templet made of ¼-inch stock will be better, as it may be chalked and rubbed to see where the stock should be removed. A good form of wooden templet is shown at *D*.

In rounding corners of large radius, they should first be gaged and then chamfered tangent to the radius at an angle of 45 degrees. To do this accurately, the corner radius should be laid out on a piece of board as at *A*, Fig. 5, a 45-degree chamfer marked out, and a line gaged from the edge each way to guide the workman in removing the corner, as at *B*.

Sandpapering

Sandpaper is a heavy paper coated with an abrasive material of different degrees of coarseness. These are designated by numbers starting with 000, which is the finest grade, and ending with 3, which is the coarsest. The numbers used in most pattern work are, 0, ½, 1, 1½, and 2. Sandpapering blocks are wooden blocks around which the sandpaper is tightly wrapped when operating on large surfaces. For plane surfaces and convex curves, a straight-faced block is used. Blocks of cork are sometimes used or wooden blocks faced with cork; they are more elastic than wood and conform slightly to irregularities in the wood. Blocks for concave surfaces should be shaped to conform to the surface, while for straight round core-boxes, cylinders should be turned and kept for this purpose. These cylinders should be of such a diameter that when the sandpaper is tightly wound around them, they will just equal the diameter of the box.

Pattern sandpapering is done by moving the sandpaper back and forth across the grain of the wood or in the opposite direction to which the tool traveled in working the pieces to shape. Coarse sandpaper should be used first and fine sandpaper for the finishing touches. Care should be taken not to destroy plane surfaces and corners that are meant to be sharp. Much of the rubbing on rounded corners will be done with the sandpaper held in the hand. The paper should be torn in square or rectangular pieces and folded twice, as in Fig. 6. This will give three working faces and is the most economical way to use it.

Pattern Varnish or Shellac

Varnish used as a protective covering for patterns has for a base what is known as yellow or orange shellac. Shellac comes in thin brown, flaking, irregularly shaped pieces. It is mixed or cut by placing a quantity of it in a glass or eathenware jar and adding enough alcohol to cover it. The alcohol may be grain, denatured, or wood; any of these will do, but grain alcohol is the best. Wood and denatured alcohol are generally used on account of their lower cost. Black shellac is made by adding to orange shellac a good quality of lampblack that is free from grit. A good grade of finely dry-ground vermillion will make an excellent red shellac.

Pots for holding clear or yellow shellac should be of glass or earthenware, as the chemical action set up by the use of a metal pot will darken the shellac; a metal pot, however, may be safely used for black or red shellac. Shellac pots should have tightly fitted covers to prevent excessive loss through evaporation. Shellac that has become discolored may be cleared or cleaned by adding a small quantity of powdered oxalic acid, but care should be taken not to get this mixture into cuts or wounds, as oxalic acid is poisonous.

Shellac is best applied with a flat chisel-shaped brush made of badger or camel's hair. These brushes come in a number of widths, but for pattern work the 1-, 1½-, and 2-inch widths will be found most convenient. A leather- or rubber-bound brush should be used for clear shellac, as a metal binding will affect the shellac in the same manner as a

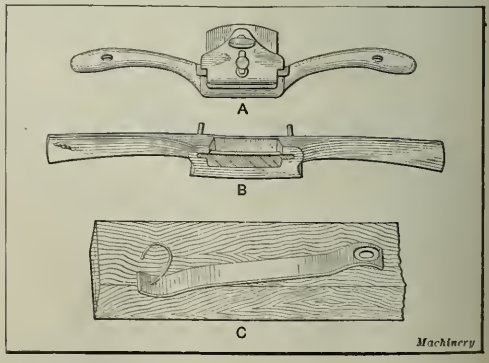


Fig. 4. (A and B) Spoke-shaves for rounding Corners. (C) Corner-rounding Tool

metal pot. To keep the bristles straight, the brush should hang in the pot and not stand on the bottom.

Shellac varnish dries quickly, and if of good quality is not easily affected by heat or moisture; it has the added advantage of being easy to cut through if alterations are called for after the pattern is finished. The first coat should be evenly applied, and the varnish should not be too thin, as the moisture has a tendency to raise the grain of the wood, and if applied too thin will roughen the surface so that it may never be smoothed. The first coat should be given ample time to dry before the second is applied. There is no rule as to the amount of time to allow, but the more the better. Before applying the second coat, the surface of the pattern should be rubbed smooth with a piece of fine sandpaper held in the hand, and this should be done between each successive coat. Never use a block for sandpapering a varnished surface. The number of coats to apply will be governed by local practice, but for good work at least three coats should be given.

Varnishing Core-prints and Outlines

Core-prints and places where cores will cut through to the exterior of the casting, as well as core outlines or sections on the joints of parted patterns, are indicated by a different color varnish from that used on the body of the pattern. If yellow is the color of the pattern, the core-prints and designated portions will be black; if black is the pattern color, the prints will be either yellow or red. It is the practice in some shops to use a given color on patterns as an indication of the metal it is to be cast in. For example, all patterns to be cast in iron would be black; red would indicate steel; and yellow would mean brass or composition.

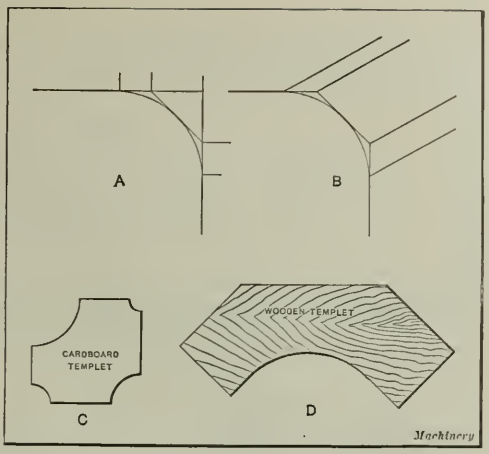


Fig. 5. (A and B) Method of chamfering Large Corners preparatory to rounding. (C and D) Corner Templets

Rapping and Lifting Plates

Rapping plates are pieces of metal let in flush with the joint or cope side of the pattern and fastened with screws. They come in different shapes and sizes (a few samples are shown at *A*, Fig. 7), and are provided with a central hole that is tapped to receive the threaded end of the lifting iron *B*. In addition to the tapped hole, there are one or more plain holes for the reception of the rapping bar. Countersunk holes are provided for the fastening screws.

The recesses for square and rectangular plates as well as for those with scalloped edges, are laid out by placing the plate on the pattern and tracing the outline with a scriber. The scalloped edge plates are designed to be let in flush by boring a series of holes to a depth equal to the thickness of the plate. A Forstner bit and a bit stop should be used for this purpose.

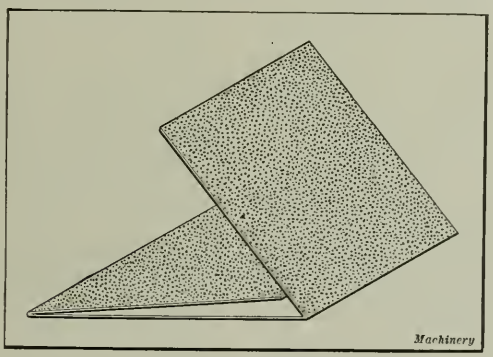


Fig. 6. Method of folding Sandpaper

The number of rapping plates and their location will depend entirely upon the shape and size of the pattern. If the pattern is small or medium sized and plain in shape, one plate will be enough. It should be located at a point where the pattern will be in balance when it is drawn with the lifting iron. If the pattern is large or cannot be easily balanced or rapped with one plate, it will be necessary to install two or more plates to carry the weight and balance the lift. Lifting straps *D*, Fig. 7, are applied to deep patterns. These are used solely for lifting purposes, and are usually made of $\frac{1}{8}$- or 3/16-inch bar iron of suitable width and provided with countersunk screw-holes.

Finishing Metal Patterns

The surfaces of metal patterns should be filed smooth and all holes should be filled with solder or lead. There are several methods of finishing surfaces, the simplest of which is called the rusting process. All oil and grease must be removed by a steam bath or by scrubbing with hot soda water; this treatment is followed by several successive applications of a solution of water and sal-ammoniac. in order to get a well rusted surface which is rubbed to a smooth finish with emery cloth. The final finish is given by heating the casting and rubbing beeswax on the surface while it is warm. This is to prevent the damp sand from sticking to the pattern or causing it to rust.

Pattern Letters

Pattern letters are used for reproducing firm names, identification letters, or figures on castings. Samples are shown at *C*, Fig. 7. They are made of either brass or a soft alloy of tin and lead, and they may be procured in three styles known as Roman, sharp-faced Gothic, and flat-faced

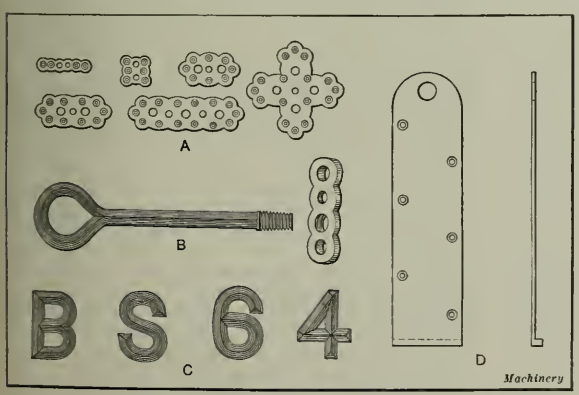


Fig. 7. (A) Rapping and Lifting Plates. (B) Lifting Iron. (C) Pattern Letters and Figures. (D) Lifting Strap

Gothic. The letters are ⅛ to 4 inches high. The brass letters are used on metal patterns, and the soft metal ones on wood.

Brass pattern letters are attached to metal patterns by sweating. The surface to be covered by the letters, and the backs of the letters themselves, are tinned or given a thin coat of solder. This is done by heating the surfaces enough to melt the solder. A flux such as sal-ammoniac should be applied before the solder. The tinned surfaces are then reheated and the letters put in position. Soft metal letters are fastened to wood patterns by means of shellac, or shellac and small brads. Before an attempt is made to apply the letters to a pattern, their position must be decided upon and lines drawn as a guide for setting the letters. The letters first should be arranged dry for position and spacing, and the position of the first and the last letter in each line marked. The letters are then placed face downward on a board and shellacked, as is also the surface to which the letters are to be applied. When the shellac has become quite sticky, the letters should be reapplied and adjusted. A knife with a sharp pointed blade is used for this purpose.

Checking is the final inspection to which all patterns should be subjected as a safeguard against possible errors before they are sent to the foundry. There are no fixed rules

FACTORS FOR OBTAINING WEIGHT OF CASTING FROM PATTERN WEIGHT

Pattern Material	Factors			Pattern Material	Factors		
	Cast Iron	Composition	Aluminum		Cast Iron	Composition	Aluminum
White Pine	13.00	15.13	4.51	Cast Iron...	1.00	1.16	0.35
Mahogany ..	10.28	11.97	3.71	Aluminum .	2.88	3.35	1.00
Cherry	10.70	12.44	3.72	Composition	0.86	1.00	0.30

Machinery

for checking work, but it is a good plan to compare the pattern with the drawing, view for view, before making any measurements. Be certain that all the pieces are on the pattern and in the proper relation to each other. The pattern should then be measured by referring first to the dimensions on one view of the drawing only. To facilitate checking, all center lines should be cut rather deeply with a sharp knife point, so that they will not be obliterated in finishing the pattern. Over-all lengths and widths, distances between centers of hubs and bosses, sizes of facing pieces, diameters of flanges, and all important dimensions on each view should be measured first. Thicknesses of webs and ribs or other parts of minor importance should be left to the last. After checking the figures, the try-square and protractor are used to test those surfaces that lie at an angle to one another.

Core-boxes should be carefully checked to see that they will leave the proper thicknesses of metal around the core and that the cores will fit the prints. Allowance must be made for a natural increase in the size of large cores due to swelling and settling, and care must be taken to see that the core-boxes are somewhat smaller than the prints. The natural tendency of plates is to increase in thickness in the casting, so that if a plate of a required thickness is wanted, the pattern will have to be made somewhat thinner. Deep beds also will increase in depth.

Approximate weights of castings may be obtained by weighing the pattern and multiplying the weight by a factor given in the accompanying table. If a white pine pattern weighs 6½ pounds, its approximate weight when cast in iron will be 6½ times the factor found in the table under cast iron and opposite white pine or $6\frac{1}{2} \times 13 = 84$ pounds. If there should be a cored hole through the casting, the weight of the cored part can be found by filling the core-box or boxes with dry sand and weighing the sand, which should then be multiplied by one of the following factors: For cast iron, 4; for composition, 4.65; for aluminum, 1.4. This product should be subtracted from the first weight obtained to get the net result. As an example, if the weight of the sand in the core-box is 8¼ pounds, then the net weight of the casting will equal approximately $84 - (8\frac{1}{4} \times 4) = 51$ pounds.

SCIENTIFIC DEVELOPMENT OF THE STEAM LOCOMOTIVE

In a paper presented before the annual meeting of the American Society of Mechanical Engineers, John E. Muhlfeld discussed the general lines along which improvements may still be made in steam locomotives. It was pointed out in the paper that despite the fact that marked progress has been made in the development of the steam locomotive, there still remains considerable opportunity for further progress. Briefly outlined, the paper dealt with factors involved in the determination of tractive power of locomotives and discussed such items as boiler feed-water, types of fuel, combustion, steam pressure, superheating, and steam generation. Acceleration and deceleration of locomotives were also considered, and in conclusion a discussion was made of the methods of saving fuel and labor in order to obtain a high standard of operation and economy.

An interesting part of the paper made reference to the power used for accessories. The steam locomotive must not only produce superheated steam for the development of draw-bar pull, but also supply saturated steam to various accessories of its own and for train operation. For example, a modern passenger locomotive is required to supply power to operate locomotive and train air brakes and signals as well as train lighting, heating and ventilating equipment, and hot- and cold-water systems, and in addition it must supply steam or compressed air for the operation of a multitude of devices. As much as 20 per cent of the fuel as fired for an average divisional run may be used for these accessories.

Not only has the use of compressed air been found to be most expensive for the working of these accessories, but the reserve supply for train braking has been frequently drawn upon for their operation. As power reverse gears, fire doors, water scoops, coal pushers, ashpan doors and like devices can be equipped for steam operation, such substitution offers possibilities for less drain on the boiler and much-needed economy in the cost for this auxiliary power production. Moreover, as all of this power for accessories is produced by saturated steam, some means for substituting the use of superheated steam for those purposes where it is more suitable and economical should be given due consideration.

It was also pointed out that the cost for locomotive fuel and repairs averages over seventy-five cents per mile run, or five times what it was ten years ago. This being the case, the question of materials, construction, and equipment of locomotives must be placed on a strictly economical engineering rather than on a purchasing price basis, because first cost is now becoming proportionately less important as compared with the efficiency and cost of maintenance.

The question of lubrication was also dealt with. It was pointed out that it is false economy to restrict the quantity of lubrication used or to employ inferior lubricants to the extent that results in excessive friction, wear and tear, and any saving thus effected is many times over expended in delays, repairs, and fuel. At the same time probably no locomotive supplies are handled more wastefully or ignorantly than oil and grease, due to the lubricant not being applied or used in the proper manner.

Difficulty of access to the various bearings to be lubricated and the necessity for frequent hand oiling have no doubt contributed to lubrication waste and trouble, but during the last fifteen years the substitution of grease for oil on many bearings, the use of larger driving wheels and lower piston speeds, and greater accessibility to certain parts, which obtains from the use of outside instead of inside valve gears and journals, have brought about a substantial improvement.

One of the greatest and simplest improvements to be made in the steam locomotive can be effected by an increase in the boiler pressure in combination with greater quantity and better quality of saturated-steam production, higher and more uniform superheat, and compounding.

Clutch Design

An Analysis of the Forces which must be Considered in Designing Multiple Disk, Cone, and Toothed Clutches, and an Application of the Inclined Plane Principle to the Tooth Form of a Solenoid-operated Clutch

By H. M. BRAYTON

A CLUTCH may be defined as a device used to connect or disconnect two revolvable parts so that motion and power may be transmitted from the driving to the driven member at the will of the operator. Strictly speaking, gears might be classified as clutches under this definition, as they are often used for this purpose but they are not generally thought of or classed as clutches for the reason that it is seldom possible to bring them into mesh while the machine is in operation unless the load is light or they are both rotating at about the same speed. If a stationary gear is forced into mesh with one which is revolving, the shock is often sufficiently great to cause breakage of the teeth of the gear.

Herein lies the necessity for clutches of other types, that is, for meshing a revolving shaft with one at rest or one which is turning at a different speed. A clutch quite commonly used under such conditions is the multiple-disk type. This clutch transmits motion and power entirely by friction developed by forcing several disks or plates together. Half of the disks or plates are held on one shaft, while the other half are held in a member secured to the other shaft. The plates are sometimes made of sheet steel, usually of a soft grade. In this case the clutch would be made to run in oil, as dry steel plates are likely to start the mechanism too suddenly. The oil reduces the coefficient of friction, thus causing the clutch to slip somewhat before it finally picks up the full load.

Steel plates lined with various friction materials are also used, and such plates may or may not run in oil. When used dry, they form what is known as the dry-plate clutch. Asbestos, interwoven with fine copper wire, is generally used for lining dry-plate clutches, and good results are obtained with this type, which is often used in automobiles.

Theory of Disk Clutches

In order to create friction between two surfaces, it is necessary to force them together, and the amount of friction thus produced is proportional to the normal force, or the force that holds them together. In other words, if it is desired to transmit power from one shaft to another by means of a disk clutch, it is necessary to force the clutch plates together. One or more springs are usually employed for this purpose, being arranged so as to force a sliding collar along the shaft, one half of the plates, of course, being held on the collar. The question now arises as to how strong the spring must be in order to drive the machine. The clutch must be capable of transmitting all the power developed by the prime mover and have an additional amount of power sufficient to insure proper operation at all times. The strength of the spring needed will depend on the following variables: Coefficient of friction between the plates, diameter of clutch plates, speed of shaft, and power to be transmitted. Practically the entire surface of each plate is in contact, but as the total friction developed is not dependent on the area in contact, it is evident that it is also not dependent on the number of plates. All of the variables referred to, however, must be known in any particular case before the size of the spring can be determined. The only factor which must be assumed is the coefficient of friction, and this may be closely estimated.

After the above factors have been determined, it is possible to find the driving force on the plates in the plane of their contact surfaces. Theoretically, there are an infinite number of forces acting tangentially, so to speak, in the surface of contact. These minute forces exist on all of the plates, and it would be impossible to determine their individual magnitude. However, it is not the value of each individual force that is required but the aggregate or total sum of these forces acting on the contact surface of one plate. These forces may properly be considered as being concentrated in one large force acting tangentially to an imaginary circle on the surface of a plate. This force will act at the radius of gyration of the surface, which in the case of a thin disk having a central hole is as follows:

$$g = 0.7071 \sqrt{R^2 + r^2}$$

in which g = radius of gyration;
R = outside radius; and
r = radius of the hole.

This force P may be determined by applying the well-known horsepower formula as follows:

$$\text{H. P.} = \frac{\pi DNP}{12 \times 33{,}000} = 0.00000794DNP \qquad (1)$$

in which H. P. = horsepower to be transmitted;
D = twice the radius of gyration, expressed in inches;
N = speed of shaft in revolutions per minute.

As the value of the force P is desired, this formula would be rewritten as follows:

$$P = \frac{\text{H. P.}}{0.00000794DN} \qquad (2)$$

This equation will give the force in pounds which represents the total friction force in the plane of the plates, but this force acts in a plane at right angles to the line of force of the spring; therefore it is necessary to take into consideration the coefficient of friction in order to determine the latter force. It is a fundamental principle of mechanics that the force required to move a body along a frictional surface is equal to the product of the normal force (that is, the force holding the two surfaces together), and the coefficient of friction between the two surfaces. Expressing this in the form of an equation in which F equals the friction coefficient and P_1 the normal force,

$$P = FP_1 \qquad (3)$$

or

$$P_1 = \frac{P}{F} \qquad (4)$$

Now, as P_1 is the value required, the value of P as given in Equation (3) is substituted in Formula (2). This gives a formula from which we can calculate the force P_1 of the spring:

$$P_1 = \frac{\text{H. P.}}{0.00000794DNF} \qquad (5)$$

It will at once be apparent that this is a very simple formula and one in which all of the factors necessary for the calculation of P_1 are known except F. Two designers

seldom agree exactly upon the value of the coefficient of friction even under the same conditions. There are many factors which affect this coefficient, such as speed, the normal pressure, character of surface, lubrication, materials used, etc., but in general a value of 0.1 is a conservative estimate for lubricated steel surfaces. This value substituted in Equation (5) gives,

$$P_1 = \frac{\text{H. P.}}{0.000000794DN} \qquad (6)$$

From this formula the force of the spring may be determined. In practice, it is well to increase this strength somewhat in order to make allowances for any slight error in estimation. This formula is invaluable in that it serves to prevent the use of a spring much larger or smaller than is needed to perform the work. It helps to put the designer's work on a scientific basis and enables him to avoid the cut-and-try method which is seldom justified if other means are available.

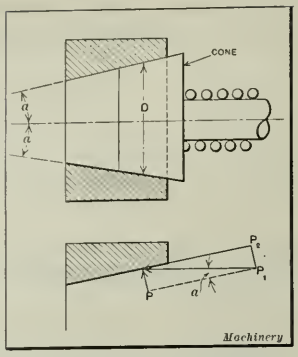


Fig. 1. Cone Clutch, and Diagram showing Relative Magnitude and Line of Action of Forces developed in Operation of a Cone Clutch

Why Several Plates are Required

The question often arises why, if friction is independent of the area of contact, it becomes necessary to use several plates, instead of simply using two plates. Theoretically, it should make no difference. Practically, however, the difference is very great, as without multiple plates the clutch would take hold so suddenly that some part would be broken or unduly strained. The thin film of oil between the plates causes them to slip upon each other for a time before they finally hold, and it is probable that some slippage is present at all times. This film should not be broken at any time because, if it is broken, the plates wear rapidly. An oil having just sufficient viscosity to maintain this film should be used. Since the viscosity decreases as the temperature rises, the maximum temperature should be considered when selecting the lubricating oil. Power is wasted if an oil having a higher viscosity than needed is used. When dry plates are used, the calculations will be the same as outlined for the lubricated plates, except that the coefficient of friction is somewhat higher, and a value of about 0.25 will generally give satisfactory results. The fact that a higher coefficient of friction is obtained with dry plates makes it possible to use a spring of less strength. Dry plates wear faster and require more frequent renewal than those running in oil, but on the other hand, they require practically no attention and are ready for service at all times until worn out.

The Cone Clutch

The cone clutch was used quite generally by early manufacturers of automobiles and is still in favor among many manufacturers. This clutch consists of a tapered circular piece called the cone, which fits into a second piece as shown in Fig. 1. One of these pieces is fastened to the driving shaft and the other to the driven. A spring placed behind the cone forces it into the other part, thus producing sufficient frictional force to drive the driven shaft. The cone is generally covered with some soft material like leather, although soft metal has been used with some success. Leather has been found very satisfactory when kept soaked with oil. The metal-lined cone clutch also requires the application of some oil. The problem is to determine the strength of the spring necessary for a clutch of this type. The forces involved and their various components are indicated in the diagram in Fig. 1. The total force is made up of numerous small forces acting along the whole surface in contact, which can all be considered as one force acting at the central point of the surface as shown. If we call the thrust of the spring P_1 as before, and the component normal to the contact surface P,

$$P = P_1 \sin a \qquad (7)$$

in which a equals the angle that the bearing surface of the cone makes with the axis, or one half the included angle of the cone. The force P_2 along the surface is:

$$P_2 = P_1 \cos a \qquad (8)$$

The horsepower formula (1) may now be applied, using as the normal force the value of P and as the tangential driving force $P \times F$:

$$P = \frac{\text{H. P.}}{0.00000794DNF} \qquad (9)$$

As P_1 is the value desired in this case, the value of P in terms of P_1 is substituted in Formula (9). Assuming for a coefficient of friction between oiled leather and cast iron a value of, say, 0.3, this formula now becomes,

$$P_1 = \frac{\text{H. P.}}{0.00000238DN \sin a} \qquad (10)$$

This equation will be found applicable to all cone clutches. The coefficient of friction used in this formula can, of course, be any value the designer determines upon, but 0.3 will

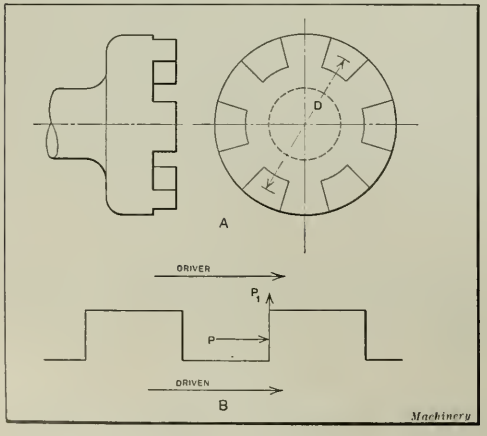


Fig. 2. Straight-tooth Clutch and Diagram indicating the Force required to mesh a Clutch of this Type

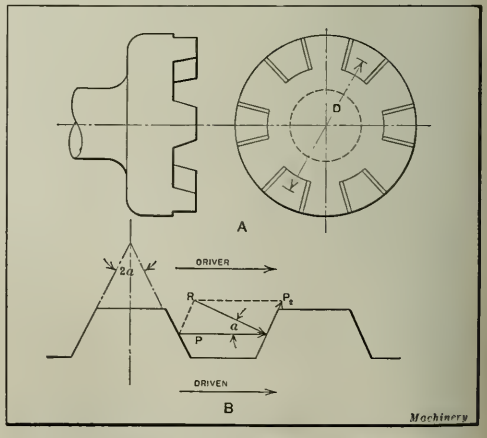


Fig. 3. Inclined-tooth Clutch and Diagram showing graphically the Forces involved in its Operation

generally give accurate results. Changing the friction coefficient changes the constant in the formula. The value of D, Fig. 1, given in the last two equations is, of course, the mean diameter of the clutch surface which is in contact, and is expressed in inches.

Positive or Toothed Clutches

Many cases arise in machine design in which it is not desired or is impossible to use a friction clutch. Such would be the case when a positive drive is required in which no slippage is permissible. If two shafts to be thus connected while in motion are in different planes and their speed is relatively slow, gears with large teeth and having plenty of clearance are sometimes employed. If the axes of the two shafts are in line, the shafts may be connected by using two couplings having radially cut teeth on their faces. Such an arrangement is used on many automobile transmissions in making the high-speed gear connection. Here one of the shafts turns at a speed determined by the speed of the car and the other at the speed of the engine. If the driver is skillful he can make these speeds equal at the moment of throwing in the high-speed gear, and the meshing will be accomplished without noise. If the two speeds are not about equal it will be either impossible to mesh them or a loud crashing noise will result. This type of clutch may also be used in other machines operated at slow speed, to connect a rotating shaft with a stationary one. The speed at which this union may be safely carried out without danger to the mechanism will depend entirely on the mass to be accelerated, that is, the weight of the parts to be set in motion beyond the clutch, and also upon the strength of the gear teeth.

At A, Fig. 2, is shown a common type of positive clutch having the teeth cut radially, and their sides parallel with the axis of the shaft. In analyzing the forces acting on these teeth, first consider them to be in mesh and the mechanism running. The result of the acting forces is obviously a driving force P as shown at B. Actually this force acts on all of the lugs, but it may be considered as concentrated at one point. In order to obtain the value of this force, the horsepower formula (2) is again employed. In this case,

$$P = \frac{\text{H. P.}}{0.00000794DN}$$

Here D represents the mean diameter of the teeth or lugs in inches. In this case the force of any spring which may be put behind the clutch to operate it is not considered. The driving force is dependent only upon the factors given in the formula.

As the driving force is the first thing to determine in the design of a clutch of this type, the writer has developed a graphical chart from which the value of P may be instantly determined without mathematical calculations. This chart is shown in Fig. 4, and the key shows how it is used. Any one of the four variables in the formula may, of course, be determined when the other three are known. Assume as an illustration that it is desired to know the driving force on the teeth of a clutch having a mean tooth diameter of 8 inches, and which must transmit 25 horsepower at a speed of 600 revolutions per minute. Draw a dot-and-dash line a connecting the numbers representing the horsepower and speed values as shown; then from the number which represents the mean tooth diameter, draw a line c through the point of intersection of line a with the diagonal line b, and extend line c until it meets the force scale. From this it is found that the driving force is about 660 pounds, and this will give the necessary value on which to base the design. In like manner any of the variables may be determined by simply following the key.

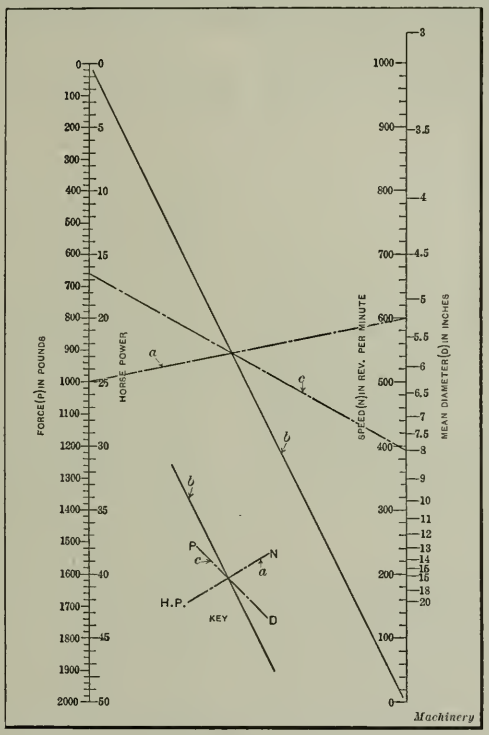


Fig. 4. Chart for solving graphically Some of the Problems pertaining to Clutch Design

This leads to a further consideration of the resultant forces produced by the driving force. The first thing to consider is what happens if an attempt is made to separate the two parts of a coupling while the full power is on. This is exactly what is usually required, as it is customary to keep the driver running continuously. It is necessary to determine how much force must be exerted in order to do this. The required force P_1 shown at B, Fig. 2, is evidently found by multiplying the driving force P by the coefficient of friction F. Expressed in the form of an equation it would be

$$P_1 = FP$$

The coefficient of friction may safely be taken as 0.2. Assuming that at B force P is 660 pounds, the force P_1 would be $660 \times 0.2 = 132$ pounds. If separating these moving parts requires this force, meshing them together will require the same force. This force must be furnished by some outside means, usually by a spring or perhaps merely by hand power, as in the case of many machine tool drives.

Meshing Clutches by Means of a Solenoid

The solenoid is quite generally used in some types of machines to force clutches into mesh. Usually the solenoid is installed in such a way that it must compress the coil spring and at the same time overcome the friction incident to meshing the gears. When it is desired to release the clutch, the current is broken in the solenoid, and the spring forces the meshing members apart. Obviously, the spring in the example under consideration would have to exert a pressure of at least 132 pounds and the solenoid double this amount because it would not only have to overcome the force of the spring but the sliding friction in the clutch as well.

It is obvious that such an arrangement would require an unduly large solenoid coil and considerable current for its operation. The mechanism may be reversed and the spring made to connect the clutch while the solenoid breaks the connection against the compression of the spring. In either case the size of the solenoid required is the same. In the latter case the current must be on the coil all the time that the main shaft is running and the driven shaft remains idle, while in the former case the current is on only while

the clutch is in mesh. The arrangement which should be used is the one which requires the smaller amount of power; this is determined by the ratio between the time the gear is in mesh and the time it is out of mesh. Obviously such a design leaves much to be desired. Many are in use, but it is reasonable to suppose that the solenoid would be employed much more if means could be found to reduce the size of the spring and solenoid required.

Type of Clutch Especially Adapted for Operation by Solenoids

The friction force P_1, on a positive clutch, can be reduced by merely cutting the driving face of the teeth or lugs at an angle instead of parallel to the axis of the shaft. Fig. 3 at *A* shows the sloping face in a somewhat exaggerated form. Let us call the included angle of the teeth $2a$ which means that each face is at an angle a with the axis. Fig. 3 at *B* shows the force diagram, in which P is the driving force, which may be determined from the chart in Fig. 4. In this case, however, the driving force has a component P_2, along the surface of the lug, and a normal force R. If in this design the force P_2 be made equal to the force necessary to overcome friction and disengage the clutch, we would have a case of equilibrium. The force of friction in this case is not P multiplied by the coefficient of friction F, but rather the normal force R multiplied by this coefficient. Expressing this mathematically by simple equations,

$$P_2 = P \sin a$$
$$R = P \cos a$$

If $RF = P_2$, we have equilibrium.

If RF is greater than P_2, the clutch will not remain in mesh but will disengage itself.

If RF is less than P_2, the clutch will remain in mesh and an outside force P_1 will be required to release it. But this force P_1 is the one which it is desired to either eliminate altogether or at least reduce to a minimum. The condition of equilibrium should therefore be obtained in order to reduce to a minimum amount the cost of operating the solenoid. In this case, $RF = P_2$. Or by substituting the above values of P_2 and R as given in terms of the angle,

$$FP \cos a = P \sin a$$

or

$$F = \frac{\sin a}{\cos a} = \tan a$$

From the last equation it is evident that in order to have equilibrium and thereby reduce P_1 to zero, it is only necessary to make one-half of the included angle on the lugs such that its tangent is equal to the coefficient of friction. Therefore if the coefficient of friction is assumed to be 0.2, then by reference to a trigonometric table it will be found that a equals approximately 11 degrees 19 minutes. The included angle $2a$ will equal 22 degrees 38 minutes.

In making the sides of the teeth at this angle the force required (theoretically) in the spring has been reduced to zero. Actually, of course, it is not possible to do away with the spring and solenoid entirely because it is impossible to machine the parts absolutely accurate or determine the exact coefficient of friction. Following up the theoretical solution by experiments under various conditions will readily give the desired results. After the angle has been determined and experiments made to ascertain the force required to engage and disenage the clutch, it is only necessary to install a spring sufficiently large to overcome slight irregularities resulting either from imperfect machine work or an error in our estimate of the coefficient of friction, as previously mentioned. The spring will, of course, be under compression while the clutch is held in mesh by a small solenoid. When the current in the coil is broken, the small spring will release the clutch. In the first case, in which the teeth were cut straight, the spring was required to exert a force of over 132 pounds, while in the latter case, a spring capable of exerting about 10 pounds will be sufficient to do the work if the angle is properly determined; therefore, a much smaller spring and solenoid will be required. The saving in space may be as important as the reduced cost of operation or the saving resulting from the use of smaller and less expensive springs and solenoids.

Referring to the diagram *B*, Fig. 3, there at first appears to be a fallacy in the theory advanced in connection with the inclined-plane clutch design. It will be noticed that nothing has been said about the meshing process in the last case as regards the forces involved. It is evident that the solenoid must be somewhat stronger than the spring and according to the original theory the force required to mesh these two parts of the clutch would be found to be exactly the same as when the teeth were cut straight, or in this case, 132 pounds. It would appear that the solenoid not only must overcome the sliding friction expressed in this case by $R \times F$ but also the component of the driving force P_2. The question then arises as to how the small solenoid can bring the clutch into mesh, as it appears that a large force is required to mesh the clutch and practically no force to release it.

This is not the case, however, and while this reasoning seems perfectly sound theoretically, it does not make allowance for other factors which must be considered when the engaging operation takes place. The sliding part of the clutch which is not rotating when out of mesh must move some distance before the teeth engage. During this movement the sliding members gather speed and store up energy. Considerable clearance is, of course, always allowed between the teeth on one part and the space on the other when the clutch is disengaged. When the teeth finally meet during the meshing process, the friction force, as well as the component of the driving force, comes into play to retard the meshing. This consumes the energy which has been previously stored in the sliding part, and when this energy has been all absorbed the meshing will stop. However, the depth of the teeth is never great, usually only a fraction of an inch, and thus the energy stored up in the sliding member is sufficient to mesh the clutch teeth properly.

* * *

AN ACCIDENT "THERMOMETER"

The safety department of E. I. du Pont de Nemours & Co., Wilmington, Del., has devised what is known as an "accidometer," which is simply a large bulletin board to which has been attached what may be termed accident "thermometers" for the various departments to which this bulletin applies. Above each thermometer is given the name of the foreman of the department together with names of the subforemen responsible to him. The number of accidents in each department is then indicated by the height of the black line in each thermometer. Suitable awards are given to the foremen and general foremen who have a clear record, or no serious accidents, during the preceding six or twelve months. It has been found that this method of making a comparison between the safety in the various departments appeals strongly to the workman's sense of loyalty to his foreman and to his department. The safety department reports that a great deal of rivalry has been created and a keen interest in accident reduction has become apparent.

* * *

Special Trade Commissioner Burwell S. Cutler, of the Department of Commerce, Washington, D. C., stated in an address recently made before the American Manufacturers Export Association at Chicago that the great loss of men in Germany due to the war has not materially affected the ranks of trained labor in the mechanical industries, because that class of labor was largely withdrawn from the Army and placed in the factories for the manufacture of war supplies. Many lines of industrial workers were thus exempt, if the industry was considered necessary to the successful conduct of the war or the maintenance of the civil population. Hence, as soon as the economic conditions of Germany have been somewhat readjusted, it may be expected that Germany will enter into industrial competition with the rest of the world in a very effective manner, and manufacturers of other nations must be prepared to meet that competition.



Valve Work on the Turret Lathe

A Review of Different Methods for Holding and Machining Valves on the Turret Lathe, Based Upon the Practice of the Gisholt Machine Co., Madison, Wis.

By ERIK OBERG

IN finishing valves on the turret lathe, there are four methods by means of which the valves may be held, according to the class of valve operated upon and its dimensions. Fig. 1 shows the method used for holding small valves. As will be seen, the valves are simply held by special chuck jaws bearing against the flange at one end of the valve, while clamps are provided binding down upon the top of the flange, and thereby holding the valve securely in place. In the case of small valves, no further support is required.

Fig. 2 shows the swivel-fixture method as it is applied for holding a small valve. An enlarged view of the holding device is shown in Fig. 3. It will be seen that special supporting arms or angle-plates are used, extending from the face of the chuck; the valve is held between two of these arms. Strictly speaking, this is a special fixture of simple design. The valve is finished complete while it is held in this fixture, being so mounted that it can be swiveled to present different flanges to be faced to the tools.

For larger valves of similar construction, a swiveling fixture of somewhat different design, but similar in principle, is used, as shown in Fig. 4. This fixture is also so arranged that the valve can be indexed around to machine the two flanges, but as a rule the valve seat is not machined in this fixture; instead it is machined by holding the valve on a threaded arbor which enters it at the end opposite the valve seat, this end being tapped to fit the threaded arbor or stud, so that the valve may be held as shown in Fig. 5, which illustrates the third method. This method, of course, can only be used when there is a hole that extends entirely through the valve. The advantage of this method of finishing the valve seat is that in cases where valves have to be reseated in the field, they may be screwed on an arbor, and will then be sure to run true.

The fourth method for holding valves for machining in a turret lathe is shown in Figs. 6 and 7, which illustrate a special fixture or angle-plate that is employed for valves of irregular shape and for which, therefore, a swiveling fixture such as shown in Fig. 4 cannot be employed. Fig. 6 shows the fixture before the valve is put in place, and Fig. 7 shows the same fixture with the valve in position and the supporting or clamping arm at the top in place. It will be noted that the arm has a roller at the top, bearing against the rotating part of the fixture in which the valve is clamped. Rollers are also provided (as will be seen in Fig. 6) at the sides, held in holders clamped to the vees of the machine. In this way, the outer end of the fixture is thoroughly supported. Examples showing the order of operations with valves held by the different methods will now be shown.

Tooling Equipment for Small Valve Held in Chuck Jaws

Fig. 8 shows a valve being held by the first method described for machining in a 21-inch Gisholt turret lathe. This is a three-way valve, having three flanges to be machined. The material is cast iron. The first operation consists of chucking the valve by the same method as shown in Fig. 1, the valve being held with special hard jaws by one flange, while the flange at the opposite end is faced by a tool held in the toolpost, as shown in Fig. 8. The time for the chucking and finishing of this end is 5 minutes.

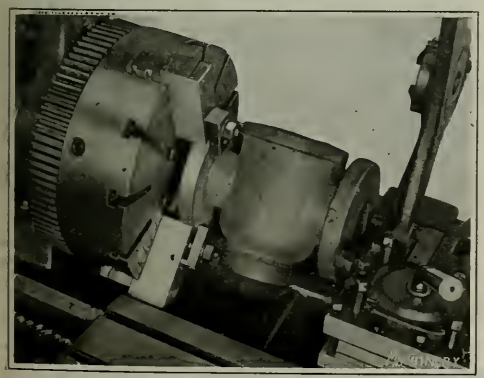


Fig. 1. Method used for holding Small Valves

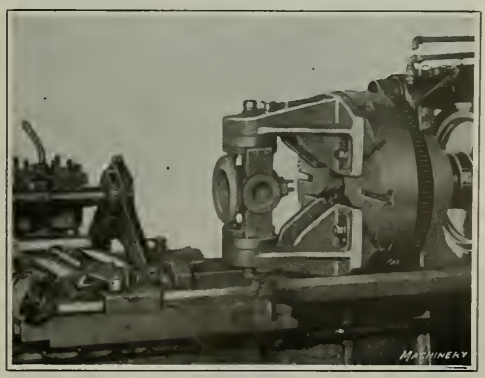


Fig. 2. Swivel-fixture Method of holding Small Valves

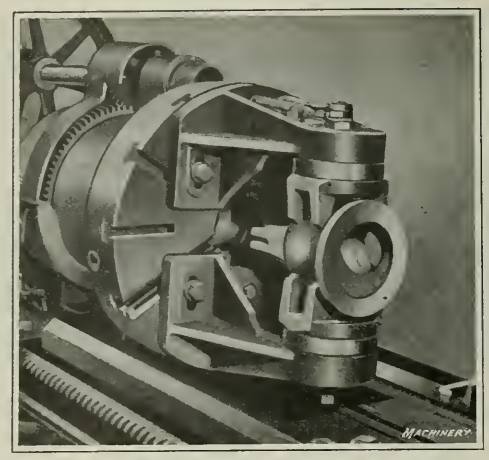


Fig. 3. Enlarged View of Holding Device shown in Fig. 2

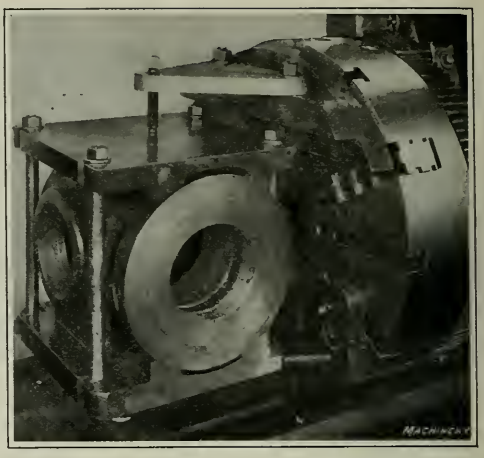


Fig. 4. Swivel Fixture used for holding Large Valves

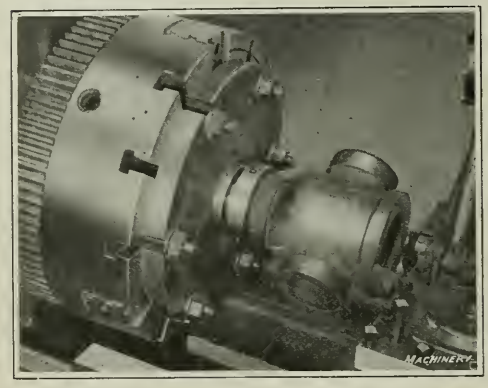


Fig. 5. Threaded Arbor or Stud used for holding Valve

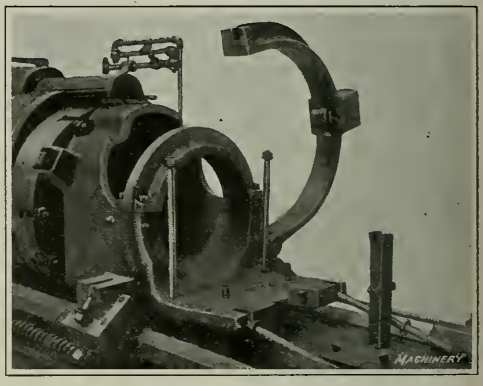


Fig. 6. Angle-plate Fixture for Valves of Irregular Shape

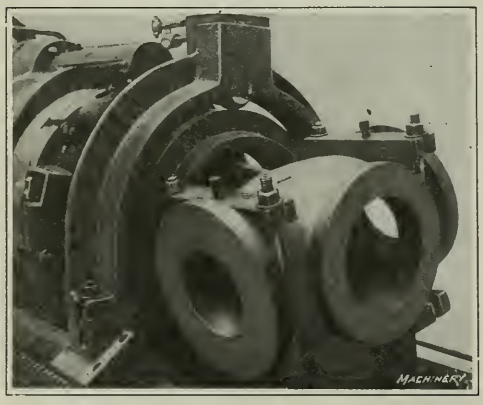


Fig. 7. Fixture shown in Fig. 6 with Work in Place

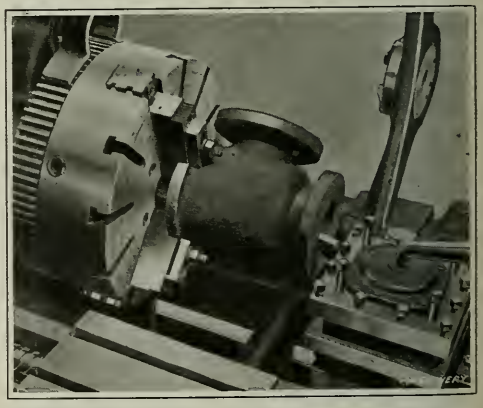


Fig. 8. Three-way Valve held by Method shown in Fig. 1

The second operation consists of holding the valve by the finished flange, while the opposite flange is machined. The time for performing this operation is 6 minutes.

The third operation, as illustrated diagrammatically in Fig. 9 and by the halftone illustration, Fig. 12, consists of finishing the face *C* with a tool in the toolpost, the valve being held on an angle-plate provided with a centering collar. A counterweight is used on the faceplate to balance the weight of the angle-plate. Uprights are provided under the flange being finished, through which screws pass, supporting the flange as shown in Fig. 12. The time for the third operation is 7 minutes.

Instead of finishing the valve at *C* by holding it by chuck jaws, as indicated in Figs. 1 and 8, the valve may be tapped at one end and held on a stud, as illustrated in Fig. 5 and as shown diagrammatically in Fig. 10, the object of finishing

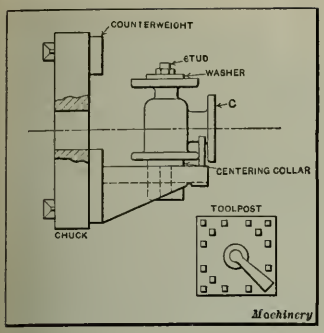


Fig. 9. Third Operation on Valve shown in Fig. 8

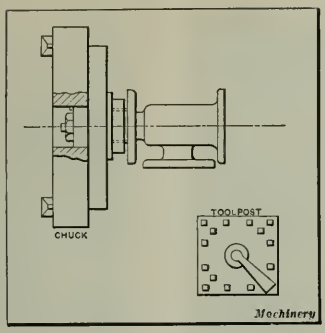


Fig. 10. Method used for holding Valve on Stud

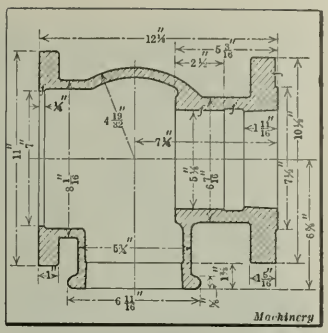


Fig. 11. Cross-sectional View of Cast-iron Globe Valve

the valve seat in this manner having already been explained. In that case, the operation consists in screwing the valve on the centering stud and facing the opposite flange. The total time for this operation is 5 minutes.

Equipment for Machining a Globe Valve

Fig. 11 shows a cross-section of a cast-iron globe valve finished on a 24-inch Gisholt turret lathe. The lay-out of the tooling equipment is shown in Fig. 14, while Fig. 13 shows the fixture in which the valve is held while being machined. This fixture is of the swiveling type, so that the valve can be turned around for machining the different flanges. Two views of the fixture are shown in Figs. 15 and 16, the illustration, Fig. 16, showing the faceplate turned around 90 degrees from the position in Fig. 15 so as to clearly show the construction of the swiveling fixture. Fig. 17 shows the machine with the complete tooling equipment required, corresponding to the lay-out in Fig. 14.

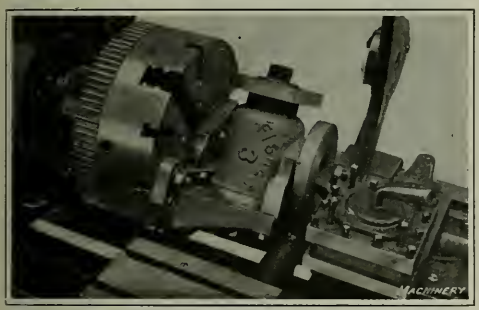


Fig. 12. Machine set up for Third Operation on Valve in Fig. 8

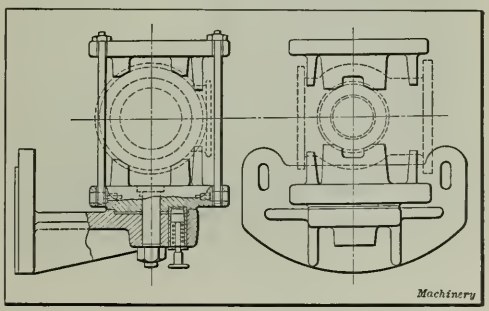


Fig. 13. Fixture in which Valve in Fig. 11 is held while being machined

The step-by-step order of operations is as follows (see Fig. 14): (1) The valve is placed between the angle-plates, being held in a special cradle as shown in Figs. 13, 15, and 17. (2) Hole *A* is rough-bored with a cutter held in the bar that is mounted in Side 1 of the turret. (3) Hole *A* is finished with a cutter held in the bar mounted in Side 5 of the turret. (4) Hole *A* is tapped with a tap held in Side 2 of the turret. After having completed the tapping, the fixture, with the valve in it, is turned around one-quarter turn. (5) Flange-faces *D* and *E* are rough-faced with tools *K* held in the toolpost. (6) Hole *C* is rough-bored with a cutter held in the bar in Side 4 of the turret. (7) Hole *C* is finished with a cutter mounted in the bar held in Side 5 of the turret. (8) Faces *D* and *E* are finished with tools *L* in the toolpost. (9) Recess *B* is bored out with tool *M* in the toolpost. (10) Hole *C* is tapped with the tap mounted in Side 2 of the turret. The total time required for the various steps of this operation is 15 minutes.

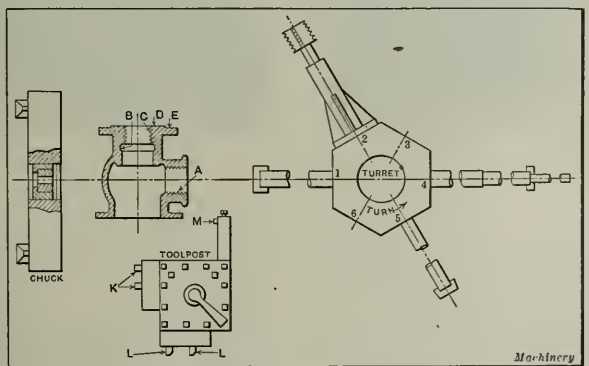


Fig. 14. Tooling Equipment for Valve shown in Fig. 11

The second operation, a detail view of which is shown in Fig. 20, consists of facing and boring the valve seat. In this case, the valve is held on a threaded center plug, as indicated in Fig. 18 and as shown more clearly in Figs. 19 and 21. Fig. 18 shows the complete tooling equipment set up on the machine. The step-by-step operations are as follows (see Fig. 21): (1) The valve is screwed on the center plug. (2) Flange *I* is rough-faced with tool *N* in the toolpost. (3) Holes *F* and *G* are rough-bored with cutters *O* and *P*, respectively, held in the boring-bar mounted in Side 1 of the turret. (4) Shoulder *H* is faced with tool *R* held in the toolpost. (5) Holes *F* and *G* are finished with cutters *S* and *T*, respectively, held in the boring-bar mounted in Side 3 of the turret. (6) Hole *F* is reamed with the reamer mounted in Side 5 of the turret. (7) Flange *I* is finish-faced with tool *U* held in the toolpost. The

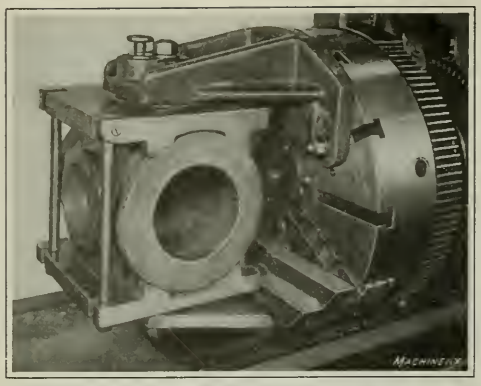


Fig. 15 Fixture shown in Fig. 13 mounted in Machine

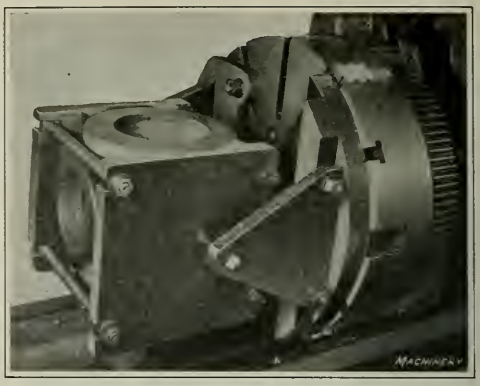


Fig. 16. Faceplate turned around 90 Degrees from Position in Fig. 15

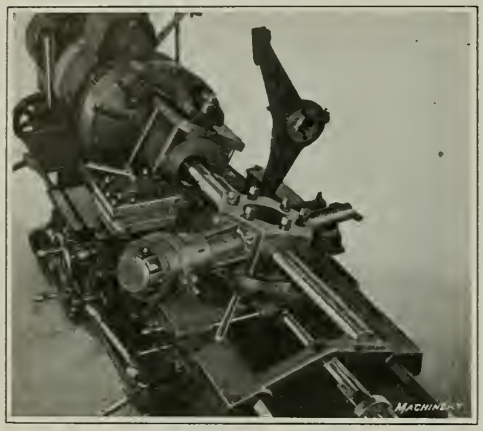


Fig. 17. Machine with Complete Tooling Equipment for finishing Valve shown in Fig. 11

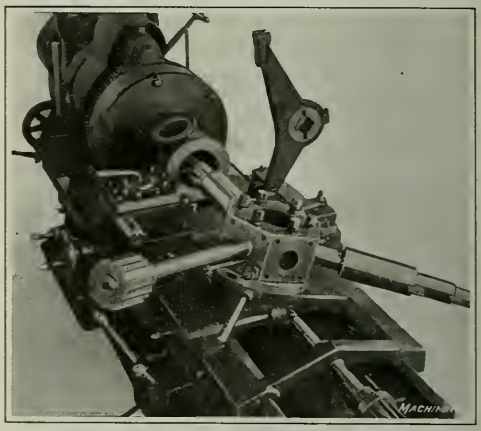


Fig. 18. Machine set up for Second Operation on Globe Valve shown in Fig. 11

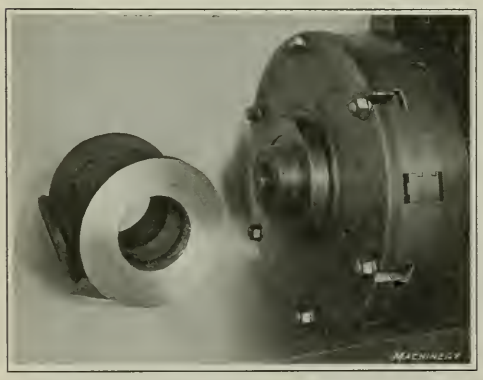


Fig. 19. Illustration showing Threaded Center Plug on which Valve is held for Second Operation



Fig. 20. A Detail View of the Second Operation on the Globe Valve shown in Fig. 11

total time required for the second operation on the globe valve is 8 minutes.

The examples given show quite clearly the four different methods that can be used to advantage for finishing valves on the turret lathe. In laying out the tooling equipment, the tool designer must, of course, decide in which case each one of the four methods can be most advantageously applied to the valve under consideration. The size of the valve has first to be taken into account, as it would not be possible to hold a large heavy valve, having a great deal of overhang, in the same way as a small and light valve could be clamped. Valves with irregular outline also require special fixtures as shown, and the tool designer sometimes must exercise considerable ingenuity in designing the simplest possible holding means that will still make it possible to obtain the accuracy aimed at and the production required. Difference in the time needed to finish a valve when a proper holding fixture is used, as compared with the time when a fixture of cumbersome or unsatisfactory design is employed, is very marked. Users of turret lathes on valve work should, there-

fore, thoroughly study the different methods used in connection with this work, noticing the four different means outlined in the present article with a view to obtain a guide for the selection of the best means in each case. That the productive capacity of the turret lathe depends very largely upon the efficiency of the tooling equipment and the careful selection of the means for holding the work, is evident; nevertheless, this fact is not appreciated by turret lathe users as much as it should be, and hence it is necessary that special emphasis be placed upon this point.

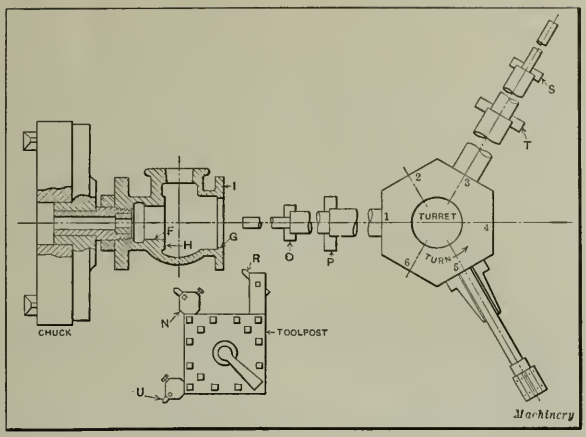


Fig. 21. Tool Lay-out for Second Operation on Globe Valve

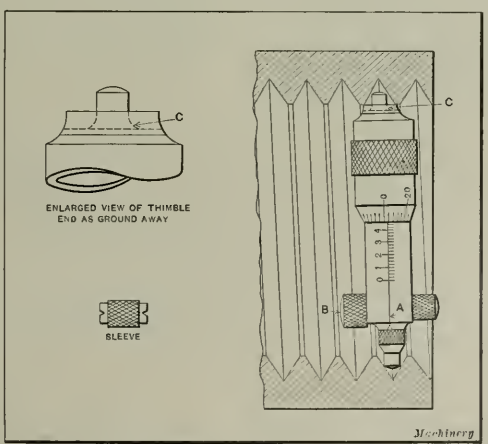
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IMPROVEMENT IN INSIDE MICROMETERS

By WILLIAM S. ROWELL

It is interesting to note how few changes have been made in the design of inside micrometers above 2 inches in size during the last fifteen years. The writer has a set, however, in which several interesting features have been incorporated, and which have been tried and proved entirely satisfactory. Referring to the accompanying illustration, it will be seen that the reading line has been extended the full length of the hub, as at *A*. This makes the reading more easily taken when the thimble covers the zero mark or when the light is poor. Another slight improvement over the standard design is that the rod-clamping screw *B* is provided with a head which is about twice the diameter of its little used mate. This identifies it and provides better contact for thumb and finger when clamping the measuring rod. The sleeves are notched at both ends, furnishing dust grooves at each end no matter which way they are put on the rods.

The fact that the head of the thimble comes so close to the contact point in the standard micrometer, has led to a slight change in the thimble, which is shown by the dotted line *C* in the illustration. It will be seen that a portion of the thimble has been ground away to provide for clearance. This improvement is very noticeable when gaging shallow counterbores, in starting cuts, and in duplicating inside threads. When the diameter and pitch of thread will admit the insertion of the micrometer, as shown in the illustration, a fairly accurate means is provided for duplicating an internal thread. It will be noticed that the rod end of the micrometer is properly entered in the thread groove, while the thimble end cannot contact with the sides of the thread owing to the shortness of the small diameter portion. However, by grinding away as indicated by the dotted line, this end also will contact on the sides of the thread. A slight difference in the diameters of the contact points is an advantage, because it enables measurements to be made from two parts of the angular sides of the thread groove. To avoid trouble with wrench flats on contact points, they should be coned to a somewhat smaller angle than that of the thread groove angle; for instance for a 60-degree thread, an included angle of possibly 50 degrees is about right. It is evident that this angle overcomes any interference that might result from the diagonal position of the micrometer when taking the measurement.



Position of Inside Micrometer when measuring Internal Threads, showing Advantages of Minor Improvements

When used to measure the diameter of a hole, it is not advisable to set the micrometer to a predetermined size, but rather to adjust it to the bored size, reading the result from the graduations on the hub. Some users, however, obtain the reading by repeated settings outside the bore and repeated trials within. A better way is to set the micrometer slightly above the actual diameter of the bore; place the measuring rod in the bore to be measured; and then bring the thimble end as nearly diametrically opposite as the length of the micrometer will permit. Use the end of the second finger against the clamp screw as a stop to prevent the head from turning when adjusting the thimble with the thumb and forefinger. With a little practice, measurements can be taken in this manner quickly and accurately.

* * *

Stevens Institute of Technology has conferred the degree of Doctor of Engineering upon Charles Eugene Schneider, president of the French Industrial Commission to the United States and the head of the Creusot Iron Works, comprising a chain of thirty industrial and manufacturing plants in France. Mr. Schneider is noted as the engineer who produced the well-known 155- and 240-millimeter howitzers that were used so successfully during the war, as well as the railway mounts for large caliber guns, advantageously used in the war by the French Army and adopted by the American Government for its ordnance. On his visit to the United States, Mr. Schneider was especially impressed by the great attention that was given to engineering schools and colleges.

* * *

It is announced that the government of Italy has taken steps to develop systematically industrial experiment stations and technical educational facilities. The introduction of the eight-hour day in many industries, it is stated, has rendered this step necessary, as with the reduction in hours, increased efficiency must be brought about if production is to be maintained.

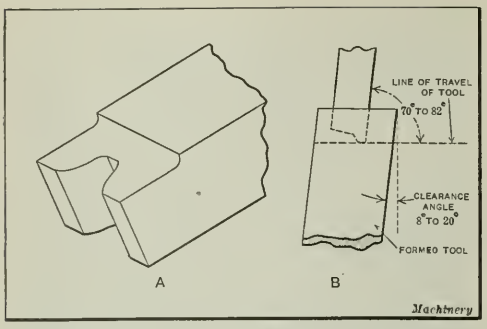


Fig. 1. (A) Formed Tool used in Backing-off Lathe. (B) Diagram indicating how the Formed Tool is planed to Shape by Formed Shaper Tool

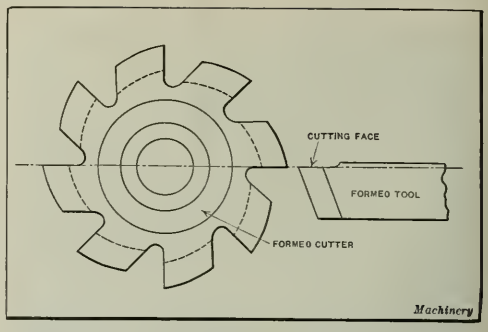


Fig. 2. Relative Positions of Formed Tool and Formed Cutter when backing off Circular Forming Tools and Formed Milling Cutters

Formulas for Formed Tools

Angular Position of Tools Used for Planing Formed Tools—Calculations for Making Circular Tools Used on Automatic Screw Machines

By W. E. THOMPSON

FORMED tools such as shown at *A*, Fig. 1, are used principally on lathes equipped with backing-off or relieving attachments in order to produce circular forming tools and formed milling cutters. These formed tools are usually shaped either in a milling machine by using a fly cutter of the required outline, or by means of a shaper equipped with a form tool having the exact contour of the piece or part to be produced. When the latter method is employed, a special clapper fixture is used which allows the shaper tool to be held in the required angular position. The method of determining the angle to which the shaper tool should be set to meet various requirements is described in the present article.

Formed tools properly shaped by accurately formed shaper tools may be ground on their cutting faces without changing their form. They are always set in the lathe with this face in a plane passing through the axis of the cutter or circular tool, as shown in Fig. 2, but the circular cutting tool may or may not have its cutting face or faces in this plane. Formed circular tools, or cutters shaped with a formed tool may also be ground on their cutting faces without changing their form.

Angular Position of Tools when Planing Formed Tool

First let us consider the case of formed milling cutters having their cutting faces in radial planes, which are to be produced by formed tools planed to the required shape by a formed shaper tool. When planing the formed tool, the cutting faces of the formed tool and the shaper tool are held in parallel planes, usually at an angle of 70 degrees with the line of travel of the fly cutter—20 degrees being the usual clearance angle for formed tools used for backing off the teeth of milling cutters. The relative positions of the tools are clearly shown at *B*, Fig. 1. The cutting face of the shaper tool, which has the exact dimensions and form of the work to be produced, thus accurately shapes the formed tool so that it will produce milling cutters or circular forming tools of the required shape.

When making circular forming tools of irregular outline for automatic screw machines, or formed milling cutters having other than radial cutting faces, the cutting face of the shaper tool is set at an angle with the cutting face of the formed tool as shown in Fig. 3, instead of parallel with it. This angle *c* depends upon the distance of the cutting edge of the circular tool or cutter below the center, and in the case of screw machine tools the two following conditions are to be considered:

1. When the face of the circular tool is set in a radial plane of the work.
2. When the face of the circular tool is set at an angle to a radial plane of the work in order to obtain top rake.

The first condition is comparatively simple to deal with,

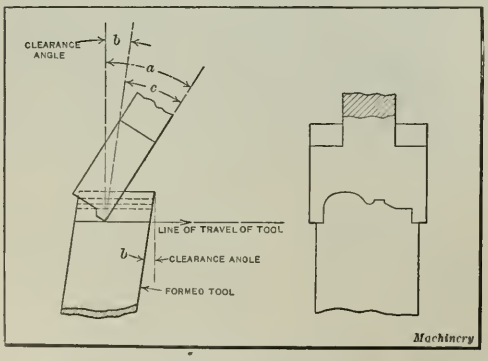


Fig. 3. Diagram showing how Shaper Tool is set to produce Formed Tool of Irregular Outline

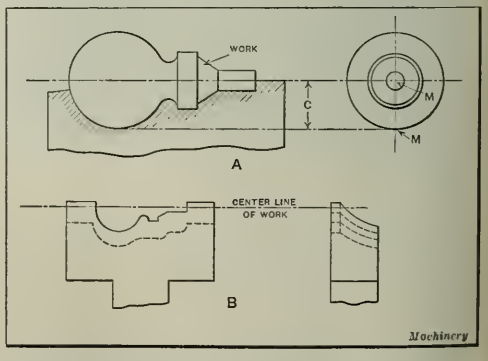


Fig. 4. (A) Work to be produced in Screw Machine; (B) Shaper Tool for shaping Forming Tool used in Screw Machine

and considerable data have been published concerning this form of tool; but the exact formula for calculating the shaper tool setting is not always readily found, and for this reason it will be given herewith. The second condition presents more complications, but the formula which has been derived to meet this condition is quite easy to apply, as it has been reduced to a simple form.

The formulas used in designing formed tools for backing off cutters having top rake on their cutting faces, or as they are commonly termed, hook-tooth cutters, are not generally known, and as similar difficulties are presented in computing the angle of correction c of the shaper tool, they are also given here in simple form.

Making Formed Tool for Screw Machine

The view at *A*, Fig. 4, represents a part to be produced in a screw machine. The dimension *C* is the working depth of the tool measured on a radial line. It should be mentioned here that the letter *C* is used exclusively throughout the present article to represent the working depth of formed tools or cutters. At *B* is shown the shaper tool employed to plane the forming tool required to produce the circular cutter. This tool, having the outline of the part shown at *A* as determined by the radial cutting plane *M–M*, is provided with a shank which permits it to be held in the tool-holder of the shaper.

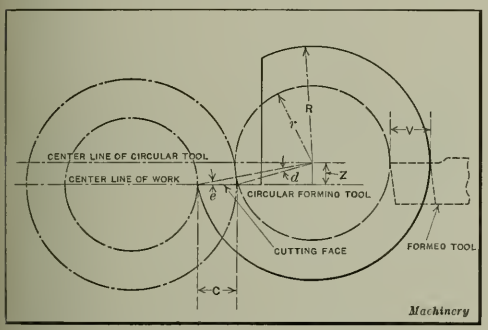


Fig. 5. Relative Positions of Work to be formed, Circular Forming Tool, and Tool used to produce Forming Tool

Fig. 3 shows the relative position of the shaper tool and formed tool when planing the formed tool for making a circular forming tool having the cutting face in a plane other than radial, or a hook-tooth cutter. The angle *a*, at which the face of the shaper tool is set, equals the clearance angle *b*, plus the angle of correction *e*. For formed tools used to produce cutters having a radial cutting face, the face of the shaper tool is set at the clearance angle *b* only, as stated before and as illustrated at *B*, Fig. 1.

Calculations for Making Circular Forming Tool

The diagram Fig. 5 represents a circular forming tool having its cutting face in a radial plane of the work. Certain dimensions must be known and tabulated in all cases in order to determine the required angular position of the shaper tool, and in this case we have given the outside radius of the circular tool; the working depth of the cut, which is taken from the work specifications; the distance of the cutting face below the center of the circular tool, which varies from ⅛ to ½ inch, depending upon the size of the tool; and the clearance angle of the formed tool. These known quantities are represented by letters as follows:

R = outside radius of the circular tool;
C = working depth of cut (Fig. 4);
Z = distance of cutting edge below center of tool;
b = clearance angle of formed tool (Fig. 3).

The unknown dimensions on the diagram Fig. 5 are represented as follows:

r = radial distance from center of tool to the inside of cutting form on cutting face;

V = actual length of form of formed tool, which is set in a radial plane of the circular tool. This distance is equal to $R - r$ and is less than the distance *C*.

The construction lines forming angles *d* and *e* are drawn for the purpose of calculating *r*.

$$\text{Sin } e = \frac{Z}{R}$$

$$\text{Tan } d = \frac{C \sin e}{R - (C \cos e)}$$

$$r = \frac{C \sin e}{\sin d}$$

$$V = R - r$$

Fig. 6 presents a diagram and a formula for determining the angle *a* previously referred to and illustrated in Fig 3. Thus in shaping a form tool for use in making a circular forming tool the shaper tool is set at an angle *a* which is determined by the formula,

$$\cos a = \frac{V \cos b}{C}$$

The second condition is represented by the diagram Fig.

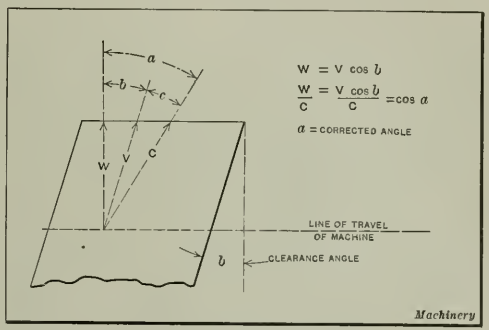


Fig. 6. Diagram showing Method of deriving Formula used to determine Shaper Tool Setting

7, which shows a circular tool having its cutting face at an angle with a radial plane of the work that passes through its highest point. The known values are tabulated as in the preceding case:

b = clearance angle of formed tool (Fig. 3);
R = outside radius of work;
r = inside radius of work = $R - C$;
e = angle of rake, or the angle that the cutting face of the cutter makes with a radial plane of the work passing through the highest point of the cutting edge;
Z = distance that highest point of cutting edge is below center of circular tool;
R_1 = outside radius of circular tool.

Construction lines are drawn as illustrated for the purpose of solving the following formulas:

$$\text{Sin } A = \frac{r \sin e}{R} \qquad (1)$$

$$S = R \cos A - r \cos e \qquad (2)$$

$$\text{Sin } f = \frac{Z}{R_1} \qquad (3)$$

$$g = f + e \qquad (4)$$

$$\text{Tan } d = \frac{S \sin g}{R_1 - (S \cos g)} \qquad (5)$$

$$r_1 = \frac{S \sin g}{\sin d} \qquad (6)$$

$$V = R_1 - r_1 \qquad (7)$$

Again referring to Fig. 6,

$$\text{Cos } a = \frac{V \cos b}{C} \qquad (8)$$

Calculations for Making Hook-tooth Cutter

An entirely different condition is found in Fig. 8, where the relation of a hook-tooth cutter to its formed tool is shown. In this case the face of the formed tool moves in a straight radial line toward the center of the cutter a given distance and returns to its starting position once during the rotation of the cutter through each tooth space. Referring to the diagram, it will be seen that the working depth V of the formed tool, will be less than the working depth C of the cutter due to the movement of the tool and the angularity of the cutting faces. The known quantities are as follows:

R = outside radius of cutter;

r = inside radius of cutter; $r = R - C$;

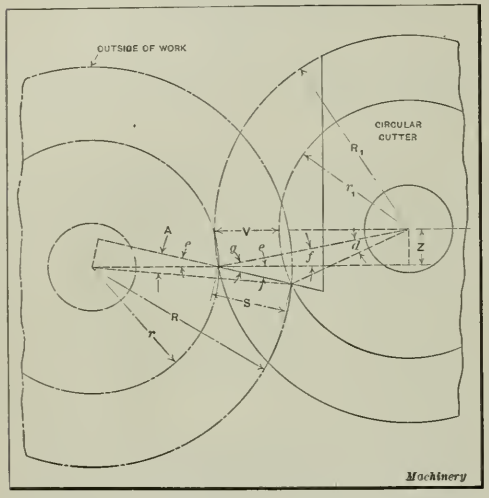


Fig. 7. Diagram used in determining Shaper Tool Setting when a Circular Formed Cutter is required which has its Cutting Face at an Angle with a Radial Plane of the Work

Z = distance of cutting edge behind center; $Z = R \sin e$

e = angle of cutter rake; $\sin e = \frac{Z}{R}$

N = number of teeth in cutter;

P = drop of backing-off cam, or distance that formed tool moves in one direction during advance of one tooth space in rotation of cutter;[1]

b = clearance angle of formed tool.

It will be seen by referring to the diagram Fig. 8 that the formed tool starts to cut on the line OM, but does not cut on its entire form until the cutter has revolved through an angle h, when the plane represented by OQ coincides with the cutting face of the formed tool. At this stage of the cycle of movements the tool has moved toward the cutter center a distance represented by x; therefore the formed tool must have a working depth equal to V, or in other words equal to $C - x$.

Using the known quantities, we have:

[1]It is customary to allow 1/8 of the tooth pitch for the return movement of the backing-off tool. The tool thus has its full forward movement in 7/8 of the tooth pitch which is stated in angular terms thus: $\frac{360}{N} \times 7/8 = \frac{315}{N}$ degrees. Then $\frac{315}{N}$ degrees equals the angular movement of the cutter while the forming tool makes its extreme movement forward. If the cam used to reciprocate the formed tool is made to return in more than 1/8 of the tooth pitch, this equation must be changed to suit the condition.

$$\text{Sin } f = \frac{R \sin e}{r} \qquad (1)$$

$$h = f - e \qquad (2)$$

$$x = \frac{NPh}{315} \qquad (3)$$

$$V = C - x \qquad (4)$$

Referring to Fig. 6,

$$\text{Cos } a = \frac{V \cos b}{C} \qquad (5)$$

The face of the shaper tool is set at the corrected angle a when planing the formed tool form.

Example of Hook-tooth Computation

Let $R = 2$ inches; $r = 1.5$ inches; $e = 15$ degrees; $N = 10$; $P = 0.200$ inch; and $b = 15$ degrees. Substituting these values in the preceding formulas we have:

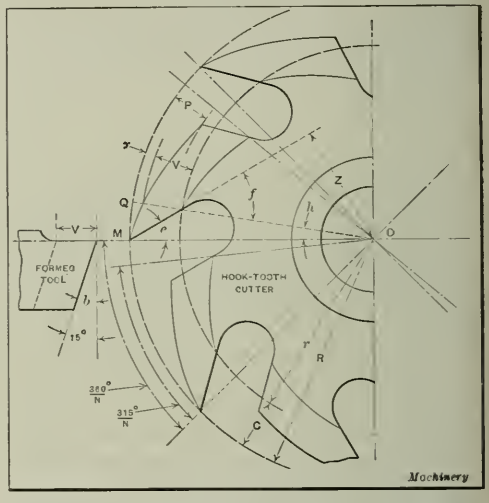


Fig. 8. Lay-out of Hook-tooth Cutter required to evolve the Formula employed in determining the Angle at which Shaper Tool is set

$$\text{Sin } f = \frac{2 \times 0.25882}{1.5} = 0.3451 \qquad (1)$$

Therefore angle $f = 20$ degrees 11 minutes

$$h = f - e = 20 \text{ degrees } 11 \text{ minutes} - 15 \text{ degrees} = 5 \text{ degrees } 11 \text{ minutes} \qquad (2)$$

$$x = \frac{10 \times 0.200 \times 5 \text{ degrees } 11 \text{ minutes}}{315} = 0.033 \text{ inch} \qquad (3)$$

$$V = 0.500 - 0.033 = 0.467 \text{ inch} \qquad (4)$$

$$\text{Cos } a = \frac{0.467 \times 0.96593}{0.500} = 0.9021 \qquad (5)$$

Therefore angle $a = 25$ degrees 34 minutes.

* * *

It is reported that successful trial flights have been made in Germany by a great Zeppelin driven by seven motors and capable of carrying 100 passengers, in addition to the crew. According to the *Scientific American*, there is information from Berlin to the effect that this airship is the first of a regular airship service to be conducted by a German company connecting Stockholm and Copenhagen with Berlin, the major object being the assumption of a leading position in Scandinavian affairs in competition with British and French rivals.



A Complete System for Thread Plug and Ring Gages

By J. E. COLLINS

THE system outlined in this article applies to U. S. standard threads and may be modified to meet the needs of the manufacturer. For example, the snap gages and plain ring gages used in connection with the thread ring gages may be, in some cases, entirely dispensed with. The system starts in the drafting-room where the part or machine drawings are detailed and where the thread tolerances must be standardized. The method to be followed is worked out in a simple manner, and will be outlined in this article.

The work shown at *A*, Fig. 1, is taken as an example, and a complete set of the gaging equipment for both the external and internal threads is detailed in this illustration. The following gages are required for the male thread: One "Go" and one "Not Go" thread ring gage for gaging the pitch diameter; one snap gage, for gaging the minimum outside diameter; one ring gage for gaging the maximum outside diameter; one check for the thread ring gages; one plug gage for the core diameter. The two thread ring gages for the pitch diameter are shown at *C*, Fig. 1, while their checks are shown at *B*. In this connection, it should be stated that it is necessary to make checks for all thread ring gages, not only to use as a check for wear but for use in manufacturing the ring itself. All checks are made to the same dimensions as the gage itself. As there must be a "Go" and a "Not Go" gage for the pitch diameters of the work, these maximum and minimum pitch diameters are taken as the basic measurement for all thread gages. The maximum and minimum pitch diameters of the male thread on the work shown at *A* are 2.4680 and 2.4620 inches, respectively; therefore, the gages must be given these pitch diameter dimensions. The tolerance for these basic dimensions is taken from Table 1, which gives the tolerances on master thread gages. As the number of threads per inch in the

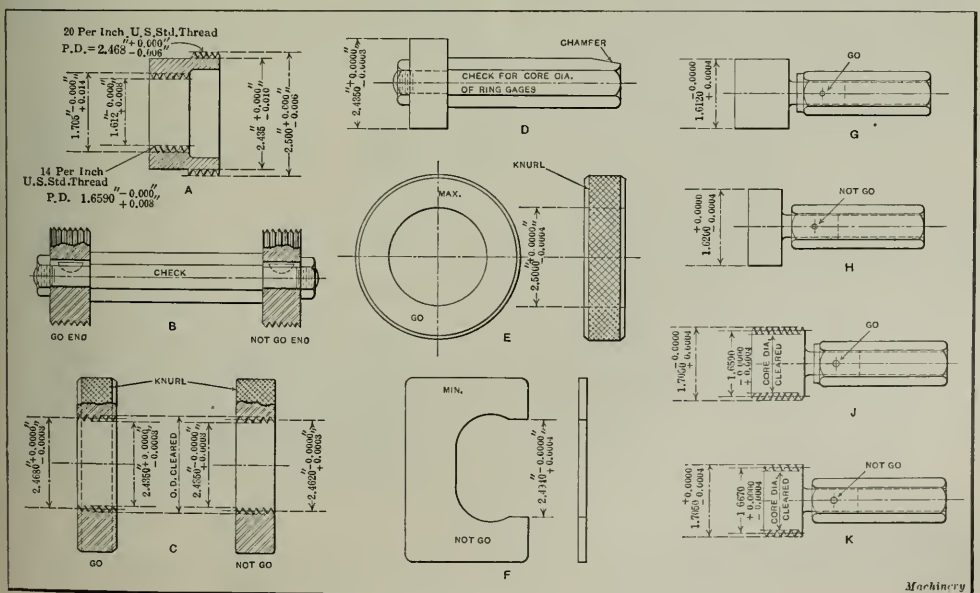


Fig. 1. Complete Set of Gages for External and Internal Threads on Work A

TABLE 1. TOLERANCES ON MASTER THREAD GAGES

Number of Threads per Inch	Allowable Variation in Lead in Effective Length of Gage, Inch	Allowable Variation in One-half Included Angle of Thread	Allowable Tolerance on Diameters of "Go" Male and "Not Go" Female Thread Gages, Inch	Allowable Tolerance on Diameters of "Not Go" Male and "Go" Female Thread Geges, Inch
4 to 6	±0.0005	±0° to 5′	−0.0000 +0.0006	+0.0000 −0.0006
7 to 10	±0.0004	±0° to 5′	−0.0000 +0.0004	+0.0000 −0.0004
11 to 18	±0.0003	±0° to 10′	−0.0000 +0.0004	+0.0000 −0.0004
20 to 28	±0.0002	±0° to 15′	−0.0000 +0.0003	+0.0000 −0.0003
30 to 40	±0.0002	±0° to 20′	−0.0000 +0.0002	+0.0000 −0.0002
44 to 56	±0.0002	±0° to 30′	−0.0000 +0.0002	+0.0000 −0.0002
64 to 80	±0.0002	±0° to 30′	−0.0000 +0.0002	+0.0000 −0.0002

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example is 20, the tolerance for the diameters will be found in the space opposite the notation 20 to 28. This tolerance for the "Go" female gage is $\begin{matrix}+0.0000\\-0.0003\end{matrix}$ and for the "Not Go" female gage, $\begin{matrix}-0.0000\\+0.0003\end{matrix}$.

The next dimension desired for the ring gages is the core diameter. This dimension is given on the work itself as 2.435 inches, which is the outside diameter minus twice the depth of the thread. The core diameter of ring gages is the same for both "Go" and "Not Go" gages, but the tolerances differ; the latter are taken from the same column in Table 1 as the pitch diameter tolerances, and are applied in the same manner. The outside diameter of the thread in the gages clears the part to be gaged, and therefore no dimensions are necessary. It will be noted that the number of threads per inch is the governing factor for determining all tolerances.

The core diameter check for both ring gages is shown at *D* in the illustration. As both the "Go" and "Not Go" gages have the same basic core diameter dimension, 2.4350 inches, one check is sufficient for checking them. Accordingly, the "Go" gage dimension 2.4350 $\begin{matrix}+0.0000\\-0.0003\end{matrix}$ is used for the check diameter, as this is the smaller diameter of the rings on account of the minus 0.0003 tolerance. At *E* is shown the plain ring gage required for gaging the maximum outside diameter of the thread. This dimension is 2.5000 inches, and the tolerance $\begin{matrix}+0.0000\\-0.0004\end{matrix}$ is taken from Table 4 in the article "Snap, Plug, and Ring Gages," published in the November number of MACHINERY, the same as for standard tabulated rings. The view at *F* represents the snap gage required for the minimum outside diameter of the thread. The minimum outside diameter dimension equals 2.500 minus 0.006 or 2.4940 inches, and the tolerance $\begin{matrix}-0.0000\\+0.0004\end{matrix}$ is taken from the same table that was used to find the tolerance for the plain ring gage *E*.

The following gages are required for gaging the female thread on the work *A*: One plain "Go" and one "Not Go" plug gage for gaging the core diameter; one "Go" and one "Not Go" thread plug gage for gaging the pitch diameter. The thread plug gages are shown at *J* and *K*, the plain plug gages being shown at *G* and *H*. The dimensions for these gages are calculated in the same manner as the thread ring gage dimensions. The pitch diameter of the work is $1.659\ \begin{matrix}-0.000\\+0.008\end{matrix}$ and as *K* is the "Not Go" or maximum gage, the tolerance allowed on the work is added to the pitch diameter, making it 1.6670 inches. By referring to Table 1, the tolerance for 14 threads per inch is found to be $\begin{matrix}+0.0000\\-0.0004\end{matrix}$ on the diameter of a "Not Go" male thread gage; therefore the pitch diameter of *K* is $1.6670\ \begin{matrix}+0.0000\\-0.0004\end{matrix}$ inches. The outside diameter dimension on thread plug gages never varies from the basic figure given on the work itself, except the tolerances on the gage proper. The work shown in the illustration gives this dimension as 1.7050 inches and the tolerance on the gage $\begin{matrix}+0.0000\\-0.0004\end{matrix}$ which is taken from Table 1. As the core diameter on male thread gages is always cleared, no dimensions are necessary.

The gage shown at *J* is the "Go" or minimum gage for the internal thread. The outside diameter, or 1.7050 inches, is the basic dimension of the work, and the pitch diameter is the minimum pitch diameter of the work, or 1.6590 inches. Referring to Table 1 for "Go" male thread gages the tolerance is found to be $\begin{matrix}-0.0000\\+0.0004\end{matrix}$. The core diameter is cleared, the same as for the "Not Go" gage *K*.

A "Go" and a "Not Go" gage are required for the core diameter of internal thread work in order to hold the work within the limits allowed. The "Go" gage shown at *G* is a standard plug gage made to the minimum diameter allowed on the work, which is 1.612 inches. The tolerance on this plain gage is also taken from Table 4, in the article published in the November number, and as the tolerance on the work is 0.008 inch, the gage tolerance will be found opposite the work tolerance 0.006 to 0.010, and in Table 1 in the column for "Go" male and "Not Go" female gages. This value is $\begin{matrix}-0.0000\\+0.0004\end{matrix}$; therefore, the gage dimension is 1.6120 $\begin{matrix}-0.0000\\+0.0004\end{matrix}$ inches. The "Not Go" gage illustrated at *H* is a maximum gage which measures the largest internal diameter on the work, which is 1.612 inches plus the tolerance 0.008,

TABLE 2. TOLERANCES ON INSPECTION THREAD GAGES

Number of Threads per Inch	Allowable Variation in Lead in Effective Length of Gage, Inch	Allowable Variation in One-half Included Angle of Thread	Allowable Tolerance on Diameters of "Go" Male and "Not Go" Female Thread Gages, Inch	Allowable Tolerance on Diameters of "Not Go" Male and "Go" Female Thread Gages, Inch
4 to 6	±0.0006	±0° to 5′	+0.0006 +0.0015	−0.0006 −0.0015
7 to 10	±0.0005	±0° to 10′	+0.0004 +0.0010	−0.0004 −0.0010
11 to 18	±0.0004	±0° to 15′	+0.0004 +0.0008	−0.0004 −0.0008
20 to 28	±0.0003	±0° to 20′	+0.0003 +0.0006	−0.0003 −0.0006
30 to 40	±0.0002	±0° to 30′	+0.0002 +0.0005	−0.0002 −0.0005
44 to 56	±0.0002	±0° to 45′	+0.0002 +0.0004	−0.0002 −0.0004
64 to 80	±0.0002	±0° to 45′	+0.0002 +0.0004	−0.0002 −0.0004

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or 1.620 inches. The tolerance for the gage proper is $\begin{matrix}+0.0000\\-0.0004\end{matrix}$ as taken from Table 1; therefore the gage dimension is $1.620\ \begin{matrix}+0.0000\\-0.0004\end{matrix}$ inches.

The manufacturing tolerances allowed on threaded parts are given in Table 4 for loose, medium, and close fits, and may be used in connection with the diagram, Fig. 2. The example taken to illustrate the gage tolerances is intended for a medium fit; therefore the tolerances on the outside and pitch diameters of the male thread (see *A* Fig. 1) are, $\begin{matrix}+0.000\\-0.006\end{matrix}$ which will be found in Table 4, for medium fits, opposite the notation which corresponds to the number of threads in the screw, which in this case would be 20-28. In like manner, the core diameter tolerance is found to be $\begin{matrix}+0.000\\-0.010\end{matrix}$. The same procedure is followed in determining the tolerance on internal threads such as in nuts or tapped holes.

Neutral Space and Direction of Tolerances

Fig. 2 illustrates the condition of the neutral space found when the female part, or nut, has its minimum dimension, and when the male part, or screw, has its maximum dimension. The maximum screw is the basic size from which all dimensions are computed. All tolerances applied to the diameters on the screw are minus, and all those applied to the diameters on the nut are plus. The view at the right in Fig. 3 shows the method of dimensioning and the application of tolerances of a screw as they should be carried out on component drawings. The tolerances given for the screw are taken from the table of tolerances for medium fits (Table 4). At the left is shown the dimensions and tolerances of a nut which is the mate of the screw shown at the right. The minimum nut diameters are found by adding the amount of the neutral space (see Table 4) to the maximum or basic screw diameters.

The question of the class of fit, that is, whether a close, medium, or loose fit is to be chosen, depends upon the function of the parts. Consideration should be given to the accuracy required, and the particular class of tolerance should be chosen that best suits the conditions involved. Attention is called to the fact that the tolerances specified in the various classes of fits (Table 4) for the core diameter of a screw and for the outside diameter of a nut differ from those specified for the other diameters. This condition results in the possible production of a thread, the flat of which at the root may be less than that of a true U. S. standard thread (see Fig. 2). This condition, however, is permissible, as it allows additional wear on the cutting tools and thus expedites manufacture. The tolerances for the core diameters of screws and for the outside diameters of nuts are so proportioned as to allow taps and threading tools to be made with a flat which is but 75 per cent of the standard flat. In no case will these tolerances result in a thread which is cleared more than midway between the flat of a true U. S. form and a sharp vee.

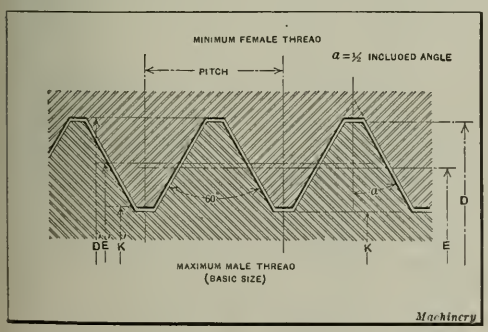


Fig. 2. Diagram showing Neutral Space between Maximum Screw and Minimum Nut

TABLE 3. TOLERANCES ON WORKING THREAD GAGES

Number of Threads per Inch	Allowable Variation in Lead in Effective Length of Gage, Inch	Allowable Variation in One-half Included Angle of Thread	Allowable Tolerance on Diameters of "Go" Male and "Not Go" Female Thread Gages, Inch	Allowable Tolerance on Diameters of "Not Go" Male and "Go" Female Thread Gages, Inch
4 to 6	±0.0006	±0° to 5′	+0.0015 +0.0025	−0.0015 −0.0025
7 to 10	±0.0005	±0° to 10′	+0.0010 +0.0020	−0.0010 −0.0020
11 to 18	±0.0004	±0° to 15′	+0.0008 +0.0015	−0.0008 −0.0015
20 to 28	±0.0003	±0° to 20′	+0.0006 +0.0012	−0.0006 −0.0012
30 to 40	±0.0002	±0° to 30′	+0.0005 +0.0010	−0.0005 −0.0010
44 to 56	±0.0002	±0° to 45′	+0.0004 +0.0006	−0.0004 −0.0006
64 to 80	±0.0002	±0° to 45′	+0.0004 +0.0006	−0.0004 −0.0006

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In order to prevent errors in the construction of gages and threading tools, a note should appear conspicuously on all part drawings, stating that the threads do not conform at the root to the U. S. form, owing to the additional tolerance allowance. It might be stated here that the tolerances on the outside and the core diameters could be greater than those given in the table on gage tolerances without making the threads dangerously weak, but the pitch diameter must be held as close as possible, as that is where a good fit is required.

Standard Thread Plugs

At *A*, Fig. 4, is shown a general design of thread plug gages used for gaging work up to and including 1 inch in diameter. For this size, a double-end gage is used on both thread and plain plug gages for measuring the core diameter. The gage is furnished with a standard hexagon handle made after the design shown in the illustration accompanying Table 2, in the article in the November number of MACHINERY. A single-ended thread plug gage is shown at *B* for use on work from 1 to 2 inches in diameter, inclusive. These plugs are too large to be made double-ended. A standard handle is used, having a bead turned at the plug end as shown, for identification purposes when used as a "Go" gage.

The plug gage at *C* is single-ended and of the built-up type. This type is used for gaging threads over 2 inches in diameter. The handle is beveled to an angle of 15 degrees on one end for identification purposes when used as a "Go" gage. At *D* is shown the detail of a standard handle for checks that are used for ring gages which gage work over 2 inches in diameter. Checks may be made double-ended, as the rings are intended to be kept together, and they should be screwed on the checks when not in actual use. When gaging work under 2 inches in diameter, the standard plain plug gage handles may be used for the checks. The same specifications that were given in the November number for plain plug gages apply to thread plug gages, but in addition the following information should be observed:

"*Not Go*" *Gages for Pitch Diameter Only*—All "Not Go" thread plug gages should be made as gages for effective or pitch diameter only. This necessitates the removal of the crest and root of the thread so that the dimensions of the outside and core diameters are less than those specified for

the "Go" gage. It may be stated that these dimensions of a "Not Go" thread plug gage should be the same as those specified for the corresponding diameters of the "Go" gage, with the exception that the tolerance to be applied on these diameters of the "Not Go" gage will be in a direction opposite to that of the "Go" gage. (See *J* and *K*, Fig. 1.)

The specifications which were given in the November number of MACHINERY for plain ring gages apply also to thread ring gages, but in addition the following information should be observed:

"Not Go" Gages for Pitch Diameter Only—All "Not Go" thread ring gages should be made as gages for pitch diameter only. This necessitates the removal of the crest and root of the thread so that the dimensions of the core and outside diameters are greater than those specified for the "Go" gage. It may be stated that the dimensions of these diameters for a "Not Go" ring gage should be the same as those specified for corresponding diameters of the "Go" gage, with the exception that the tolerance to be applied on the core and outside diameters will be in a direction opposite to that on the "Go" gage. (See *C*, Fig 1.)

Clearing Outside Diameter—On a thread ring gage the portion of thread which is above the outside diameter of a true U. S. standard form may be cleared to allow clearance in grinding and lapping. In no case, however, should the full diameter which results from this clearing be greater than the full diameter of a ring gage having a sharp V-thread of the same pitch and effective diameter as those which are specified for the gage.

TABLE 4. TOTAL MANUFACTURING TOLERANCES ON UNITED STATES STANDARD THREADS

	No. of Threads Per Inch	TOLERANCES ON SCREWS			Neutral Space Between Max. Screw and Min. Nut	TOLERANCES ON NUTS		
		D Outside Dia. Inch	E Pitch Dia. Inch	K Core Dia. Inch	Inch	D′ Outside Dia. Inch	E′ Pitch Dia. Inch	K′ Core Dia. Inch
LOOSE FIT	4 to 6	+0.000 −0.030	+0.000 −0.030	+0.000 −0.045	0.008	−0.000 +0.045	−0.000 +0.030	−0.000 +0.030
	7 to 10	+0.000 −0.020	+0.000 −0.020	+0.000 −0.030	0.006	−0.000 +0.030	−0.000 +0.020	−0.000 +0.020
	11 to 18	+0.000 −0.012	+0.000 −0.012	+0.000 −0.018	0.005	−0.000 +0.018	−0.000 +0.012	−0.000 +0.012
	20 to 28	+0.000 −0.008	+0.000 −0.008	+0.000 −0.012	0.004	−0.000 +0.012	−0.000 +0.008	−0.000 +0.008
	30 to 40	+0.000 −0.006	+0.000 −0.006	+0.000 −0.008	0.003	−0.000 +0.008	−0.000 +0.006	−0.000 +0.006
	44 to 56	+0.000 −0.004	+0.000 −0.004	+0.000 −0.006	0.002	−0.000 +0.006	−0.000 +0.004	−0.000 +0.004
	64 to 80	+0.000 −0.003	+0.000 −0.003	+0.000 −0.004	0.001	−0.000 +0.004	−0.000 +0.003	−0.000 +0.003
MEDIUM FIT	4 to 6	+0.000 −0.016	+0.000 −0.016	+0.000 −0.035	0.008	−0.000 +0.035	−0.000 +0.016	−0.000 +0.016
	7 to 10	+0.000 −0.012	+0.000 −0.012	+0.000 −0.022	0.006	−0.000 +0.022	−0.000 +0.012	−0.000 +0.012
	11 to 18	+0.000 −0.008	+0.000 −0.008	+0.000 −0.014	0.005	−0.000 +0.014	−0.000 +0.008	−0.000 +0.008
	20 to 28	+0.000 −0.006	+0.000 −0.006	+0.000 −0.010	0.004	−0.000 +0.010	−0.000 +0.006	−0.000 +0.006
	30 to 40	+0.000 −0.004	+0.000 −0.004	+0.000 −0.007	0.003	−0.000 +0.007	−0.000 +0.004	−0.000 +0.004
	44 to 56	+0.000 −0.003	+0.000 −0.003	+0.000 −0.005	0.002	−0.000 +0.005	−0.000 +0.003	−0.000 +0.003
	64 to 80	+0.000 −0.002	+0.000 −0.002	+0.000 −0.003	0.001	−0.000 +0.003	−0.000 +0.002	−0.000 +0.002
CLOSE FIT	4 to 6	+0.000 −0.008	+0.000 −0.008	+0.000 −0.025	0.008	−0.000 +0.025	−0.000 +0.008	−0.000 +0.008
	7 to 10	+0.000 −0.006	+0.000 −0.006	+0.000 −0.016	0.006	−0.000 +0.016	−0.000 +0.006	−0.000 +0.006
	11 to 18	+0.000 −0.005	+0.000 −0.005	+0.000 −0.010	0.005	−0.000 +0.010	−0.000 +0.005	−0.000 +0.005
	20 to 28	+0.000 −0.004	+0.000 −0.004	+0.000 −0.008	0.004	−0.000 +0.008	−0.000 +0.004	−0.000 +0.004
	30 to 40	+0.000 −0.003	+0.000 −0.003	+0.000 −0.006	0.003	−0.000 +0.006	−0.000 +0.003	−0.000 +0.003
	44 to 56	+0.000 −0.002	+0.000 −0.002	+0.000 −0.004	0.002	−0.000 +0.004	−0.000 +0.002	−0.000 +0.002
	64 to 80	+0.000 −0.0015	+0.000 −0.0015	+0.000 −0.003	0.001	−0.000 +0.003	−0.000 +0.0015	−0.000 +0.0015

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Application of Tolerances

The tolerances for thread gage diameters given in Tables 1, 2, and 3 are applied in such a manner that the tolerances permitted on the gages include part of the manufacturing tolerances allowed on the work. This insures that any work passed by the gages will be within the tolerance specified on the part drawing. The tolerances given also permit a gage that is not suitable for a master gage to be classified and used as an inspection or working gage. The application of the tolerances on the diameters of thread gages is exactly the same as that for plain gages. In connection with the tolerances for working thread gages, attention is called to the fact that if the tolerances given (especially those for lead and angle) are used, working gages which have been reduced by wear may be utilized as inspection gages.

Clearing Core Diameter—On a thread plug gage the portion of the thread that is below the core diameter of a true U. S. standard form may be cleared to facilitate grinding and lapping. In no case, however, should the core diameter which results in the clearing be less than the core diameter of a thread plug gage having a sharp V-thread of the same pitch and effective diameter as those which are specified for the gage.

The tolerances on lead are given in terms of an allowance for the effective length of the gage. This allowance depends

upon the number of threads per inch, as indicated in Tables 1, 2, and 3. For instance, a "Go" master thread gage is, say, 1.18 inches in effective length and has 12 threads per inch. The "Go" gage should be made 1.18 inches long, and the error in lead over two threads which are not further apart than 1.18 inches, should not, according to Table 1, exceed ±0.0003 inch. For the "Not Go" gage, the tolerances on lead will be the same as for the "Go" gage, with the exception that the effective length of the "Not Go" gage, or 1.18 inches, will be the actual length of the gage.

The tolerances on the included angle of thread gages, as given for the various pitches in Tables 1, 2, and 3, are on the basis of threads having straight sides. The equivalent deviations from the true thread form by such irregularities as concave sides, rounded crests and slight projections, should not exceed the tolerances allowed on the angle. The various elements of thread ring gages should be correct within the previously mentioned tolerances for thread gages. Thread ring gages may be standardized with reference to the fit on a plug gage that does not differ appreciably from the thread ring gage in its elements of lead and angle of thread.

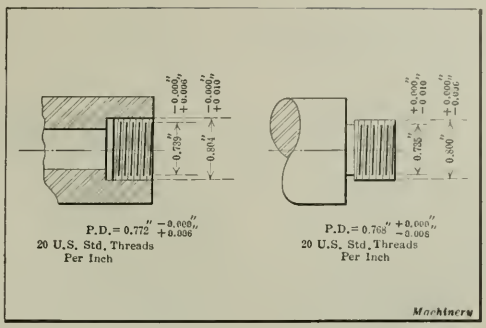


Fig. 3. Application of Neutral Space Dimensions to Thread Measurements

Measurement of Pitch Diameter of Thread Gages Using Three-wire Method

The various elements of thread plug gages should be correct within the variations allowed in the previous scale of tolerances when the measurements are made by reliable methods. In measuring the effective diameter of thread plug gages, the three-wire method of measurement in which the "best" size of wire is used, is well known and reliable. By the "best" size wire is meant the wire which touches at the mid-slope of the thread. For the U. S. standard form of screw threads the "best" sizes of wires for the various pitches are given in Table 5.

The set of three wires for use in measuring screw threads should each have the same diameter within 0.00005 inch. This common diameter, however, may vary from the "best" sizes as given in the table by as much as 0.001 inch, but preferably not more than 0.0005 inch. If there is any difference in diameter in the three wires, the two which are nearest the same size should be used on one side of the thread, and the mean value of the diameters of all three wires should be used in making the computations of the pitch diameter. The formula for use in computing the pitch diameter, where the "best" size of wire is used, is

$$PD = M + H - 3D$$

in which PD is the effective or pitch diameter, M the measurement over the wires, D the mean diameter of the wires, and H a variable value determined by Table 5.

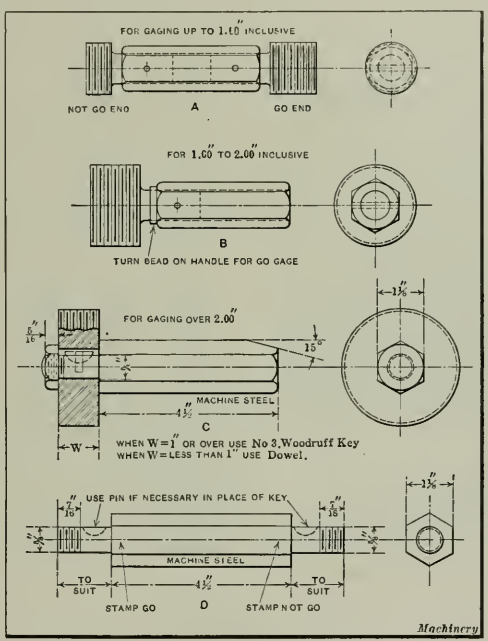


Fig. 4. Standard Thread Plugs

TABLE 5. VALUES FOR COMPUTING PITCH DIAMETER WHEN USING THREE-WIRE METHOD

Thds. per Inch	Best Wire Diameter	H	Thds. per Inch	Best Wire Diameter	H
80	0.0072	0.01083	14	0.0412	0.06186
64	0.0090	0.01385	13	0.0444	0.06662
50	0.0116	0.01732	12	0.0481	0.07217
44	0.0131	0.01968	11	0.0525	0.07873
40	0.0144	0.02165	10	0.0577	0.08660
36	0.0160	0.02406	9	0.0642	0.09623
32	0.0180	0.02706	8	0.0722	0.10825
28	0.0206	0.03093	7	0.0825	0.12372
26	0.0222	0.03331	6	0.0962	0.14434
24	0.0241	0.03603	5½	0.1050	0.15750
22	0.0262	0.03936	5	0.1155	0.17321
20	0.0289	0.04330	4½	0.1283	0.19250
18	0.0321	0.04811	4	0.1443	0.21651
16	0.0361	0.05413			

Machinery

Effects of Heat-treatment

Thread gages have given more trouble to manufacturers, possibly, than any other type of gage, since a considerable understanding of detail is required in their manufacture. Most gages are held to a 0.0003-inch limit, including the lead, and when the shape of the thread is examined by projecting it on a screen by means of a projection lantern, the difficulties of manufacturing thread gages of any design become apparent. Experience with several brands of non-shrinking steel has shown that quenching after heating lengthens the lead at least from 0.0025 to 0.0035 inch. It is difficult to understand why a gage should lengthen instead of shrink, and no satisfactory explanation has ever been given of this condition, as far as the writer knows. The steel used, of course, has a great deal to do with what happens in hardening, and some steels have a tendency to lengthen.

Lapping

Four sizes of laps should be sufficient. In the case of large size gages, for instance 2 inches or more in diameter, 0.005 inch of metal should be left for lapping, although it is the practice of some concerns to leave less, but in such cases there is the possibility that, due to hardening, the gages will not "clean up" in finishing. Some gage manufacturers grind the threads, which is an efficient process, but requires a grinding wheel of the correct shape and one that will hold its shape. There should be no great difficulty in this respect, however, since there may be found on the market various types of wheels which will hold their cutting edge. The wheel should

be wide enough and the fixture heavy enough to take care of possible vibration. A wheel ¼ inch in width and as large in diameter as the fixture will permit should be used, as the larger the diameter, the better the cutting edge of the wheel will hold.

Thread Gage Inspection Department Equipment

An outline of the equipment a thread gage inspection department should have to insure the highest possible grade of gages is given in the following: It should be equipped with (1) a pitch-measuring machine to read an error in lead of at least 0.0001 inch; (2) an appliance to take casts of ring screw gages, so arranged that the cast may be accurately set up in the pitch-measuring machine or in the projection apparatus; (3) a screw measuring machine to check the governing diameters of a punch screw gage to within an accuracy of 0.0001 inch, and an equipment of "best" diameter and maximum diameter wires and triangular pieces to be used in conjunction with the screw measuring machine; (4) thread micrometers, checked for accuracy, also for use in conjunction with the screw measuring machine; (5) ordinary micrometers for use in measuring outside diameters, and precision gage-blocks to insure the accuracy of the micrometers; and (6) a complete set of check plugs for the several diameters, pitch and form of thread in ring screw gages. The above equipment would be complete with a projection apparatus for observing the angle between the slopes of the thread, and the form of the entire thread.

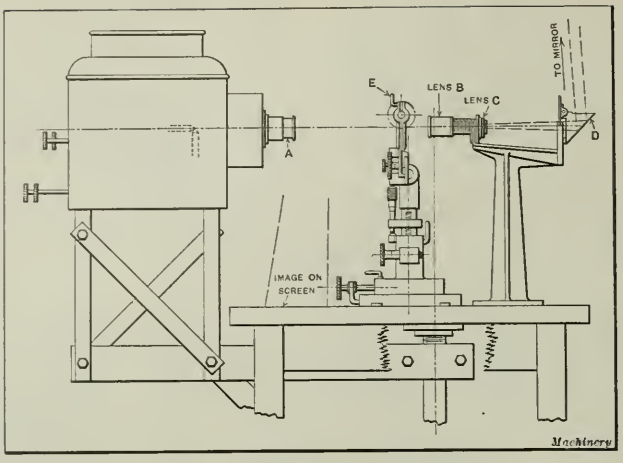


Fig. 5. Projection Lantern Apparatus used in inspecting Threads

Measurement of Screw Threads by the Shadow Projection Method

In principle, the use of the projection apparatus is as follows: The screw is placed in a parallel beam of light and an enlarged image of its shadow is obtained on a distant screen by means of a projecting lens. The screen is optically parallel with the axis of the screw and perpendicular to the axis of the projecting lens. The parallel beam of light must pass through the thread of the screw at the helix angle, so that the shadow cast will be that of a section made through the axial plane of the screw.

Referring to Fig. 5, which shows the assembly of the projection apparatus, the operation is as follows: The screw to be examined is supported on the stand *E* and occupies the position indicated by the dot-and-dash circle. If a male gage is to be measured, it is supported between the centers, and after the screw is fixed, the lamp is turned about the axis of its support, until it is in a proper position to provide that parallel rays of light from the lens *A* pass through the helix angle of the thread. This adjustment is made when the thread is slightly out of focus, as when the fringe pattern formed about the image of the screw is symmetrical, the correct position of the lantern has been secured. The position of the screw is then changed until the image on the screen has a sharp outline. The angle of thread is determined from the shadow by means of a suitable protractor, templet, or other device. The thread is also examined for imperfections in lapping, and in case it is desired, an exposure may be made with bromide paper, to record such details. In the apparatus shown, the projection is directed upward by the prism *D* to a mirror which is supported about 10 feet above the prism from which it is directed by the mirror vertically downward to the top of a table which forms the screen. The use of the prism and the mirror may be dispensed with, and the projection made directly on a vertical screen at the proper distance from the lens.

Examination of the thread form of ring gages is made by

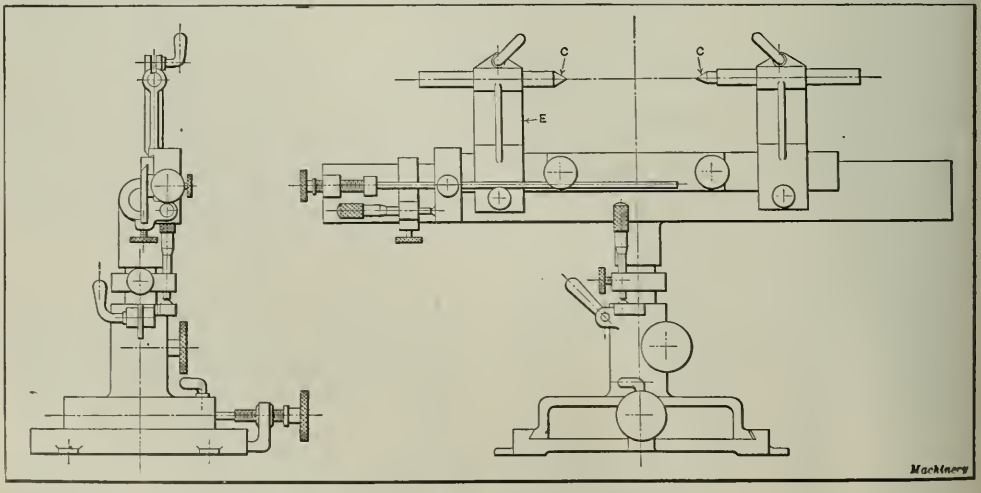


Fig. 6. Screw Gage Support used on Equipment shown in Fig. 5

making a cast of a segment of the thread. A mixture of about 1 part lampblack or graphite, and 18 parts sulphur, is heated to a fluid state and then poured into the lower side of a ring gage, which is held in a vertical position in a vise, and provided with suitable means of preventing the melted mixture from escaping. The threads are carefully cleaned so that the cast will represent the actual shape of the thread. Casts should not be poured deeper than ⅜ inch, on account of distortion caused by unevenness in cooling—shallow casts of a size sufficient for handling being preferable. Great care should be taken to prevent heating the sulphur or graphite beyond the melting point, as when overheated it becomes thicker, and imperfect casts may result. Very small casts should be mounted on a small block of wood with a drop of glue. Casts change shape gradually, and all examinations should be completed within three hours after pouring. The casts are supported in the apparatus by removing the gage support centers *C*, Fig. 6, and changing their ends so that the butt of each is resting against the cast. The use of the prism and a mirror enables one operator to adjust the screw and lantern conveniently and at the same time to be able to observe the image at close range. A 2½-inch aperture right prism will be found of sufficient size, and a mirror having a diameter of about 8 inches will be amply large. It is necessary to secure a prism whose three faces are accurately flat within one wave length of light, which corresponds to about 0.00001 inch. The same degree of flatness is required in the mirror, and in addition the mirror must be silvered on the front. A screw gage support, the assembly of which is shown in Fig 6, will be found convenient, as it has adjustments for focusing the screw, as well as for raising and lowering it, and also for shifting the screw parallel to its axis in order that different threads may be examined.

* * *

POSSIBLE IMPROVEMENTS IN LUBRICATION METHODS

By CHARLES A. TRASK

Now that the war is over, machine tool manufacturers have an opportunity to look into such possible improvements in their product as their experience and the experience of their customers—the users of machine tools—during the past few years have shown to be desirable or necessary. Recent developments in manufacturing methods have imposed greater strains and more severe conditions on machine tools than those to which they were subjected in the past. This severe usage has served to disclose any weak points existing in their design.

Among the various improvements that have been shown to be possible, those relating to lubrication methods assume an important place. As an example may be mentioned the countershaft equipment frequently furnished with machine tools. Although this equipment does not form an integral part of the machine itself, many manufacturers supply complete countershafts, and in many instances these countershafts are provided with universally adjustable hangers, as well as with means for making ample adjustment of clutches, and proper means for retaining the lubricant, etc. Countershafts of this type are appreciated by the machine tool buyer. If, on the other hand, he receives a countershaft having non-adjustable hangers fitted with cast-iron boxes provided with only an oil-hole for lubrication, he may form an unfavorable opinion of the machine because of the countershaft, in spite of the fact that the machine tool itself may be of the highest quality.

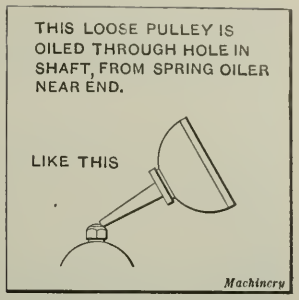


Fig. 2. Notice placed near Loose Pulley which shows Method of oiling

Countershafts, such as have been described, often cause considerable trouble due to improper lubrication and alignment. Loose pulleys which can be oiled only through a small oil-hole are almost certain to give trouble sooner or later, and it is not the man doing the oiling in the shop who should be blamed when the pulley sticks, but the designer who failed to make adequate provision for lubrication.

Improved Oiling System for Countershaft Boxes

Frequently, oiling devices are seen applied to loose pulleys, which, although quite elaborate in nature, fail to provide proper lubrication. A system which is furnished with a well-known make of machine tools has many excellent features, but due to a small point having been overlooked, the writer met with some difficulty in its use. These countershafts were supplied with cast-iron boxes in which oil cellars had been cast. In these cellars a small amount of cotton wick had been placed. There was not a sufficient amount of wicking to insure contact with the shaft, but the designer's intentions were all right. By removing the wick and pressing blocks of felt into the cellars with sufficient force to insure contact with the shaft, this difficulty was overcome, and in all probability no trouble will result from improper lubrication of the shaft boxes for several years, at least.

The loose pulley furnished with this equipment was provided with a pipe which screwed into the hub and extended through the rim. At the outer end, the tube, or pipe, was tapped and provided with a threaded plug intended to be removed with a screwdriver. The bore of the pulley was grooved for almost its entire length, the groove being ½ inch wide by ¼ inch deep. The oil-pipe connected directly with the oil-groove. The pipe and the groove would contain enough oil to lubricate the pulley for months, provided it could be retained and kept in contact with the shaft at all times; but in designing this oiling device the effect of centrifugal force had not been taken into consideration. As the loose pulley was intended to run at 450 revolutions per minute, the centrifugal force proved sufficient to throw the oil away from the shaft so that only at the noon and night shut-down were the contents of the pipe allowed to come into contact with the shaft, shortly before the pulley came to rest. If the oil-pipe happened to be above the horizontal position when the pulley stopped, the oil supply would diminish rapidly due to leakage between the shaft and the pulley. If the oil-pipe came to rest below the horizontal position it would retain all the oil and as a result no oil would be likely to reach the shaft until the next shut-down. Then, too, unless the screw plug were properly seated, the oil would leak.

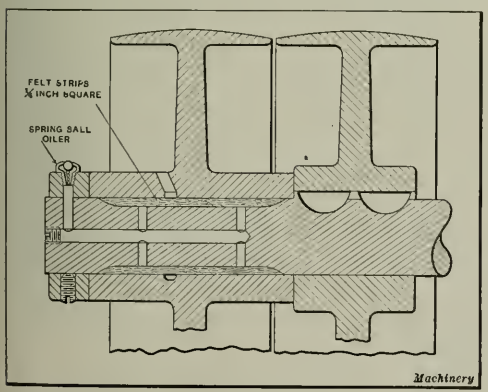


Fig. 1. Diagram showing Improved Oiling System for Loose Pulleys

It should be noted that the firm which furnishes the machine and the equipment seldom hears of these troubles. In cases like that cited, the machine builders could easily and inexpensively make the required improvements if the users of machine tools would inform the makers of such troubles.

Improved Oiling System for Loose Pulleys

A method of dealing with loose pulley trouble which has been found quite satisfactory is illustrated in Fig. 1. The writer has used this method of lubrication for many years on pulleys that were in constant operation. These pulleys fit as well today as they did when fitted up several years ago. When the loose pulley is close to the end of the shaft, a spring ball oiler is arranged in the cellar as shown, but when the pulley is so far from the end of the shaft that a very long hole would be required, a groove ¼ by 3/16 inch is cut all around the shaft under the oil-hole in the pulley. This permits both strips of felt to be thoroughly saturated at each application of oil. When the spring ball oiler is used, the notice shown in Fig. 2 is placed on a board and nailed up where the oiler will be sure to see it when he climbs up to oil the bearing.

Improved Oiling System for Spindle of Special-purpose Lathe

Some years ago several lathes were purchased from a firm with the understanding that the machines were to be operated at a higher speed than was common practice. These machines were finally delivered and they bore evidence of having been designed by an experienced and practical mind. The ends of the carriage where they came in contact with the ways were fitted with felt wipers and spring ball oilers; no back-gears were furnished or required. The cone ran loose on the spindle in the usual way, the spindle being picked up by a friction clutch operated by a hand-lever, and stopped by a brake operated by the same lever when the cone clutch was released; thus the cone rotated all day without stopping. Although liberally oiled through a screw plugged pipe, the cone stuck to the spindle three times during the first week it was in operation. The spindle was taken out each time, the bronze bushing scraped, and the lathe reassembled. The bore of the cone was about 13 inches long, and was bushed at each end with a bronze bushing about 5/16 inch thick and 4 inches long; thus the space for oil was about 5 inches long and 5/16 inch deep all around the spindle. This space held a large amount of oil, but at 700 revolutions per minute the oil held there was of no benefit; it is the writer's opinion that the arrangement would have been equally troublesome if the machine had been operated at only 250 revolutions per minute.

The trouble was remedied, however, by removing the bushings and drilling ten or a dozen 3/8-inch holes through each bushing. On the outside of the bushing helical grooves were cut running from each hole to the inside end of each bushing—right-hand helixes on the left-hand bushing and left-hand helixes on the right-hand bushing. Felt plugs, 3/8 inch in diameter and slightly over 5/16 inch long, were inserted in the holes before the bushings were replaced. This arrangement completely eliminated all further trouble, as the felt plugs were constantly saturated with oil and always in contact with the spindle. The same changes were made in the other lathes before putting them in service, and they have all operated satisfactorily.

* * *

INTERNATIONAL EXPOSITION OF INDUSTRIES

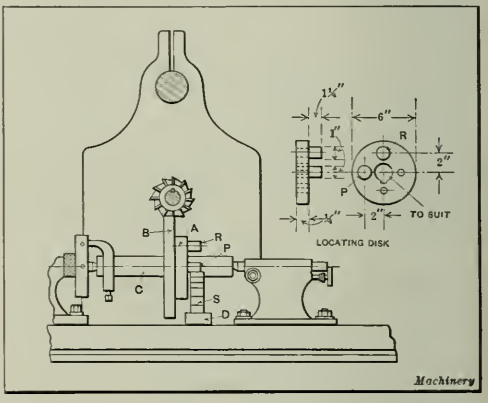
The management of the permanent exposition at the Grand Central Palace, New York City, announces that the organization of foreign exhibits has begun to assume tangible form. Contracts have been made for space for a permanent exposition of Swedish products, arrangements are pending for a Norwegian government exhibit, and negotiations with other countries are progressing. Two floors are given over to the exhibition of machinery of various classes. Farm tractors, trailers and agricultural machinery will occupy large space.

DIVIDING A DISK INTO EQUAL PARTS

By KURT MANRODT

The following method for dividing a disk into a given number of equal parts is mathematically correct. The work is performed on a milling machine, using an index-head and a locating disk which is made to suitable dimensions and to the design shown in the illustration. The locating disk should be accurately made, and the two plugs *P* and *R* should be precisely the same distance from the center of the disk and exactly 90 degrees apart.

In the example chosen for illustrating this method, it is required to cut thirteen notches in the circumference of disk *B*. This disk is clamped by suitable means to the locating disk *A*, both being concentric with the arbor *C*. The locating disk is so placed for the first cut that the center of plug *R* lies in the vertical center line of the arbor, which brings the center of plug *P* into the horizontal center line of the arbor, and, of course, parallel with the milling machine table. This is accomplished by placing a parallel block *D* on the table and using the proper gage-blocks *S* between the parallel block and plug *P*, to bring the indicating



Dividing the Periphery of a Disk into Equal Spaces

disk into the position mentioned. If the distance from the table to the horizontal center line is assumed to be 5 inches, and the thickness of the block *D*, 1 inch, then as *P* is 1 inch in diameter, the height of the gage-blocks is 3½ inches.

After the first notch has been cut with the disk in this position, the work must be revolved 1/13 of the circumference, or 27 degrees 41 minutes 32 4/13 seconds. This will result in dropping the position of plug *P* a distance equal to 2 × sin 27 degrees 41 minutes 32 4/13 seconds, or 0.9295 inch. This, then, represents the amount that must be taken from the 3½-inch stack of size blocks which leaves the height of the stack under plug *P*, 2.5705 inches. The index-head is then turned until this plug is pressed hard against the gage-blocks. The second notch is cut with the disk in this position, and the remaining cuts are spaced in practically the same manner, except that plug *P* is not used in every instance. As soon as the disk has been revolved more than 45 degrees, plug *R* is used to locate the succeeding notches, and when this plug has arrived at an angle of 45 degrees or more with the horizontal, the blocks are changed to the opposite side of the arbor and plug *P* is again used until it passes beyond the 45-degree angle from the vertical, at which time plug *R* is employed again. In this particular instance, the first, second, sixth, seventh, eight, ninth, and thirteenth cuts are located by means of plug *P*; while the third, fourth, fifth, tenth, eleventh, and twelfth cuts are located by means of plug *R*.

In using this method, it is best to prepare a table showing the plug to use for each notch, the height of the size-block stacks (exclusive of the parallel block *D*), and the angles corresponding to each notch.

Tool Salvage Department

Organization, Routine, and System of a Tool Salvage Department in a Modern Plant

By C. B. COLE, Chief Tool Inspector, Wright-Martin Aircraft Corporation, Long Island City, N. Y.

THE tool salvage department in manufacturing concerns is a comparatively new institution. Lately, however, many manufacturing concerns, and railroad and steamship companies have begun to realize the amount of tools, material, etc., that can be salvaged, thereby saving considerable expense and time. In modern manufacturing plants, large amounts of raw material, tools, fixtures, jigs, and gages can be salvaged and, with small cost, repaired to give further service by the adoption of a system such as here described.

The Tool Salvage Clerk

The man in charge of a tool salvage department should be a man who is thoroughly conversant with the tools, and also with the products that are being handled in the factory. Tools that are worn, broken, or otherwise damaged, can thus be passed upon as to their further serviceability. Tools that are rejected in the tool inspection department should be sent into the tool salvage department for final disposition.

The tool salvage man should have as much assistance as possible from the management of the factory in order to enable him to dispose of the tools properly. A tool salvage committee should be organized to cooperate with the salvage clerk. This committee should consist of at least three members, one from the tool design department, one from the tool-room, and one from the production department. A large saving in time and in the cost of replacing tools will be gained from a properly operated tool salvage department. All tools, jigs, fixtures, gages, etc., that are received in the tool salvage department from various other departments should be properly tagged to show the department, the foreman's name, and the purpose for which the part is used, so that these various parts can be properly disposed of by the tool salvage man.

Functions of the Salvage Department

The tool salvage man should first consider whether the tools received for salvage could be repaired and used again, or whether it would be cheaper to scrap them outright. In connection with the tool salvage department, two storage rooms should be established, one for active and one for obsolete tools, the purpose of the latter room being to take care of tools whose usefulness has been destroyed through changes in design, or tools that have been altered. All tools, etc., sent to either of these store-rooms should have the signature of the tool salvage clerk on the tag and any other data that it might be necessary for the tool salvage man to refer to.

It has been shown by experience in large plants that departmental foremen have often become prejudiced against a certain type of tool and have ordered that it be scrapped. The tool salvage man, nevertheless, may be able to offset this condition by proving the usefulness of the tool. Sometimes the blueprints specify that a tool should be made to unnecessarily close limits. If the tool inspector finds that tools are not up to the blueprint specifications, he rejects them, although the close tolerances specified may not be necessary. The tool salvage man, being thoroughly familiar with the function of all tools in the shop, would often decide to pass such tools without having any alteration or corrections made on them. On the other hand, if the blueprint should not show close limits on classes of tools such as gages, the tool inspector might decide to pass such tools without knowing the circumstances under which they were to be used, and poor production would be the result. The tool salvage department acts as a check against any occurrence of this kind.

In many large tool-rooms, standard, temporary, and semi-finished tools are allowed to accumulate, as well as pieces of high-speed steel and tool steel. These are often permitted to gather on or under the benches until they have been forgotten, finally becoming classed as junk and sold as such, at a considerable loss to the factory. In a modern plant, however, such tools and material are sorted and kept in a place provided for them, until they are properly disposed of by the tool salvage department. It has often been discovered, after a little careful consideration, that such tools and material can be used to advantage. This method has saved considerable expense to the companies that have adopted it. The advice and opinion of a tool salvage man who is thoroughly familiar with his duties has often proved of invaluable assistance to the tool designer and to the production supervisors in keeping down the cost of production.

DEFECTIVE MATERIAL No. 115442

Date	From Dept.	Job No.	Part No.	Collector's Receipt
Emp. No.	Quantity Defective	Name of Part		
Supplier			Purchase Order No.	Receiving Report No.
Nature of Defects			X	Scrap
				Accept
				Corrective Order
				Repair
			Original	Dept.
				Corrective Order
			Caused in Dept. No.	Return
Def. Oper.	Last Oper.	Tools	Material	Inspected and Coucted by
				Shipping Order

Machinery

Fig. 1. Defective Material Slip

Instruction and Routine under which a Modern Salvage Department is Operated

The following is an outline of the instruction and routine under which a salvage department of a certain large plant operates, and may serve, with proper modifications and changes, to meet the needs of other large plants. Many of the tools used in this particular plant are furnished by outside sources, that is, by venders. The tool salvage department consists of

a chief salvage clerk and any other necessary help, such as clerks and stenographers. This department is not a storage crib, and all material sent there for final disposition is disposed of as promptly as possible. Tools that are to be returned to the vender, are not held longer than forty-eight hours without an inquiry being made as to the delay in delivery. Tools that are received in the salvaging department are disposed of by being returned to the vender, repaired or corrected in the tool-room, or sent to the tool distribution crib, the obsolete tool-crib, the tool storage, or to scrap.

2439—7500—11-30—18

TOOL INSPECTION RECORD

TOOL NUMBER | Tool Name | ORDER NUMBER

Part No. | Part Name

RESULT OF INSPECTION

	DATE	Passed	Rejected	Inspected by	REASON FOR REJECTION
FIRST INSPECTION					
SECOND INSPECTION					
FINAL INSPECTION					

Delivered to | By | Date

Remarks:

Machinery

Fig. 2. Tool Inspection Record

The chief salvage clerk reports directly to the chief tool inspector. The former acts on the final disposition of all tools, both durable and non-durable, that have been rejected by the tool inspection department. When a tool that has been rejected by the tool inspection department is accepted by the salvage man, notation is made on the defective material tag, Fig. 1, a duplicate copy of which is filled out, detached, and filed in the tool salvage crib, and all other tags or papers are forwarded to the tool distribution man.

The salvage clerk also finally disposes of all semi-finished tools received from outside sources, as well as special tools that have been made or used by the vender on fabricated parts. All tools received from outside sources, if rejected by the tool inspection department, are sent to the tool salvage department, accompanied by the properly filled out defective material tag. All necessary information regarding the reason for rejection is filled in on the tool inspection record slip, Fig. 2, which together with the receiving slip and other information that may be of value, is sent to the salvage clerk to guide him in disposing of the tools. If several tools are received from an outside vender, and some of them are rejected by the tool inspection, the entire quantity, both passed and rejected, is sent to the chief salvage clerk who decides as to the disposition of the rejected tools.

When an entire lot or shipment of tools received from outside sources has been rejected by the tool inspection department, the tool salvage department makes out a deduction notice, Fig. 3. There are seven copies of this form, which must be properly made out, showing the reasons for rejection and the disposition of rejected tools. One copy is retained in the tool salvage crib for its files, while the other copies, and all other accumulated papers, are forwarded to the purchasing department as a request for a shipping order. Upon receipt of the shipping order, all tools are delivered by the salvage department to the shipping department, which returns them to the vender.

All tools that are obsolete, worn, or broken are also sent to the tool salvage department from various parts of the shop, and disposition is made of them. Tools that have been declared obsolete are not to be used on production; they are entered on the records in the tool salvage crib and turned over to the tool distribution crib for proper storage in the obsolete tool crib. These tools in all cases are accompanied by the defective material tag. When tools become worn or broken, or when for any other reason it becomes necessary to scrap them, the tool salvage clerk examines them carefully, to ascertain if they can be repaired, or if it would be more profitable to scrap them. All scrapped tools also have a defective material tag attached to them. In all cases the tool salvage clerk should secure the signature of the proper authorities before such tools are sent to scrap. The condition of the tool received by the salvage department clerk is stated on the tag or in some other way by the tool inspection department, before it is disposed of.

The tool salvage clerk makes final disposition of all tools that do not come up to the blueprint specifications. If he does not believe that he can arrive at a reasonable decision in regard to the rejected tools, he calls in the salvage committee to act in conjunction with him, and he assumes full responsibility for prompt disposition of the tools after a decision has been reached. In general, the salvage clerk should make the final disposition of the tools received in his department, after determining the following points:

(1) Whether the tool rejected by the inspection is within the tolerance allowed for production.

(2) If the tools are not made to blueprint specifications, whether or not they are made to limits that would allow them to produce good work, and whether or not they should be given a trial.

(3) Whether the basis on which the tool is contracted for from outside sources is an hourly rate, or on a contract price. This information is obtained from the purchase order files in the tool construction department.

When a tool is made by an outside source on a contract price, it should, in all cases possible, be returned to the vender for correction, unless the need for it is very great. When the salvage department receives tools that are made by an outside source on an hourly rate, they are thoroughly investigated to see whether or not they are actually needed, and whether it would be better policy to have them repaired at the firm's expense or return them to the vender to be repaired.

When any tools are received in the tool salvage department and a change has been made in the blueprints or designs, rendering those tools useless for production, the salvage clerk ascertains whether or not the vender was given proper notice of the change of design. If the vender is found not to be responsible, the salvage clerk accepts the tools and then examines them to see if

Received from | Part No. | Purch.Ord.No. | Date | No.

Article Received | Vendors Ref.No. | QUANTITY: Received | Sent to Stores | Rejected | Held for Cor.

Receiving Report — Disposition Made By | Checked By (Gov't) | DEDUCTION NOTICE

Accounting Dept. Copy / Deduction Authority	Quantity	WHY REJECTED	Quantity	DISPOSITION OF REJECTED

Form 1340 1 10-M-8-18 | Amount of Your Invoice | We Deduct above Amt. for Above Rejections at Your Price to Us | Date of This D.N. | Made out By | Above is the Amount of Your Invoice Less This Deduction

Date of Inv. | Your Inv. Reg. No. | Deducted from Inv. | Your Invoice Is Approved for this Amount

Machinery

Fig. 3. Deduction Notice for Vender

they can be altered in the tool-room, so that they may be used. If they cannot be used, the tools with all information pertaining to them, are turned over to the tool distribution for final storage.

The tool salvage department should not keep complicated records. One copy of the receiving slip for all of the tools, both passed and rejected, received from outside sources, is filed under the tool number in numerical sequence. A copy of the defective material tag is filed on all material while it is passing through the tool salvage department. The department clerk renders a progress report at the end of each day, showing the receipt and actual deliveries or other disposition, and always keeps a record of the number of tools held in the salvage department. One copy of this daily progress report is sent to the tool superintendent, one to the accounting department, and one is filed for record. A similar statement is also made at the end of each week, copies of which are sent to the factory manager, the chief tool inspector, and the department file.

* * *

BUYING SECOND-HAND MACHINERY FROM THE GOVERNMENT

By DONALD A. HAMPSON

The Government has on hand vast quantities of machine tools which have been appraised in an admirable manner and which it pretends to want to sell. The inducement to buyers naturally must be that of price, because there is no other reason why one should buy from the Government rather than from the dealer, whose guarantee is of considerable value.

In going over the charts used in appraisal, one cannot fail to be impressed with the fair and comprehensive system adopted; but after the appraisal has been made, one would expect that every machine offered for sale would be tagged with the appraisal value or price. Then the buyer could consult the list, inspect the machine, and be guided by the conclusions thus arrived at. Nothing could be simpler or fairer. Some of the salvage boards have, in fact, handled the matter in this manner—notably some in the Middle West—but one of the boards located in the East has followed an entirely different policy. Statements of facts are better than statements of opinion, and for this reason the writer will merely indicate the experience that he has had in trying to obtain some machine tools in Bridgeport, Conn.

There were eight of these tools listed by the Government—two of them used. The writer's firm had a job in view which could be done very nicely on one of these machines, and it was decided to buy one of them and ask for a price for the entire lot, as the needs of replacement and future expansion might make it worth while to keep the tools in storage for some time. The machines were of a type too light for general manufacturing purposes and had always been made to order by their manufacturer, who states that there are only six shops in the country that have work for this type of machine. The itinerary for the transactions with the Government were as follows:

September 26. Visited Bridgeport, saw machines, was told by officer seen to bid whatever they were worth to us. Incidentally, saw friends who said that six dealers had put in bids for the machines at $150 for the second-hand ones.

September 27. Sent in bid for one used machine at $300. Check enclosed.

September 29. Bid rejected as too low.

September 29. Bid $350.

October 3. Bid rejected as too low.

October 3. Bid $400.

October 9. Bid rejected as too low.

October 9. Telephoned Bridgeport asking what price was settled upon for the machine.

October 11. Letter from Bridgeport saying that bid was about $100 too low.

October 13. Bid for $500. Check enclosed.

October 17. Bid rejected as too low.

October 18. Sent letter asking for an explanation of statement that $400 was $100 too low.

October 21. Received letter ignoring ours of October 18, but saying that the machine was a "new" machine.

October 28. Noticed that one of the second-hand machines had disappeared from the weekly bulletin.

November 13. In the latest Bridgeport Board's list to hand on that day saw all eight of the original machines listed as in the beginning.

November 14. Decided to try once more by bidding $600 for one of the used machines, having ascertained from the charts meanwhile that, based on the present new price and the Government's statement of use, the machine should be appraised at $592.

November 28. Bid rejected. Accompanying note says that the machine is valued at $690.

December 4. Letter saying $690 is too low, but can have machine for $700.

This is the end of the story. The job that our firm had in view has been finished on other machines. The price of $700 is entirely too high. Based upon the estimates of dealers—names including some of the best known machine tool dealers in the United States could be mentioned—the original bid of $300 was a fair value. These eight machines will probably stand for years just where they are, unless one of the six concerns in the United States that use that class of tools should be willing to pay an exorbitant price, which they are not likely to do. This is the weak point in the appraisal system which does not appear on the surface—no account of *demand* is taken into consideration.

As it appears to the writer that it is only one or a few of the salvage boards that handle their transactions in the manner outlined, this experience should not be taken as a criticism of the Office of the Director of Sales at Washington, but merely as an account of the manner in which one of the subordinate boards handles its sales, and if the detailed account given herewith will help to place the selling of the Government machine tools on a more rational basis, the purpose of this article will have been achieved.

* * *

SAVING THE COST OF A DRILL JIG

By S. B. ROYAL

The following method of providing a means for locating and centralizing the drill when drilling parts such as shown at *A* and *B* may be employed to advantage if absolute accuracy is not required in spacing or locating the holes. The method consists of providing the molds with conical shaped projections which produce small pockets in the castings or forgings at the points where holes are to be drilled. A centralizing pocket formed in this way is shown in the enlarged view at *C*. This method eliminates the necessity of providing a drill jig, and also enables the work to be done more rapidly than if a jig were used or if the work were laid out by the usual method.

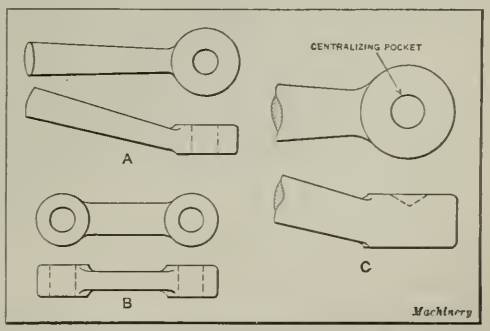


Illustration showing Pocket formed in Casting or Forging for centralizing Drill when drilling Parts such as shown at A and B

Practice in Making Component Drawings for Interchangeable Manufacture

First of Two Articles on the Application of the Principles of Dimensioning Drawings and Indicating Tolerances

By EARLE BUCKINGHAM, Engineer, Pratt & Whitney Co., Hartford, Conn.

AS a practical and specific illustration of the principles governing the dimensioning of component drawings set forth in preceding articles, a small unit assembly showing the percussion firing mechanism for a large cannon is taken as an example. This particular mechanism is chosen because it is composed of a small number of parts; also because it contains several examples of comparatively unusual conditions. In studying the various component or detail drawings to be referred to, the relation between the methods of dimensioning, the tolerances and clearances specified, and the functional requirements of each part should be carefully considered.

Drawing of Firing Mechanism Assembled

The assembly of this mechanism is shown in Fig. 1. The operation is as follows: The firing mechanism container assembled must be withdrawn before the breech of the cannon can be opened, and cannot be replaced until the breech is closed. (The safety mechanism controlling this is not shown on this drawing). While this assembled container is being withdrawn, a primer *A* is inserted in the primer extractor. This primer is held in place by the pressure of the firing pin guide spring acting against the firing pin guide *B*. After the breech has been closed again, the container *C* with the primer is inserted into the housing *D* and screwed home by hand. The primer must seat tightly on the sharp taper in the spindle plug *E*. A lanyard is attached to the striker *F* with a connection that slips off when the end of the striker is withdrawn beyond the end of the container cover *G*, thus allowing the striker to move forward at the proper moment under the impulse of the firing spring *H*. The firing pin transmits the blow of the striker to the primer, thus detonating it and igniting the charge in the cannon.

Functional Requirements of the Mechanism

The following functional conditions must be maintained: The primer must be seated in the spindle plug in such a manner that no gases can escape when the gun is fired. Any leakage of these gases, which are at a very high temperature and under high pressure, will quickly erode or burn out the parts of the mechanism, thus destroying its effectiveness. This requires that the surfaces of the seat for the primer be smooth and that its dimensions be maintained within close limits. The blow imparted by the striker must be sufficient to insure that the primer will always be detonated, since the sole object of the mechanism is to detonate the primer. In order to insure this result, the firing pin must always protrude, in operation, a certain minimum distance (determined by experiments), while, in order not to pierce the primer cup, it must never protrude beyond a certain maximum distance (also determined by extensive experiments). The various unit assemblies of the mechanism must be interchangeable in order to allow quick replacements in service—a very vital requirement. As far as proves economical, the various component parts of the unit assemblies should be interchangeable to permit ready repairs in service. Unless noted otherwise, the parts of this mechanism must be interchangeable. These are the most important of the functional requirements. Others will be discussed as they arise in connection with the details.

Drawing of Firing Pin Guide

A detail drawing of the firing pin guide is shown in Fig. 2. The outside diameter is 0.782 inch plus 0.000, minus

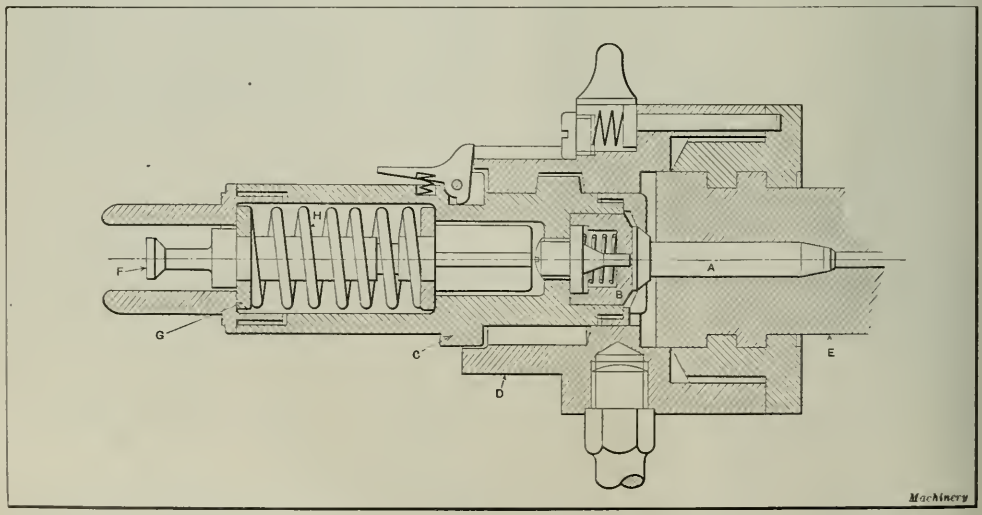


Fig. 1. Firing Mechanism assembled

0.003. This guide must be an easy slide fit in the container. It has a minimum clearance of 0.002 inch, as will be seen by a comparison with that part of the container (see Fig. 7) which receives the guide. With a tolerance of 0.003 inch on each part, it has a maximum clearance of 0.008 inch. With a reasonably smooth finish, such as that obtained by a finishing cut on the guide and a finish-reaming operation on the hole in the container, these clearances will maintain the conditions required.

The firing pin must be an easy slide fit in the guide. The diameter of the firing pin hole is 0.118 inch plus 0.003,

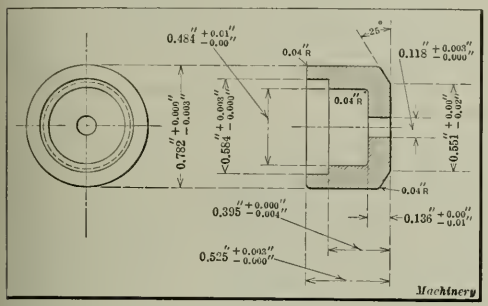


Fig. 2. Firing Pin Guide

minus 0.000. The diameter of the firing pin is 0.117 inch plus 0.000, minus 0.003; hence the minimum clearance is 0.001 and the maximum clearance (with tolerance of 0.003 on each part), 0.007 inch. With a reamed finish in the hole and a finishing cut on the pin, these clearances will maintain the proper conditions.

The diameter of the large counterbore in the rear of the guide is 0.584 inch plus 0.003, minus 0.000. The flange of the firing pin must be an easy slide fit in this counterbore. The diameter of the flange is 0.582 inch plus 0.000, minus 0.003; therefore the minimum clearance is 0.002 and the maximum clearance, 0.008 inch. With a reamed finish in the counterbore and a finishing cut on the flange of the firing pin, these clearances will maintain the proper conditions.

The diameter of the smaller counterbore is 0.484 plus 0.01, minus 0.00. This counterbore contains the firing pin guide spring. The minimum clearance is 0.020 and the maximum clearance 0.040 inch. It is apparent that this surface is of minor importance. The only limit to the increase in diameter of this surface is controlled by the width of shoulder at its mouth which is needed to act as a stop for the firing pin. The basic width of this shoulder is 0.05 inch; the tolerance on the counterbore diameter is 0.01, thus reducing the effective width of the shoulder by 0.005 inch. The tolerance specified should be sufficient to enable this counterbore to be finished in one cut. No finishing operations are necessary on this surface either for smoothness or accuracy.

An Exception to the General Rule for Basic Dimensions

The length of the guide (Fig. 2) is 0.525 inch plus 0.003, minus 0.000. This dimension is an exception to the general rule of making the basic dimension represent the maximum metal conditions, because of the functional conditions which must be maintained in this case. When the firing pin and the guide are seated solidly in the container, the face of the guide and the end of the firing pin should be as nearly flush as possible. Under no conditions must the firing pin project, because any such projection makes possible a premature explosion of the primer. The basic dimensions on the firing pin and guide are identical for this point, thus making these surfaces flush under basic conditions. The direction of the tolerances in each case is such that the pin can never project. This method of dimensioning, therefore, adheres to the principle of making the basic dimensions represent the danger point, while the direction of the tolerance is such as to move away from this danger point. On the other hand, there is another danger point in the other direction, although not as serious a one as the first. In such cases, the basic dimension should always represent the more dangerous point, while the tolerances should limit the extent of the other. In this case, the second danger point is that the end of the firing pin should be held as nearly flush with the face of the guide as possible so as not to form a pocket into which the primer cup might be forced under firing conditions. If this happens, it is very difficult to remove the exploded primer. This may retard the rate of fire and possibly put the gun out of action. The tolerances on these dimensions limit the depth of this pocket to 0.006 inch which is as great as is considered safe. The front face of the guide must be smooth; a polished surface is desirable, as this facilitates the insertion and removal of the primers.

The dimension from the bottom of the large counterbore to the front face is 0.395 inch plus 0.000, minus 0.004. This dimension controls the protrusion of the firing pin and is therefore the dimension to be maintained. Experiments show that the firing pin should protrude at least 0.026 inch in order to insure detonation, while it should not protrude over 0.034 inch or there will be danger of piercing the primer cup; therefore, the corresponding length of the firing pin is made 0.421 inch which gives the minimum protrusion of 0.026 inch while the tolerance of 0.004 inch applied to each part limits the maximum protrusion to 0.034 inch.

Maintaining a Common Locating Point

Inasmuch as the important functional dimensions of length are given from the front face, the bottom of the small counterbore is also located from that surface so as to maintain one common locating point. This surface is unimportant; a dimension of 0.136 inch plus 0.00, minus 0.01 is specified, which should give wide enough limits to enable it to be machined in a single cut.

The bevel at the front of the guide is provided to assist in the insertion of the primer. The diameter of the intersection of this bevel with the front face is given as 0.551

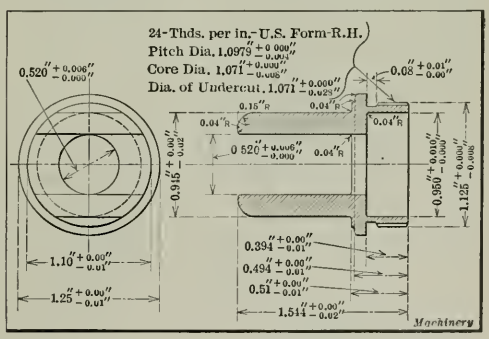


Fig. 3. Firing Mechanism Container Cover

inch plus 0.00, minus 0.02. These limits should be wide enough to meet any normal manufacturing conditions. The surface of the bevel must be smooth; a polished surface would be desirable. The angle of the bevel is given as 25 degrees. No tolerance is specified, as the permissible variation is controlled by the tolerance given for the face. The angle of the corresponding surface of the primer extractor is 14 degrees. The angle on the guide is made greater to insure that the forward corner of the guide will not project above the bottom of the primer slot in the extractor. Any such projection would interfere with the ready insertion of primers.

No tolerances are given for the radii of the corners of the guide. In the first place, a reasonable variation is

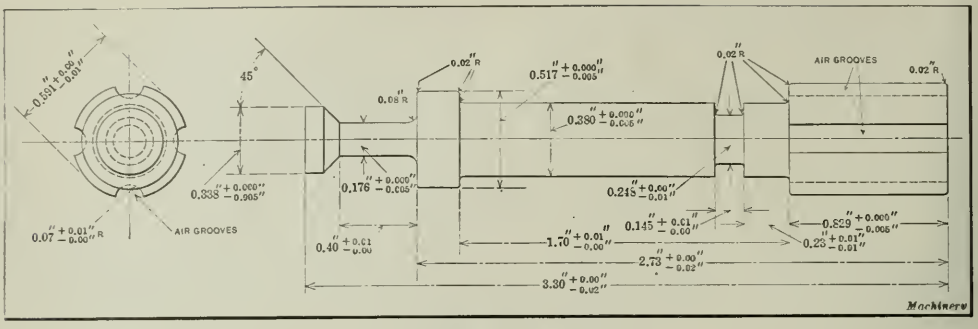


Fig. 4. Striker of Firing Mechanism

already established for them by the tolerances given on other dimensions. In the second place, their exact contour is of no importance, their purpose being to remove the sharp corners. A straight bevel of the same dimensions would be as effective.

Drawing of Firing Mechanism Container Cover

The thread of the container cover screws into the container and must be set up as tightly as possible. The outside diameter of the thread is 1.125 inch plus 0.000, minus 0.008 (see Fig. 3). The pitch diameter is 1.0979 inch plus 0.000, minus 0.004. The minimum clearance is 0.000 and the maximum clearance on the pitch or effective diameter, 0.008 inch, as will be seen by comparing Figs. 3 and 7. This tolerance should be kept as small as normal manufacturing methods will permit.

The diameter of the flange is 1.25 inch plus 0.00, minus 0.01. This surface is an atmospheric fit and of little importance, as regards either smoothness or accuracy; hence it should be completed in a single machining operation. The diameter of the stem is 1.10 inch plus 0.00, minus 0.01. This surface is an atmospheric fit and should be machined in a single operation. The distance across the flats on the stem is 0.945 inch plus 0.00, minus 0.02. This surface is for the wrench used in assembling and is of little importance. It should be machined in a single operation by a straddle-milling tool.

The diameter of the hole and the width of slot is 0.520 inch plus 0.006, minus 0.000. These surfaces are for the striker and lanyard connection. They should be as smooth as careful reaming and finish-milling operations will leave them. The hole and the slot must be matched so that no shoulder will be left at their intersection, which would retard the striker in its action. This will probably require a slight filing operation to match the cuts properly. The tolerance given should be sufficient to meet all normal manufacturing conditions. The diameter of the counterbore is 0.950 inch plus 0.010, minus 0.000. This counterbore forms a seat for the spring seat washer and is relatively unimportant. It should be finished in a single operation with a counterbore. The surface left by such a tool will be as smooth as is necessary.

All Length Dimensions Given from Logical Working Point

The dimensions of length are all given from the front surface. From a functional viewpoint, there is little choice between this surface and any of the others. The manufacturing operations will be simplified by the maintenance of one common working point. As the front surface is the logical working point, this has been chosen.

The length of the thread is 0.394 inch plus 0.00, minus 0.01. The width of the recess is 0.08 inch plus 0.01, minus 0.00. The requirements of these dimensions are that there shall be sufficient threads to hold the cover in position and that the length of this stem shall be less than the depth of the recess in the container, as the cover must always seat on its flange. The depth of the recess into which the thread projects may extend about 0.01 inch below the bottom of the threads to give a suitable clearance for threading. Also, the end of the stem and edge of the recess may be beveled about thirty degrees to facilitate this operation. The depth of the counterbore is identical with the length of the threaded stem. This depth is of relatively small importance.

The location of the rear face of the flange is 0.494 plus 0.00, minus 0.01. This surface is an atmospheric fit and should be finished in a single operation. The bottom of the wrench cuts is 0.51 plus 0.00, minus 0.01. This is a clearance surface of little importance. It is left above the rear surface of the flange to eliminate all matching operations. The bottom of the slot is located by these same dimensions, and its surface is of equal unimportance.

The length over-all is 1.544 inches plus 0.00, minus 0.02. The rear surface of the cover is an atmospheric fit of minor importance. No tolerances have been specified for any of the radii, as their exact contour is of no importance. Their purpose is to remove the sharp corners. Furthermore, sufficient variations have been established for these radii by the tolerances on other dimensions.

Drawing of Striker

The diameter of the front end of the striker (see Fig. 4) is 0.591 inch plus 0.00, minus 0.01. This surface must clear the counterbore in the container (see Fig. 7). The minimum clearance is 0.019 inch and the maximum clearance 0.039 inch. The radius of the air grooves is 0.07 inch plus 0.01, minus 0.00. No finishing cuts are required on these surfaces. The stem which has a diameter of 0.38 inch plus 0.000, minus 0.005, must be a free sliding fit in the spring seat washers. The minimum clearances are 0.002 inch and the maximum 0.012 inch. This stem must have a smooth surface, such as will be secured by a finishing tool.

The rear shoulder which has a diameter of 0.517 inch plus 0.000, minus 0.005, must be a free sliding fit in the cover. The minimum clearance is 0.003 inch and the

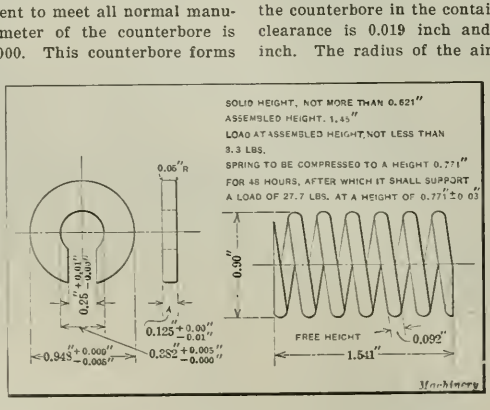


Fig. 5. Spring Seat Washer

Fig. 6. Firing Spring

maximum clearance 0.014 inch. This surface must be as smooth as a careful finishing cut will leave it. The length of the front end (0.829 inch plus 0.000, minus 0.005) should be held within reasonably close limits in order to insure a uniform blow on the firing pin. Variations in this dimension will affect the force of this blow. The front face of the striker must be as smooth as a finishing cut will leave it. The length of the stem (1.70 inches plus 0.01, minus 0.00) should also be held within reasonably close limits, as it controls, to a certain extent, the force of the blow of the striker. This stem could be machined with a form tool, the roughing tool being made to form the neck for assembling the washers. The neck is, therefore, located from the front end of the stem, the dimension being 0.23 inch plus 0.01, minus 0.01. The width is 0.145 inch plus 0.01, minus 0.00. These limits should be adequate to permit this groove

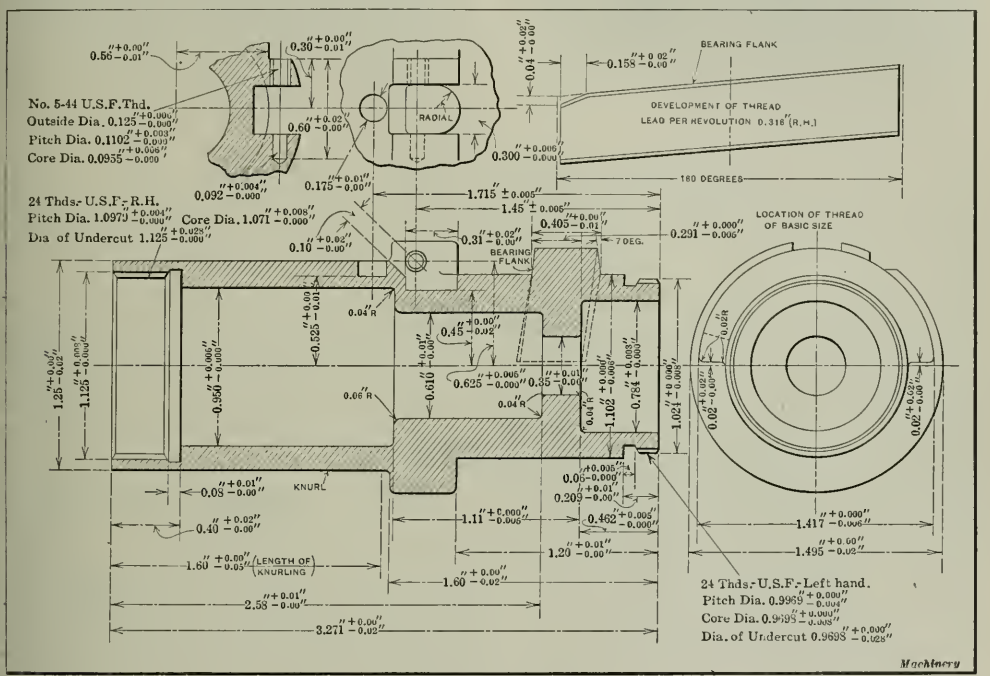


Fig. 7. Firing Mechanism Container

to be finished with a roughing tool without any unnecessary refinements.

The location of the rear shoulder from the front end (2.73 inches plus 0.00, minus 0.02) and the width of the bottom of the groove (0.40 inch plus 0.01, minus 0.00) are relatively unimportant. The surfaces, however, must be reasonably smooth ones such as are obtained with a finishing tool. These limits should be sufficient for all manufacturing purposes. The length over all (3.30 inches plus 0.00, minus 0.02) is also relatively unimportant. A sufficiently smooth surface for the rear end will be obtained with a cutting-off tool.

No tolerances are given for the 45-degree bevel at the rear end, nor for the radii, because none are required. A reasonable variation is already established by tolerances given on other dimensions. Sufficiently accurate radii will be obtained by touching with a file the various corners which are not broken by form tools, to remove the sharp edges.

Drawing of Spring Seat Washer

If a large number of spring seat washers (see Fig. 5) were to be manufactured, they might be made in a punch and die. The surface obtained in a well made sub-press die would be sufficiently smooth, but the surface obtained on the usual punch press in an open die would probably require some polishing. For a small number of parts, bar stock could be used. The surface obtained with a finishing tool would be satisfactory.

The hole must be a free sliding fit on the stem of the striker. The minimum clearance is 0.002 inch and the maximum clearance 0.012 inch. A surface equal to that obtained with a reamer should be secured. The width of the assembling slot is unimportant. The faces of the washer are of but minor importance. The original surface of flat stock, if that is used, or the surface obtained with a cutting-off tool, if bar stock is used, will be satisfactory.

Tolerances are not needed for the radius of the corners, but enough of the corner must be removed to permit the washer to seat properly in the counterbore in the cover. It will be satisfactory to remove this corner on a polishing wheel or with a file in the lathe.

Drawing of Firing Spring

No tolerances are given on the dimensions of the firing spring (see Fig. 6), because the functional requirements are covered by the weight specifications, and the manufacturer is allowed reasonable latitude in these dimensions as long as the weight requirements are maintained. The dimensions given are nominal. A variation of 0.005 inch in the diameter of the wire, or of 0.030 inch in the diameter of the coils or free length of the spring will be of no moment. If these tolerances were expressed on the drawing, some manufacturer would complain that the weight specifications would not allow him to take full advantage of them, and would seek to have the weight requirements altered or removed. These weight conditions are the essential ones, as they control the force of the blow on the primer. A minimum load of 3.3 pounds is required at the assembled height of 1.45 inches. A load of 27.7 pounds is required at a height of 0.771 inch plus 0.03, minus 0.03. By thus specifying loads at two heights, the strength of the spring is very closely controlled.

Drawing of Firing Mechanism Container

The container is shown in Fig 7. The housing thread (which has an outside diameter of 1.417 inches plus 0.000, minus 0.006) is a special thread and will undoubtedly be milled. It must be a very free fit in the housing, as the container is inserted and removed every time the gun is fired. It must assemble readily, even if a certain amount of dirt and grit is present. The minimum clearance is 0.008 inch and the maximum clearance 0.020 inch. The surfaces must be smooth. A finish-turning or milling cut will be satisfactory. It will be necessary to match the turning and milling cuts where the bottom of this thread matches the cylindrical portion of the container with a file after the part is machined.

The thread for the primer extractor (outside diameter 1.024 inches plus 0.000, minus 0.008) must be left hand to prevent the primer extractor from unscrewing as the mechanism is removed from the housing. The minimum clearance is 0.000 and the maximum clearance on the pitch or effective diameter, 0.008 inch. The primer extractor must be screwed home as firmly as possible, and the variations on these threads should be kept as small as normal manufacturing methods will permit.

The small counterbore in the rear end (diameter 0.610 inch plus 0.01, minus 0.00) is for clearance and is unimportant. It should be finished at a single operation of a counterbore. The large counterbore in the rear end (diameter 0.950 inch plus 0.005, minus 0.000) must be a free sliding fit for the washer and should be reamed. The minimum clearance between the hole having a diameter of 0.35 inch plus 0.01, minus 0.00, and the firing pin is 0.05 inch, while the maximum clearance is 0.07 inch. This surface is unimportant and should be machined by a single drilling operation. The diameter of the counterbore in the front end is 0.784 inch plus 0.003, minus 0.000. This surface must be an easy sliding fit for the guide and requires a careful finish-reaming operation. The length over all (3.271 inches plus 0.00, minus 0.02) is relatively unimportant, yet both the front and the rear faces must be smooth, as they form the seats for the cover and primer extractor. The majority of the length dimensions are located from the front face. A few are given from the rear end because of manufacturing considerations. The remainder are given from intermediate points because of the functional requirements of the mechanism.

The length of the thread for the extractor is 0.209 inch plus 0.01, minus 0.00, and the width of the under-cut, 0.06 inch plus 0.005, minus 0.000. The requirements of these dimensions are that there shall be sufficient threads to hold the extractor properly and that the length of the stem be always long enough to permit the extractor to seat on the front face of the container.

The bottom of the large counterbore, which is 1.11 inches plus 0.000, minus 0.005, from the firing pin seat, is an important functional surface and should be finished by a special operation, locating from the firing pin seat. This dimension controls, to a great extent, the force of the blow of the striker. The location of the housing thread is also controlled from the firing pin seat. This dimension (0.291 inch plus 0.000, minus 0.005) controls the angular position of the mechanism when it is screwed home in the housing. A plus variation on this dimension might prevent the mechanism from locking. The width of the housing thread is 0.405 inch plus 0.00, minus 0.01. The rear surface or flank of this thread is a bearing surface and must be smooth. A corner of this rear flank is beveled with a file to facilitate entering the housing (see view showing development of thread). The length of bevel is 0.158 inch plus 0.02, minus 0.00, and the width of bevel 0.04 inch plus 0.02, minus 0.00. This should give sufficiently liberal tolerances for all manufacturing purposes. Double this tolerance could be given, however, if necessary.

The latch-pin and spring holes are both located from the front face of the container, as this is the logical locating point for the drill jig. The distance from the latch-pin hole to the center of the container is 0.625 inch plus 0.005, minus 0.000. A minus variation on this last dimension would develop interference between the bottom of the slot and the latch. The latch-pin thread is a standard No. 5-44 A.S.M.E. thread. Taps should be available from stock from any reliable tap manufacturer. This is a fine thread and should be held as close to size as normal manufacturing conditions will permit.

The distance to the cut on the left side of the flange is 0.30 inch plus 0.00, minus 0.01, and the height from the bottom of the cut is 0.56 inch plus 0.00, minus 0.01. The requirements of this cut are that the cutter shall not gouge the knurled handle by cutting too deeply and that the tap shall not gouge the bottom of this cut. The limits specified give the greatest permissible variations under maximum metal conditions and should be great enough to allow this cut to be machined in a single operation. The width of the latch slot is 0.300 inch, plus 0.006, minus 0.000. This surface must be reasonably smooth so as to maintain an easy action of the latch. The minimum clearance is 0.003 inch and the maximum clearance, 0.013 inch. With the proper surfaces, these clearances will maintain the desired conditions.

The location of the bottom of the slot from the center of the container is 0.45 inch plus 0.00, minus 0.02. A plus variation on this dimension would develop interference with the latch. The surface of the bottom and ends of this slot is not important and requires no finishing cuts. The cuts on the side of the slot must be matched to provide a smooth bearing for the latch.

The ends of the housing thread are 0.02 inch plus 0.02, minus 0.00, from the center of the container. These surfaces require no finishing cuts. The length of the knurling is 1.60 inches plus 0.00, minus 0.05. A scale measurement will be sufficient to check this dimension. No tolerances are given on the various radii or angles, as none are required. Tolerances on other dimensions establish liberal variations for these surfaces.

* * *

REDUCING ACCIDENTS BY SYSTEMATIC EFFORT

An interesting report of the reduction in accidents at the Ford motor and ship plants is made by Robert A. Shaw of the Department of Safety and Factory Hygiene of the Ford Motor Co., Detroit, Mich. According to this report, the number of accidents has been materially reduced in the last three years, the number of lost-time accidents in October, 1916, being 194, while in April, 1919, there were only 32. By lost-time accidents is meant accidents in which eight or more consecutive hours are lost from work. This is a reduction of 83.5 per cent in two and a half years. In October, 1916, the number of employes who had to take some time off because of accidents amounted to 4.8 per thousand employes. In April, 1919, this number was reduced to 0.8 per thousand employes. The record covers in both cases 49,800 employes. If the number of work-hours and the number of hours lost through accidents are compared, it will be found that the plant had an efficiency rate of 99.95 per cent, which is probably as high a record as most plants could show. In addition, it is pointed out that in a plant employing about 50,000 men, nine months were passed during the fiscal year 1918-1919 without a fatal accident, and in 1917-1918 eleven months were passed without a fatal accident. In addition to ordinary care taken in shop operations, electric tripping devices have been installed on all large punch presses. It is interesting to note that the use of these devices has not only practically eliminated all accidents to hands and fingers on the presses, but has also increased the production about 10 per cent. Incidentally, the fatigue of operators has been greatly reduced through the elimination of the foot tripping device. At the Ford Eagle plant the reduction in the number of accidents was 75 per cent.

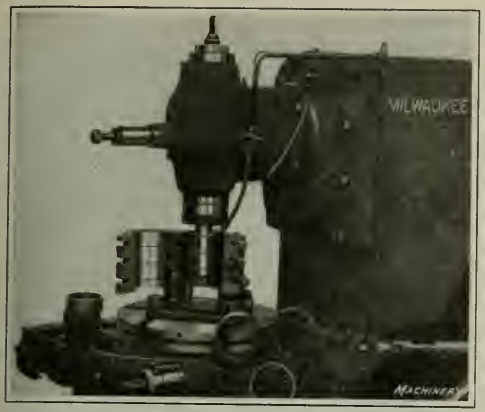


Fig. 10. Unusual Form of Fixture provided on a Kearney & Trecker Machine used by the Hyatt Roller Bearing Co. for milling Grooves in Outer Raceways of Roller Bearings

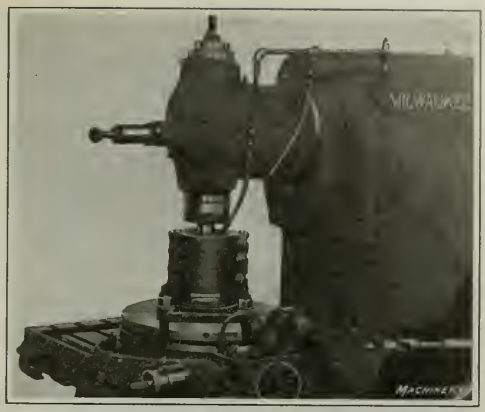


Fig. 11. Same Milling Machine and Work-holding Fixture illustrated in Fig. 10, but with the Fixture closed, Ready for milling the Three Retainer Anchorage Grooves

String Milling Fixtures

A Discussion of Typical Examples of Design and Results Obtained in Operating the Fixtures—Second of Two Articles

By EDWARD K. HAMMOND

IN the December number, string milling fixtures employed for milling gear-box levers, clutch shifter forks, connecting-rods, and racks, were described. In the following, additional examples of string milling fixtures are presented.

Milling Hudson Crankshaft Bearing Caps

On passenger cars built by the Hudson Motor Car Co., heavy aluminum caps are used for the crankshaft bearings. In machining these caps, it is necessary to perform milling operations on four faces of the work, and in order to allow all of these surfaces to be milled simultaneously, a milling machine built by the Kearney & Trecker Co., of Milwaukee, Wis., is equipped as illustrated in Fig. 12. It will be seen that four cutters are mounted on the arbor—two inserted-tooth mills for facing the large side surfaces of the work, and two plain cutters for milling the small surfaces at each side of the bearing groove. Four pieces of work are mounted in a string fixture on the table, and this fixture is equipped with a quick-acting clamping mechanism in order to facilitate the rapidity with which the pieces may be loaded in the fixture, or removed after the milling operation has been completed. Between each pair of bearing caps there is placed a bolt *A*, which holds down a semi-cylindrical shaped strap *B* that fits into the bearing groove in the two caps at each side of this clamping bolt.

It will be noticed that the hole in strap *B* is made of sufficient size to clear the nut on bolt *A*, so that the strap may be dropped over this bolt and then pushed sidewise in order that the groove cut in the side of the hole may allow the strap to slide under the nut ready for clamping it down on the work. It will be quite obvious from Fig. 12 that provision must be made for so locating the work that the sides of the bearing caps will be milled square with the ends. This result is accomplished by having small blocks *C* placed on the bed of the fixture, which come into contact with ribs extending across the sides of the work. The way in which these blocks *C* locate the work will be readily understood by referring to the piece which is shown clamped in place on the fixture. Owing to the different sizes of the cutters used for the performance of this milling operation, the speeds vary considerably, the rates employed being 280 and 220 feet per minute, respectively, with a feed of 18 inches per minute. In quoting these speeds and feeds, it is repeated that the material is aluminum; otherwise, such rates could not be successfully employed. In an eight-hour working day, the output of each machine is 700 bearing caps.

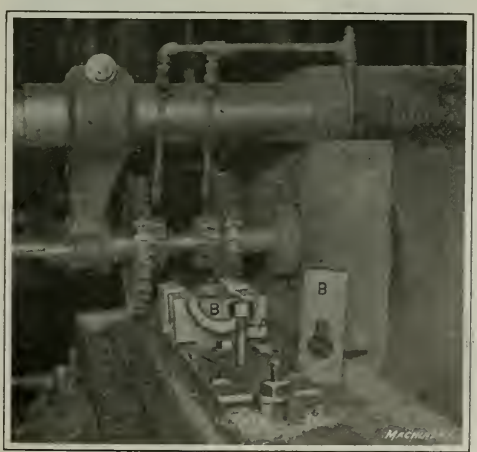


Fig. 12. Kearney & Trecker Milling Machine equipped for simultaneously milling Four Faces of Hudson Crankshaft Bearing Caps

Milling Retainer Rings in Roller Bearing Raceways

In the process of making roller bearings of the type manufactured by the Hyatt Roller Bearing Co., Newark, N. J., it is required to mill grooves in the outer raceways to form an anchorage for the roller retainers. There are various methods by which this operation could be performed, but probably there are few which would enable as efficient results to be obtained as those which are secured through the use of a Kearney & Trecker vertical-spindle milling machine equipped with a rotary table and work-holding fixture of the type shown in Figs. 10 and 11. In Fig. 10 it will be seen that three slitting saws are mounted on the arbor, which are 1/16 inch in width;

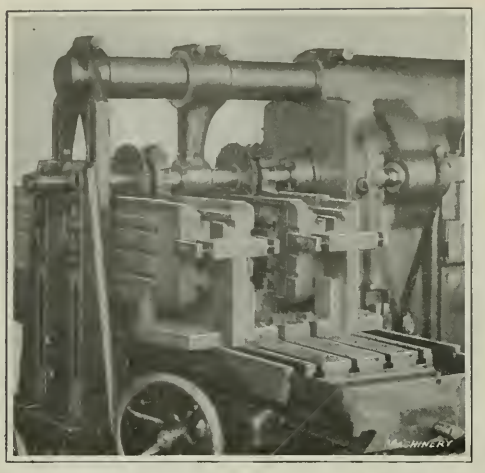


Fig. 13. Rough-milling Angular Sides of Slides on Milling Machine Tables at the Brown & Sharpe Mfg. Co.'s Plant, using a No. 5B Milling Machine of this Company's Manufacture

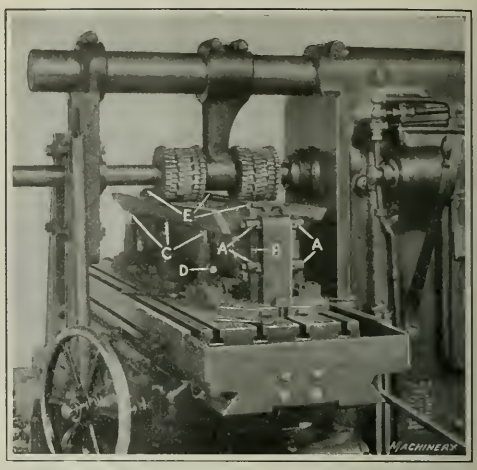


Fig. 14. Milling Operation simultaneously performed on Two Grinding Machine Tables in the Brown & Sharpe Mfg. Co.'a Plant, using a No. 5B Heavy-duty Brown & Sharpe Milling Machine

that is, the proper width for cutting the retainer grooves in the roller bearing raceways. The fixture mounted on the rotary table of this machine provides for holding three raceways, in each of which the retainer groove is cut by one of the saws. As each raceway is located in this fixture, the two half rings which hold it in place are bolted together. Then after all three pieces have been set up, the rotary table is started, and also the transverse feed movement. As the rotary table revolves the work, the saws cut continuous slots all the way around the three pieces held by the fixture. A limit stop for the transverse movement of the table stops this feed when the slots have been milled in the work to the required depth. The parts being milled are pieces of seamless steel tubing, and the rate of production obtained is three pieces per minute.

Milling Footstocks for Spiral Heads

Fig. 15 shows a Brown & Sharpe No. 3B heavy-duty type of plain milling machine equipped for facing off the sides and milling the center space of footstocks for spiral heads. This operation is of interest owing to the height of the side surfaces which have to be milled, making it necessary to employ a gang of cutters of unusually large diameter. It will be apparent from the illustration that three castings are set up in a string fixture, so that they can all be milled at a single traverse of the table. The outsides of the uprights on these castings are faced, and the space between the two uprights is cut to the required width. Side milling cutters with inserted teeth are employed for this job, these cutters being 12 inches in diameter. The two outside cutters have their teeth set parallel with the axis of the arbor on which they are carried, because the face width is not great enough to cause an objectionable amount of shock when the teeth engage the work, or other undesirable conditions of operation which are obviated through the use of milling cutters with spiral teeth. The middle cutter, which is of greater face width, has the teeth set at an angle with the axis of the arbor, in order to produce a shearing action, and these teeth are nicked to break up the chips. It will be apparent that the fixtures used for holding the work while performing this milling operation are of extremely simple design, consisting merely of bolts fitted into the T-slots on the table to provide for holding straps down on the flange which extends around the base of each footstock casting. The machine is shown in operation at the plant of the Brown & Sharpe Mfg. Co., in Providence, R. I.

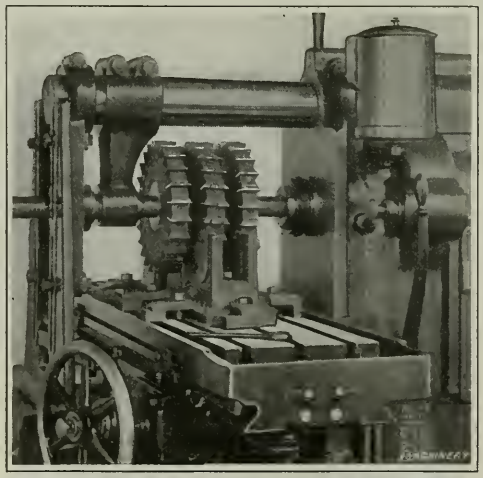


Fig. 15. Milling Footstocks for Spiral Heads at the Plant of the Brown & Sharpe Mfg. Co. This Operation is performed on a No. 3B Heavy-duty Plain Milling Machine of this Company's Manufacture

Multiple Work-holding Fixtures Placed Side by Side

The term "string milling fixture" is generally applied to that class of fixture in which the castings are placed in a row on the milling machine table, running in a direction parallel to the line of travel of the table. With such an arrangement, provision is made for milling all of the castings with a single cutter, or gang of cutters, mounted on the arbor. In some cases, however, it may be found more desirable to set up the work in fixtures that provide for holding the castings or forgings side by side, instead of end to end. A case in point is illustrated in Fig. 13, which shows a Brown & Sharpe No. 5B plain milling machine engaged in simultaneously rough-milling the angular sides of the slides on four milling machine tables. The machine is shown in operation at the Brown & Sharpe plant. This is the kind of job that could be performed on a planer or slabbing type of milling machine equipped with a table of sufficient length to set the four castings up end to end; and if such a practice were followed it would only be necessary to use one milling cutter. However, by performing the operation as shown in Fig. 13, a less expensive

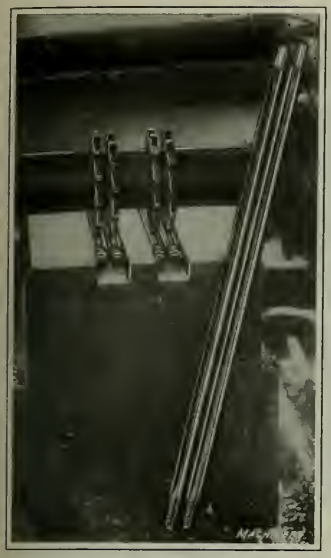


Fig. 16. Briggs Miller built by Gooley & Edlund, engaged in milling Grooves in Carriage Roll Guides at the Plant of the Royal Typewriter Co.

machine is utilized; but in order to do so it is necessary to set the castings up side by side, because the length of the table is insufficient to mount them in a single row. It will be seen that the castings are set up on two knee type fixtures, each of which provides for holding two castings, one on each side of the fixture. The same fixture is used to mill the opposite angular sides of the slide, the four pieces of work being merely turned over and reset for taking the second cut.

At the plant of the Brown & Sharpe Mfg. Co., No. 5B plain milling machines of this company's manufacture are used for simultaneously performing a milling operation on two tables for Brown & Sharpe grinding machines, as shown in Fig. 14. The reason for setting up the castings side by side on this machine is the same as that explained in connection with the job illustrated in Fig. 13. The two grinding machine table castings are held at opposite sides of a knee fixture, and two gangs of cutters, with six in each gang, are employed for simultaneously milling the various surfaces which have to be finished. To provide for holding these castings back against the locating points, there are four straps *A* at eacn end of the fixture, these straps being provided with lugs which project inward to engage the flange *B* on each end of the castings that have to be milled. By tightening the nuts over straps *A*, the lugs on these straps pull the work securely back against the locating points. Owing to the form of the castings to be milled, it is necessary to afford means of supporting the work to avoid danger of its being distorted through pressure applied by the milling cutters. Such means are furnished by three spring plungers *C*, which come into engagement with the inside of the work, after which nuts *D* are tightened to lock these



Fig. 17. No. 2 Becker-Brainard Plain Milling Machine equipped for milling Grooves in Two Tabular Rods at the Plant of the Royal Typewriter Co.

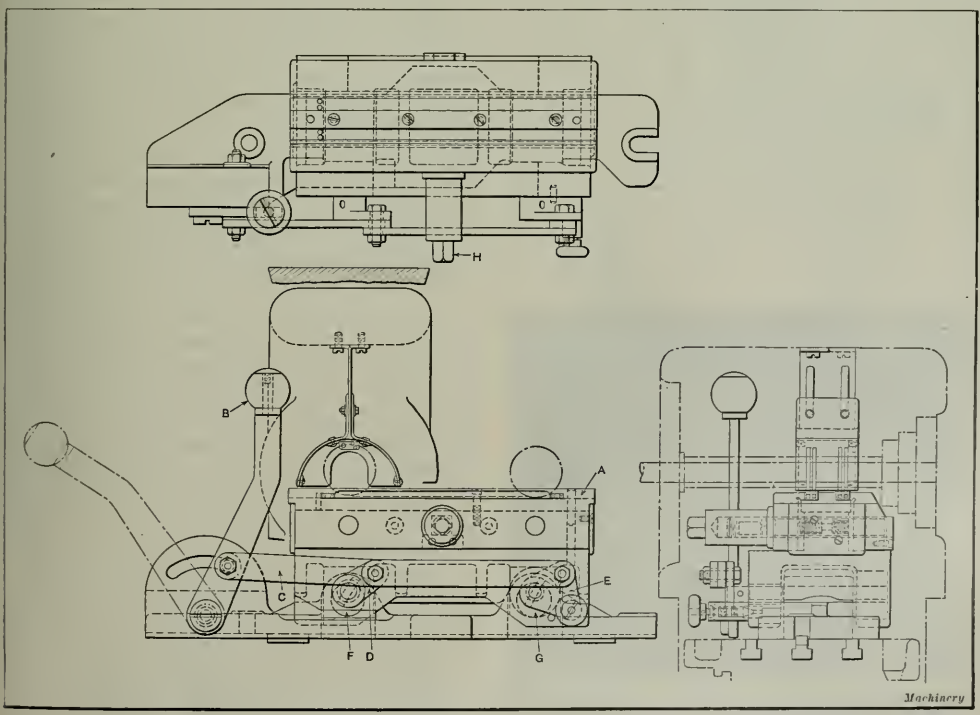


Fig. 18. Design of Elevating Device for Work-holding Fixture used on Briggs Milling Machine shown in Fig. 16

plungers in place. Additional support is furnished for the work by means of three straps *E*, which straddle the two castings and provide for holding them firmly against the locating points on the fixture, in addition to keeping them down in place.

Milling Typewriter Carriage Roll Guides to Reduce their Weight

At the plant of the Royal Typewriter Co., Inc., of Hartford, Conn., a large number of parts known as carriage roll guide rods are required, these pieces being of the form shown in Fig. 16. It is important to reduce the weight of all typewriter parts as far as possible, without seriously impairing their strength. To provide for cutting down the weight of the rods shown in Fig. 16, a practice is made of milling a longitudinal slot along the back side of each rod, in order to remove as much surplus metal as possible. This job is done on one of the Briggs milling machines built by Gooley & Edlund, Inc., Cortland, N. Y. It will be evident that provision is made for setting up four of the carriage roll guides at a time, the fixture consisting of a special form of vise provided with two openings, in each of which two of the carriage roll guide rods can be mounted. The jaws are slightly under-cut so that when they are tightened on the work, they serve the double purpose of gripping it and forcing it downward so that an accurate location and secure hold are obtained simultaneously. The two outer jaws move inward in opposite directions, and grip the work against the central jaw, which constitutes the fixed jaw for each of the two vise openings.

Rather an unusual type of fixture is used on this machine to provide for feeding the work up against the milling cutters, in order to cut grooves of the required depth in the carriage roll guide rods. This fixture is merely a sub-table on which the special milling vise is mounted, and by simply throwing over a lever, provision is made for raising the work against the milling cutters so that the groove will be cut to exactly the proper depth. The reason for following this procedure will be made quite evident by referring to the form of the work shown in Fig. 16, where it will be seen that at each end of the carriage roll guide there is a threaded section, while the groove milled in the work projects beneath the level of the threads. Consequently it is not possible to mill the groove by a single horizontal feed movement of the table; the work must be raised into engagement with the milling cutters at the point where the groove starts, and then lowered away from the cutters at the opposite end of the groove. By this method of procedure, the groove is cut to the proper depth and the threads at either end of the work are not damaged.



Fig. 19. No. 25 Becker-Brainard Machine used for milling Shift Locks for Royal Typewriters. Five Pieces are held in the Vise, with a Locating Pin passing through a Hole in Each Piece of Work

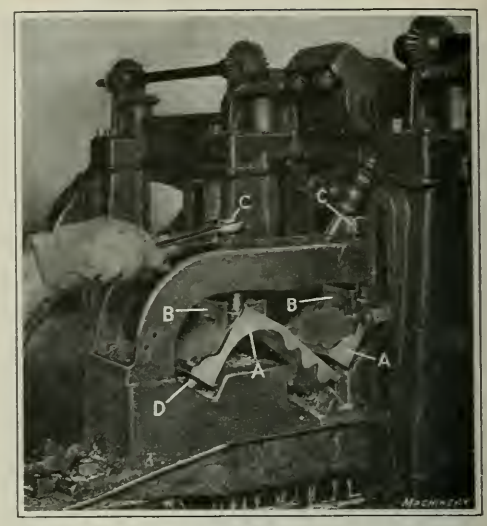


Fig. 20. No. 8 Double-head Lincoln Miller built by the Hendey Machine Co., and used by the Dayton Engineering Laboratories Co. for milling Self-starter Generator Frames

Reference to Fig. 18, while reading the following description, will give a clear idea of the way in which this fixture operates. The vise which holds the work is shown at *A*, and in order to raise this vise and to bring the pieces carried by it into engagement with the milling cutters, it is merely necessary to throw lever *B* over from the position indicated by broken lines to the position where the lever is shown by full lines. It will be seen that attached to lever *B* there is a link *C*, which has two pivoted levers *D* and *E* secured to it. These two pivoted levers are keyed to the ends of two eccentric shafts *F* and *G*, which are free to rotate in close-fitting bearings. When lever *B* is pushed forward to the position shown by the full lines, the motion is transmitted through links *C*, *D*, and *E*, to the eccentric shafts *F* and *G*; and the rotation of these eccentrics, which are held in a fixed position, results in imparting a vertical movement to the bed of the fixture and the work carried by the vise mounted on it. After the horizontal feed movement has advanced the cut to the far end of the groove which is required in the work, lever *B* is simply pulled back to lower the work out of engagement with the cutter, so that the threaded ends of the carriage roll guide rods will not be damaged. Stops are furnished to locate the starting and stopping points of the cut. The vise jaws, between which the four pieces of work are held, are tightened by turning the square end of screw *H* which is threaded right-hand at one end and left-hand at the opposite end, to provide for moving the two outer jaws in opposite directions. A special form of ratchet handle is provided to go on this square end of the operating screw, so that the vise jaws may be tightened or loosened by a reciprocating action of this lever, which is far more convenient than having to make complete rotations of a crank handle. The work to be milled is made of cold-rolled steel and the slots are 10 inches long; the rate of production obtained is 325 pieces in a nine-hour working day.

Milling Slots in Tabular Rods of Royal Typewriters

Fig. 17 shows a Becker-Brainard No. 2 plain milling machine equipped for milling grooves in two tabular rods for Royal typewriters. This operation is quite similar to the one which has just been discussed in connection with the two preceding illustrations. But the work-holding fixture is of a less highly perfected form, as provision is only made for setting up two pieces of work at a time,

so that the percentage of a full working day during which the machine is idle is substantially increased. The influence of such a condition upon the daily output of work is indicated by the fact that on this job the rate of production obtained is only 200 pieces per nine-hour day, instead of 325 pieces secured on the equipment shown in Fig. 16. In order to emphasize the fact that these two jobs are entirely comparable, mention is made of the fact that the length and cross-sectional area of the groove to be milled is the same for both jobs, and the parts are both made of cold-rolled steel. The special form of fixture for raising the work into contact with the milling cutters is not required in this case, because, although the work is threaded at each end, the diameter of the threaded sections is sufficiently reduced from the height of the body of the work, so that the milling cutters may be fed straight across the work without damaging the threads. On both of these jobs the work is kept flooded with lard oil.

Form-milling Shift Locks at the Royal Typewriter Plant

At the front of the work-holding fixture illustrated in Fig. 19, there are shown two of the finished shift locks which are form-milled on their upper surface by means of the equipment shown in this illustration. After being milled, these parts are gaged, as shown at the right-hand side of the illustration, in order to make sure that they fulfill the specified requirements. Reference has already been made to some of the ways in which milling vises of standard or special design can be utilized for the performance of milling operations on production work, but in the present instance a rather different scheme is followed from any which have previously been mentioned. The illustration clearly shows the way in which the form milling cutter on the arbor is used to obtain the required contour for the top surface of the work. It was not felt, however, that this could be performed with the required degree of accuracy if the edges of these thin stampings that have to be milled were allowed to project the required distance above the jaws of the vise. Consequently, the tops of these jaws were milled to the same contour that it is required to produce on the work; and with such an arrangement, the pieces can be clamped between the jaws in a manner that assures complete support without in any way hampering the work of milling them. Five stampings are set up in the vise at a time, and the pierced hole in one end of the stampings is utilized as a locating point, by slipping the hole in the work over a locating pin that is provided in one of the vise jaws for the purpose. This job is done on a Becker-Brainard No. 25 plain milling machine, and the rate of production obtained in performing this operation is 350 shift locks from one machine in a nine-hour working day.

Milling Generator Frames for Automobile Self-starters

Fig. 20 illustrates a method employed by the Dayton Engineering Laboratories Co., of Dayton, Ohio, for tooling up and operating a No. 8 double-head Lincoln milling machine built by the Hendey Machine Co., Torrington, Conn., for use in simultaneously milling both sides of the frames of electric generators for the self-starting and ignition system on Buick motor cars. It will be apparent from this illustration that the fixture is designed to hold two pieces of work which are shown at *A*. After the piece that is located nearest the cutters has been set up, the feed is started and the operator then proceeds to set up the second piece. This method works out nicely, because the length of cut is ten inches, so that ample time is afforded to set up the second piece before the cut has been completed on the first casting. The use of such a plan is also the means of keeping the machine operator employed during the greater part of the day. These generator frames are made of malleable iron, and on this job, the rate of production is 300 pieces in a working day of nine and three-quarter hours.

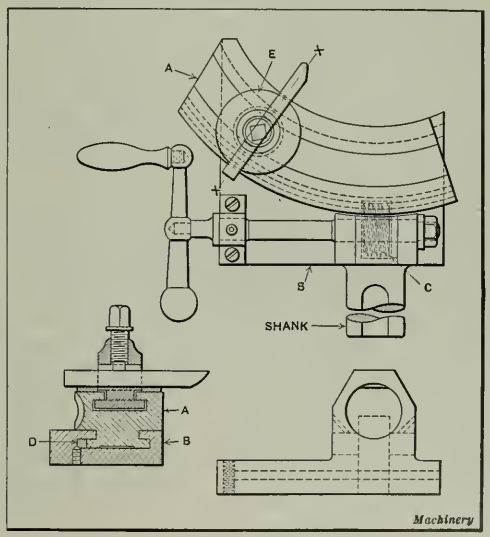
Two pieces of work *A* are set up in the string fixture on this machine, which is of relatively simple design. The two opposed spindles of the duplex machine provide for milling opposite faces of the work, each piece being clamped down in the fixture by means of a V-block *B*, which is forced down by tightening the bolt *C*. At the time the work comes to this machine, none of the surfaces have been finished, and so three suspension points are provided on each station of the fixture, one of which can be seen in contact with the casting at *D*. After the operator has set the second casting up in the fixture, he moves around to the back of the machine; and as soon as the first casting has passed out of engagement with the cutters, he releases the clamping bolt and removes this casting from the fixture. Then it is only necessary for him to remain idle during a short space of time while the cut is being completed on the second casting. As soon as this piece comes out from between the cutters, the operator removes it and goes back to the front of the machine to set up fresh castings for the next operation.

* * *

RADIUS-TURNING TOOL

By NORMAN McCLEOD

The accompanying illustration shows a tool which has been utilized on turret lathes for turning the half-ball joints used on locomotive steam and dry pipes. A tool of this design, however, could be used on other similar spherical turning jobs. A brief description of the device should be sufficient. The slide *A* moves in a T-slot in bracket *B*, the



Turret Tool for turning Spherical Work

shank of which is secured in the turret. This slide, in which the toolpost *E* is clamped, is operated through worm *C*, (which meshes with teeth cut in the slide) by means of a bellcrank handle. Adjusting screws and gib *D* afford means of adjustment to compensate for wear of the slide.

* * *

Iron ore is graded according to the percentage of phosphorus it contains. A low percentage of phosphorus—under 4½ per cent—makes it available for the Bessemer steel-making process, and such ore is called Bessemer ore. The non-Bessemer ore, which contains a higher percentage of phosphorus, is made into steel by the basic open-hearth process, which admits of the elimination of the phosphorus.

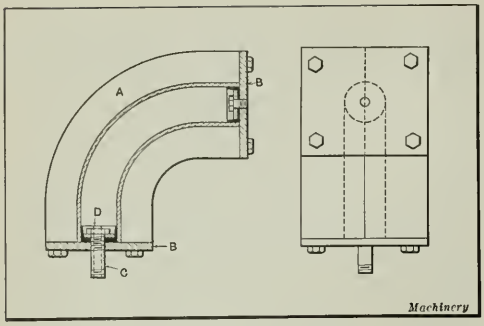


Fig. 1. Mold for expanding Bends

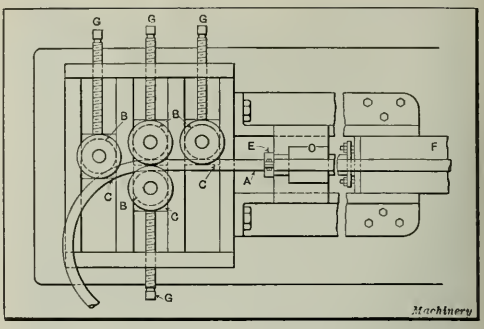


Fig. 2. Hydraulic Pipe Coiling Machine

Pipe Bending Machines

By R. P. DEANE

THE principles employed in bending pipe and the details of some of the machines used in making pipe bends, coils, plumbers' fittings, etc., from both iron and brass pipe and tubing, are dealt with in the present article. In most bending operations on smooth tubing, a device called a "ball mandrel" is used to keep the tube from collapsing. This is illustrated in the upper view, Fig. 3, in which *A* is the mandrel proper and *B* the balls linked to it, which straighten the wrinkles from the tube as it is bent. Rod *C* must be somewhat longer than the pipe before bending. Very short bends such as required in plumbers' supply elbows, offsets, traps, etc., cannot be made in one operation, for if they are kept from collapsing by the use of a ball mandrel the strain will break the tube. They are therefore allowed to collapse when bending. After being bent they are annealed in a gas furnace through which they are fed on a conveyor chain which allows them to drop in a pile to cool at the discharge end.

After annealing they are placed in the dies of a machine such as shown in the lower view, Fig. 3, called a "ball pusher." In this illustration, *A* represents the dies which hold the work. The lower die is bolted to the bed of the machine *B*, while the upper half is bolted to hinged lever *C*, the other end of which is operated by cam *D* on shaft *E*. Another cam *F* on the same shaft operates plunger *G* which pushes a row of steel balls through the partially collapsed bend clamped in the dies. The first one or two balls which enter the collapsed tube are the exact size of the inside of the tube, while the others are a little smaller and act simply as pushers. The machine is set on a slight angle so that the smaller balls roll back by gravity as the plunger returns to its starting point. Of course, the full-size balls will not roll back through the bend, but will roll back through the die when the tube is removed. Some of the bends used in cash carrier systems are required to have a greater inside diameter than the straight sections in order to allow the cash box to pass around the bend. These bends are expanded after bending by hydraulic pressure while the bend is held in a die or mold of the required shape such as shown in Fig. 1. The ends of the tube are closed by cup packings which are prevented from being blown out by plates *B* on the ends of the mold. The water is admitted by nipple *C* which passes through the packing and is held by lock-nut *D* and a washer as shown.

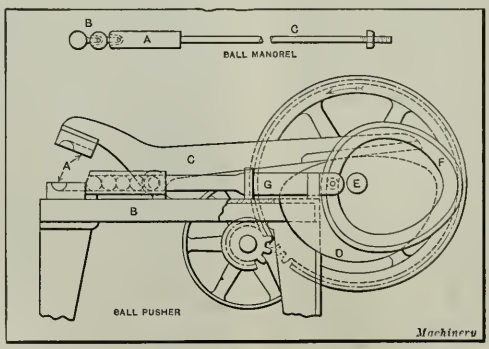


Fig. 3. (Upper View). Ball Mandrel employed to prevent Tubes from collapsing during Bending Operation. (Lower View). Machine of the Ball Pusher Type employed to expand Tubes which have been permitted to collapse during the Bending Operation

Making Pipe Coils

In making coils the radius is not so short and the pipe is usually heavier; therefore no great difficulty is experienced from collapsing of the tube. Coils are usually made with no mandrel inside, and unless very small, no filling is used. They are made by two methods, one of which is illustrated in Fig. 2. When in operation the machine forces the pipe *A* between formed rollers *B* which are held on sliding blocks *C*, the latter being held in position by adjusting screws *G*. The formed rollers can be changed to fit any size pipe, and the position of the last roller governs the radius to be bent. The pipe is forced through the grooves on the rollers by a hydraulic carriage *D*. A collar *E* is clamped to the pipe which is moved back on the pipe after each stroke of the carriage. The pipe is rolled or rotated slightly to give the coil the required pitch. The hydraulic cylinder *F* is below the center line of rollers *B* so that the pipe passes over it.

Some iron pipe coils have to be bent hot, in which case the coiling machine draws the pipe through a long gas furnace which heats it as fast as it is drawn through, the machine, of course, being set close to one end of the furnace. Coils of this nature often require several hundred feet of pipe. The pipe is usually welded on an electric butt welding machine although some are welded by hand, the welding being done before coiling. Flat spiral coils are made on the machine shown in Fig. 2, by changing the adjustment of the rolls as the pipe is forced through. Coils are also made on a machine called a "swiper" which is shown in Fig. 4. In this machine, a former *A* the size of the inside of the coil is driven by a central shaft *B*, which is driven by a worm *G* and worm-wheel *C*. The end of the pipe is clamped to the former by clamp *D*, and after about a half revolution the clamp is loosened and the machine reversed so that the clamp can obtain a new

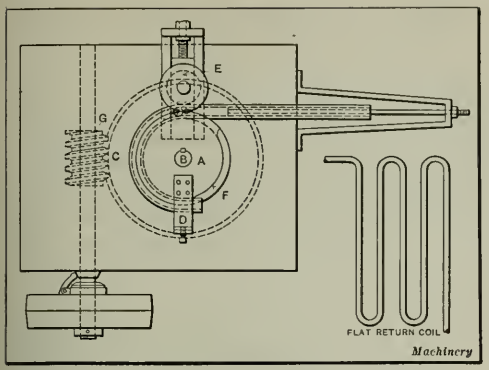


Fig. 4. Type of Bending and Coiling Machine commonly termed a Swiper

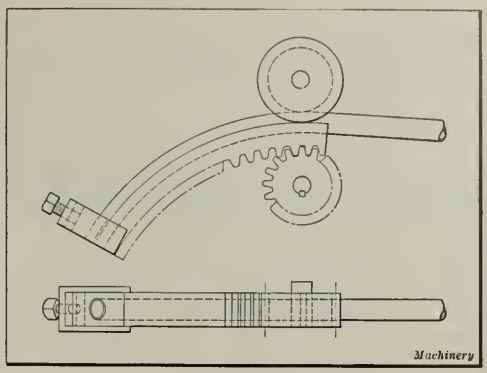


Fig. 5. Former and Driving Pinion used in making Bends of Large Radius

grip on the pipe. The pipe is also turned or revolved slightly each time in order to give the proper pitch to the coil. The pipe is held against the former by a follower roll *E* or sometimes by a formed block. The top flange of the former is cut away beyond the clamp at *F* to allow the pipe to be raised to form the pitch of the coil.

Flat return coils like the one shown in Fig. 4 are made on machines of this type, the pipe being bent before welding. As many bends as possible are made from each length of pipe, the first bend in each succeeding length being made the proper distance from the end to match the preceding one. They are then welded on the electric welder. This type of machine is also used to make the most simple bends and is often used in connection with hall mandrels. The rod on the mandrel must be longer than the pipe before bending, as the pipe is slipped over the rod and mandrel and drawn off as bent. As the end of the mandrel is located at the point of bending, the balls are allowed to swing around the bend, thus ironing out the wrinkles. The end of the rod must be attached very firmly, the means of attaching depending on the length of pipe and other conditions.

When making bends having a longer radius than can be swung from the central shaft, the former is replaced by a coarse-pitch pinion gear and a former such as shown in Fig. 5. As will be seen, this former has rack teeth on the inside. The guide roller keeps the teeth in mesh with the pinion. By this method, bends of any radius can be made on a machine of the same strength and power as required for small bends.

Machines Employed in Bending Large Pipe

The bending of large pipe is accomplished by quite different methods and on an entirely different machine, as will be seen by referring to Fig. 6 which shows one of the types commonly employed. These machines are built of I-beams *A* having large V-shaped rolls *B* and *C* attached as shown, which support the pipe *D*. *E* is an adjustable bracket which is clamped to the I-beams at the proper height to produce a bend of the required radius. This bracket carries a radius-bar *F*, the end of which hooks to a clamp on the end of the pipe. At *G* is a circular gas burner carrying two or four blast nozzles, according to the size of the pipe. The inside of the burner is lined with fireclay. These burners heat only a very small section of the pipe at a time so that it cannot collapse. In operation, streams of water are played on the pipe on each side of the burner to keep the heat from spreading. Pressure is applied to the end of the pipe for medium sized work by a chain arrangement operated by a chain hoist, not shown. This hoist is equipped with a ratchet and pawl which replaces the hand chain sprocket, the pawl being connected to a crank on a countershaft. The lift chain runs over idlers on the frame and around one end of the pipe as shown.

As the chain is tightened the pipe is forced through the gas burner, but since the other end is attached to the radius-bar it must bend to a radius equal to the distance from the center of bracket *E* to the center of pipe plus some "spring back." As only a few inches length of the pipe is hot, it cannot collapse any appreciable amount, and as fast as the chain pulls the pipe through the burner it is heated and bent. For the largest sizes of pipe, the roll *C* is replaced by a long I-beam bed carrying the ratchet rack and hydraulic creeper shown in Fig. 7, in which pawl *A* pushes along one notch which is held by pawl *B*, while *A* reverses and engages another notch. This device has been used to bend pipe 24 and 30 inches in diameter. Large bends sometimes must be rectified to make up for the spring back or errors in measuring angles on the machine. This is done on large floor-plates provided with holes for stakes so that blocking may be used to hold the pipe in the proper position. After being fastened in place, the pipe is sprung with chains and hoists so attached as to pull in the proper

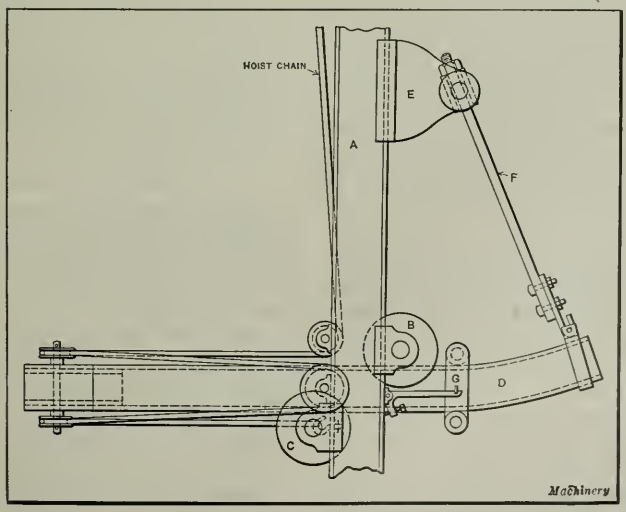


Fig. 6. Machine used for bending Pipe of Large Diameter

direction while the pipe is being reheated with circular burners of the same type as is used on the machine. When the bend must be made close to the end of the pipe it is usually flanged before bending and a short piece of pipe bolted on, to which the radius-bar is attached, thus giving the machine more leverage.

Some bends of large radius are threaded for screwed flanges on a machine with a revolving die-head, this operation being usually done after bending. Other bends are flanged for the "Van Stone" system of joint. For this work, the end of the pipe is heated and clamped in a ring or form allowing enough pipe to project to make the flange. A revolving head located close to the clamp carries a slide provided with a roller which rolls the flange over the face of the clamp. This slide is fed out by a screw and star feed. The big bending machines always have a pit in front to facilitate the handling of offsets, expansion bends, etc. Bends of a radius equal to three times the diameter of the pipe or larger are made with good results on these machines. The writer has seen bends of even shorter radii made; but three times the diameter or larger is the usual rule.

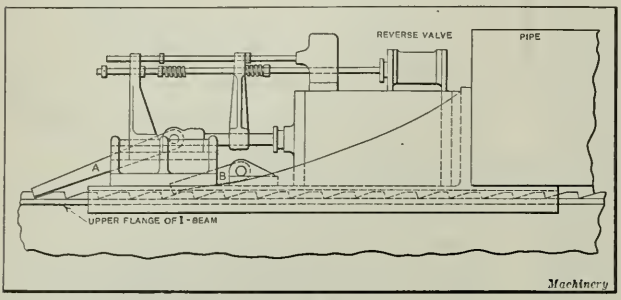


Fig. 7. Hydraulic Creeper mounted on I-beam Bed, which is used in Place of the Chain Feed shown in Fig. 6 when bending Pipes of the Largest Size

* * *

JAPAN'S INDUSTRIAL EXPANSION

According to a recent Commerce Report, the industrial progress of Japan which has been especially rapid during the period of the war, has been promoted to a large degree by the introduction of American and other foreign machinery. In changing from ancient to modern methods, almost every type of machinery perfected in foreign countries has been imported by Japan. An idea of the increasing market for machinery may be obtained from the value of machinery imported into Japan within the past five years which shows that in 1914 the imports amounted to $12,471,182 as compared with that of $29,248,999 in 1918. It is interesting to note that in 1914 only 20 per cent of the machinery imported by Japan came from the United States, while tables compiled by the Commerce Department show that 80 per cent of the machinery imported by Japan in 1918 came from the United States. As a result of these extensive imports, the manufacture of various types of machinery has increased quite rapidly in Japan so that the value of the machinery exported by Japan during the year 1918 amounted to $7,898,268 as against $634,483 in 1914. Statistics show that practically all the machinery exported was sold in the Far Eastern countries although they indicate that an effort was made in 1918 to establish a market for Japanese machinery in South America.

* * *

Casein glues are exceedingly resistant to the action of water, and retain a high percentage of their original strength even after long immersion under water. Waterproof glues have been developed primarily for aircraft purposes. Information on casein glues and their application may be obtained from the Forest Products Laboratory of the United States Forest Service, Madison, Wis.

WHEN MACHINERY MUST BE GUARDED

By CHESLA C. SHERLOCK

For many years the law has recognized the danger of moving machinery and sought to lessen it by proper legislation, requiring an employer to provide safeguards for his machinery where that machinery was dangerous to the persons employed. The law did not impose this duty as an alternative to the relief afforded by the common law or even as an alternative to the relief afforded by the compensation acts. It imposed the duty to safeguard machinery independently and in addition to such liability as might fall upon the employer *after* the accident had occurred.

When Must Employers Install Safeguards?

The question naturally comes to the mind of every employer who uses machinery in his business: "When must I install safeguards; what are the safeguards mentioned by the statute; what appliances in my shop or factory should be classed as dangerous machinery within the meaning of the law?" Perhaps the matter might be stated with a little more clearness by asking this question: "When is there a legal necessity for safeguarding machinery?" All machinery, tools or appliances are evidently not dangerous within the meaning of the statute; nor are all dangerous agencies employed in the average shop or factory "machines or appliances" within the meaning of the law. Then, when must the employer provide safeguards in order to comply with the rules laid down by the statute? There is only one answer. It is not found in reading the statutes, but in the decisions handed down by the respective courts which have been called upon to deal with this matter. These decisions are conclusive where they cite specific instances regarding the kind of machinery under consideration. It is by these decisions, and by these decisions only, that the employer should be guided. They give him the advantage of a rule used by the courts in deciding questions relative to a specific type of machinery. With these rules he may judge the meaning of the statute in question.

For instance, in Indiana there is a statute which requires employers to safeguard machinery. It is shown in a case decided by the court of that state that a certain employer had an open space in his floor, and underneath this open space revolving machinery containing knives and rollers. The employer in this case failed to safeguard this place and legal action was brought against him under the statute. The court held that he was not liable, inasmuch as this opening in the floor could not be considered within the statute requiring him to safeguard his machinery, because a hole in a floor was not deemed to be, in a legal sense, a machine, a tool or an appliance.

Kind of Safeguards Required

It has been pointed out in so many cases that it has come to be generally understood that the employer is not required to provide the best safeguards, or the most complete safeguard, or the latest on the market. There may even be a new safety appliance on the market which entirely revolutionizes the old ones, but it is not necessary, under the decisions, for the employer to discard the old ones for the new, because the law requires nothing unreasonable of the employer. He is only required to use such precautions as reasonably prudent men in the same business employ. In doing this he fulfills the purpose of the law, provided he acts in good faith. No employer is excused from liability by any plea when it was plainly his intention to evade the law.

In both Minnesota and Indiana it has been said that mere inconvenience will not excuse an employer from using the safeguards required by law. In the latter state it was said that a 1500-pound hammer, used in crushing car wheels be-

fore melting them, was a machine within the meaning of the law and that it must be safeguarded in the manner provided, even though it proved inconvenient to do so.

When a Law Becomes Effective

Employers often contend that they are not liable under the safety appliance acts because they have not been notified by the state factory inspector to make installation of appliances intended to safeguard the workmen, but the fact that the state factory inspector has made no objection to the methods or lack of methods used by any employer does not lessen his liability. The law is notice to everyone the minute it is written into the statute books and it becomes immediately effective, provided it has been duly enacted.

In an Illinois case an employe was injured by a machine as a result of being pushed by another employe. The employe, in trying to save himself from falling on a moving belt, put his hand into his machine which contained moving knives. As a result he lost three fingers. The employer in this case contended that he was not liable under the statute because the state factory inspector had not given him notice to put a guard over the knives in that particular machine. The court said that the statute imposed an absolute duty upon the employer to safeguard that machine regardless of what the factory inspector might have said.

Personal Liability of Employer

In Washington it was said that friction wheels were within the meaning of the statute of that state and that they must be guarded, while in Indiana it was said that they came within the provision relating to gearing. In Minnesota it was held that a traveling screw in a conveyor box, used for moving grain from one part of an elevator to another, was a dangerous machine and that under the statute it must be guarded in order to prevent injury to workmen who might come in contact with it. In another Minnesota case where a workman on a ditching machine injured his foot by stepping into an unguarded bevel gear, it was held that the employer was not excused from liability merely because he had directed other employes to put a cover over the gears, and they had failed to do so. In this connection it might be noted that it is the settled rule of law practically all over the country that the duty imposed by the statute is a personal one and one which cannot be delegated to another person. The employer is the person directly charged with the responsibility of safeguarding machinery, and if he were permitted to delegate his duty to another he could readily escape liability in nearly every case by claiming that the responsibility had been transferred to a subordinate.

Injuries Caused by Materials in the Process of Manufacture

In a Washington case a distinction between machines and their products was noted which is of great importance to the employer when considering the extent of his liabilities. It was held that the statute, while it applied to the machine itself, did not apply to the material fed into the machine. In other words, under the ordinary safety appliance act there is no duty imposed upon the employer to take means to guard the employe from accidents caused by the material which is fed into the machine. Fully half of the accidents occurring in the average factory and shop are caused by the material. However, another point should be brought up in this connection. The mere fact that an employe is injured by a piece of material while feeding it into the machine does not excuse the employer from liability in all cases, but merely from liability under the safety appliance acts. Where the workmen's compensation acts are in force, another liability for the accident is imposed entirely independent of the cause of the injury.

In Wisconsin it was said that the mere fact that a machine caused injury to an employe was insufficient to show that it was a dangerous piece of machinery within the meaning of the safety appliance acts. In another state it has been held that any machine operated by hand is not required to be guarded, as it is not considered dangerous, but in Indiana it was held that a crane operated by hand must be safeguarded. It has been pointed out in other cases that the mere fact that a dangerous situation is created when a machine is operated in a careless manner does not in itself bring the machine within the class required to be safeguarded by the statute.

In Minnesota it was said that the actual question as to whether a machine is of such a dangerous type as to require safeguarding under the statute, is one for the jury to decide. This seems to be the case in most of the states, as it nearly always amounts to a question of fact. In Michigan it was said that the factory inspector's decision as to whether a machine is dangerous is not always conclusive. This decision was reached in the case where a workman tripped on a belt lying on the floor and caught his hand in the gearing of the machinery.

When Guards Interfere with Practical Operation of Machine

As showing the common sense trend of the decisions, employers can note with satisfaction that it has been held in a large number of cases that the test of a safeguard is its practicability. If the measures which are necessary to safeguard the machine properly are such that they destroy its practical value in the factory or shop, it is held, in Indiana, Maryland and a number of other states, that the safety appliance act is inapplicable. This decision is based on the fact that it is not the intention of the statutes to interfere with the practical operation of machinery. In Minnesota, as well as in Washington, it was held that the question of whether or not the appliance for safeguarding is practical, was one to be decided by the jury. Where questions arise as to the necessity of safeguarding internal portions of machinery, particularly that relating to gearing and as to whether a sufficient guard is presented by the frame of the machine itself, it is generally held to be a question for the jury. In a New York case it was shown that a machine had a space of about 4 inches between a partition and revolving disks. While attempting to clean the revolving disks the operator was injured. The court held that in this case the employer was not liable for failing to safeguard the disks.

Summary

From the preceding it seems that the employer must guard his machinery under the following conditions:

1. When it is expressly required by statute; that is, when certain kinds of machinery are expressly named in the statute itself.

2. When this machinery is dangerous to the life and limb of workmen under normal and careful operation; or where it is plainly evident that the machine should have been included in the enumerated list of the statute, but was apparently overlooked. Where there is no list given in the statute, the employer can only have discharged his duty when he has safeguarded all dangerous machines or appliances as a reasonably cautious man in the same profession, trade, or calling would have done.

* * *

According to a recent Commerce Report, there is a movement on foot in Germany to organize the automobile manufacturers into what appears to be a cartel similar in form to the German Dye Syndicate. The object of this organization would be to diminish cost of sales and to bring into operation an agreement whereby each factory would limit the number of types which it made. The first results of this movement have been the establishment of the Gemeinschaft Deutscher Automobilfabriken (Association of German Automobile Manufacturers), by the National Automobil Gesellschaft, the Hansa-Lloyd Werke, A. G. Bremen and the Brennaborwerke at Brandenburg. These three concerns have made an agreement covering their manufacturing program, and are said to have agreed also to have their local sales conducted jointly.

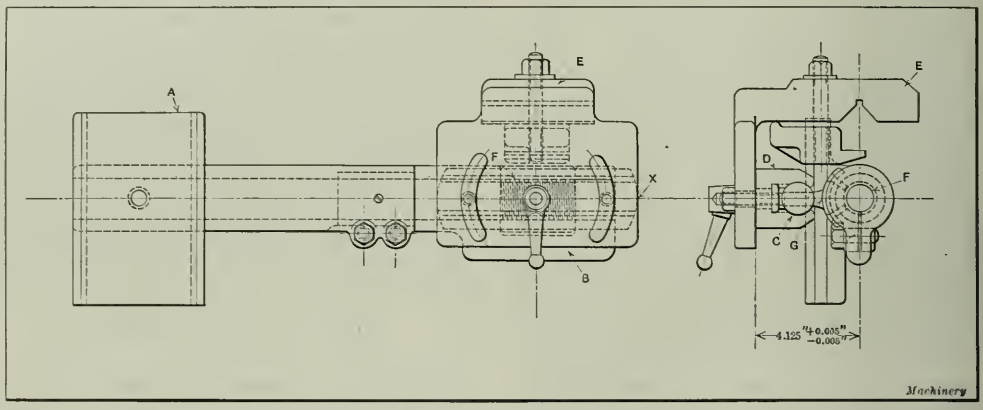
PITCH COMPENSATOR FOR THREAD-CUTTING LATHES

By J. B. CONWAY

The illustration accompanying this article shows the assembly of a device for compensating the error in the lead-screw of a lathe when cutting threads. It is well known that the ordinary commercial lead-screw is not intended to be sufficiently accurate for cutting precision threads. It is also known that the cost of manufacturing a lead-screw which is suitable for this type of work is almost prohibitive for general use. When making fine instruments and gages, even a minute variation in the lead of the thread must be avoided, and to this end the compensator here described was designed for use in the Gage Division of the Frankford Arsenal. Other lead-screw pitch compensators have appeared on the market from time to time, and while they all follow the same fundamental principle, the construction of each is different. The principle involved in this design is also used by the Pratt & Whitney Co., Hartford, Conn., and by the Greenfield Tap & Die Corporation, Greenfield, Mass.

The design consists essentially of a carrier block *A*, an extension arm and nut retainer *B*, roller *C*, roller guide *D*, roller guide support *E*, compensating nut *F*, compensating nut stem *G*, besides the miscellaneous details. The carrier block *A* is made of cast iron and is fitted to the apron slide, the split nut on the lead-screw and the cam which operates it being removed for this purpose. Provision is made for bolting the carrier block securely in place, utilizing the cam bolt hole. The extension arm *B* is made separate to allow it to be replaced by arms of various lengths as occasion requires. The compensating nut *F* is made of bronze and is fitted to the lead-screw of the lathe to which the device is to be applied. It is supported by the extension arm and is free to turn upon the lead-screw. The compensator nut stem *G* is fastened to the compensator nut and carries the roller *C* which is free to slide on the stem. The roller guide *D* has a circular groove extending its full length in which the roller slides as the nut travels laterally. The guide is pivotally clamped to the roller guide support *E*, which is clamped to the ways of the lathe.

With the attachment in place, it is only necessary to adjust the position of the roller guide as determined by the arc-shaped slots in the roller guide support, so as to shorten or lengthen the travel of the carriage in relation to that of the compensator nut. The studs projecting through the slots are provided with a clamping handle. The movement of the lead-screw imparts motion to the nut, which in turn actuates the apron and the carriage. If the error in lead is assumed to be +0.005 inch in 3 inches, this can be compensated for by swinging the end of the roller guide upward sufficiently to shorten the lateral travel of the carriage 0.005 inch during the 3-inch travel of the nut. The end of the roller guide and its support is graduated (the zero line being at *X*) in order to facilitate the setting, but this must be established after the attachment has been tried out and the existing error in the linear pitch of the lead-screw determined. This attachment may, of course, be used in the neutral or central position, the same as with the ordinary split nut. It cannot be disengaged, however, unless it is removed from the lathe, which can be readily accomplished by removing the supporting bracket at the end of the lead-screw, thus allowing the device to be easily disassembled.



Assembled View of Compensator for Errors in Pitch of Lead-screws

* * *

RESEARCH IN ALLOYS

The Division of Industrial Research of the National Research Council is arranging for the formation of a cooperative association to plan and support fundamental researches in alloys. Although much valuable work has been done in this field by scattered investigators, there is no doubt that a well-planned and coordinated effort by a cooperative association working under the general guidance of the National Research Council and composed of specialists representing both the manufacturers and the more extensive users of alloys can produce additional results of great importance. The success of other industries which have supported research on a cooperative plan, such as has been done by the National Canners' Association and the Malleable Iron Manufacturers, is evidence of this. It is planned to create a special scientific staff composed of a director and assistant director of research and a group of scientific investigators and technical experts who will give their whole time to the work. To finance the organization, each member of the cooperative association will pay $1000 a year, and all contributing members, who may be either alloy manufacturers or users (individuals or companies) are to benefit alike by the results of the researches.

* * *

A new method for regulating the heat in an electric furnace has been developed by Walter P. White and L. H. Adams, of Washington, D. C. By making the heating coil of the electric furnace one arm of a Wheatstone bridge, the inventors have succeeded in keeping the temperature of a laboratory electric furnace constant, for hours, within 0.1 degree C., at temperatures between 500 and 1400 degrees C., and this practically without any attendance. Previous to this development, a regulation within 5 degrees C. was considered good. The present arrangement appears to be limited to direct currents.

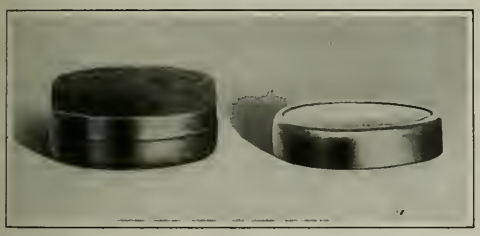
LETTERS ON PRACTICAL SUBJECTS

WE PAY ONLY FOR ARTICLES PUBLISHED EXCLUSIVELY IN MACHINERY

LUBRICATING DEVICE FOR SMALL TOOLS AND INSTRUMENTS

Squares, rules, protractors, and other similar steel graduated tools, if not properly cared for, soon acquire a slight coating of rust caused by handling or by atmospheric conditions. The result is that it becomes difficult to read the graduations and makes it necessary to polish the tools frequently. As the graduations are not very deep, this scouring, especially if abrasives are used, may in time obliterate the markings and thus destroy the usefulness of the tool.

The writer has devised the lubricating device illustrated herewith, which may be inexpensively made and which, if regularly used, will prevent the accumulation of rust, and consequently preserve the life and usefulness of the tools. The lubricator consists simply of a small tin ointment box procured for a few cents at almost any drug store, in which is inserted a roll of felt. The felt should be of the proper width so that the cover may be easily put in place after the roll has been wound to tightly fit the box. A small bottle of vaseline costing about 5 cents should be purchased and the contents applied to both sides of the felt before it is rolled up. The felt might be saturated with lubricating oil instead of vaseline, but oil usually contains traces of acid, the action of which will tarnish the steel surface. Vaseline,



Lubricator with Cover removed, showing Roll of Felt

being a petroleum product, keeps the surfaces bright and free from rust. Steel tools should be greased every day before going home from work. The cover should be kept on the box at all times, except when in use, so as to exclude dust from the felt.

Youngstown, Ohio W. S. STANDIFORD

DEVELOPMENT OF TIME SLIDE-RULE

The diagrams shown in connection with this article illustrate three different methods by which the time required to complete a job may be instantly found if the starting time and the finishing time are known. Each idea originated from a different source in the shop, the slide-rule shown in Fig. 3 being the final and best scheme devised.

Fig. 1 represents the first idea—that of a chart for calculating elapsed time. In changing over from a system of figuring time in which hours and minutes are used, to a system calculating in tenths of an hour and hundredths of a minute, some trouble was experienced by the time clerks. Ordinarily this change would have been easily handled, but at the time that the change was made, the jobs were short, one man often having several job tickets per day. This frequent changing of tickets and the computation involved, caused confusion and errors which resulted in the design of the chart and subsequently of the slide-rule.

From the point representing the starting time, at the top of chart, follow the corresponding diagonal downward until it intersects the vertical line corresponding to the finishing

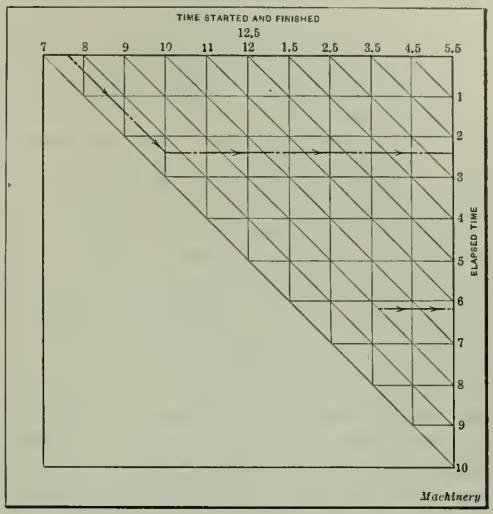


Fig. 1. Chart for finding Elapsed Time when Starting and Finishing Times are known

time, and thence along the horizontal line to the right-hand side of the chart where the elapsed time can be read. For instance, if the starting time is 7.6, that is 7:36 A. M., and the finishing time 10 A. M., the reading at the right is 2.4 hours; or, if the starting time is 9 A. M. and the finishing time 3.7 or 3:42 P. M., the elapsed time will be 6. 2 hours The main divisions of the chart should, of course, be divided into ten subdivisions when the time is figured by tenths of hours, whereas if the time is figured by minutes, there should be sixty divisions, which would require a large chart.

For the benefit of those who desire to construct a chart, the following explanation is offered. Lay off on the horizontal axis a number of divisions equal to the working

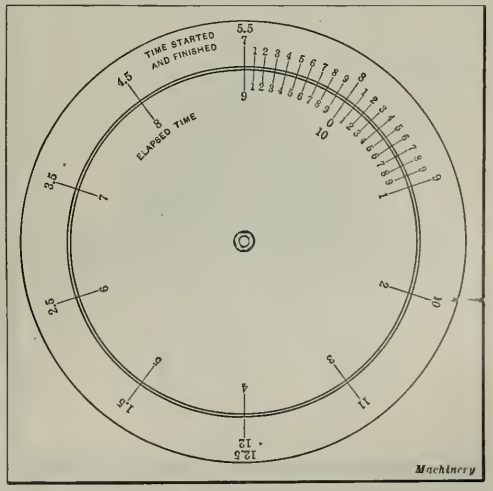


Fig. 2. Circular Slide-rule, the Use of which is Identical with that of the Chart

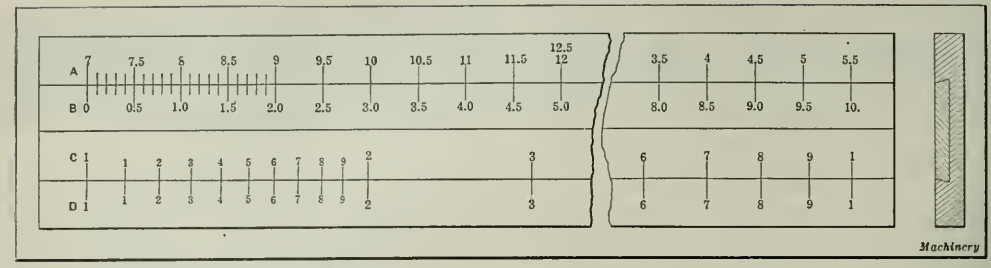


Fig. 3. Slide-rule Arrangement by Means of which Elapsed Time may be found. Arithmetical Operations may be performed on the Lower Scales

hours in the day, as for instance, ten. Mark the left end of the line as the starting time, or 7 o'clock, and each of the divisions to represent one hour, that is, 8, 9, and so on up to the lunch hour, or 12 o'clock. As the lunch hour must be deducted from the time included between start and end of the working day, the starting time after lunch will begin at the same point at which the quitting time is registered. The next division after the lunch hour will be marked to represent an elapse of one hour from the time of the start of the afternoon work, in this case, 1.5 or 1:30 P. M. Continue thus, to the time for quitting. Draw a vertical line of the same length as the horizontal axis at the right-hand side of the chart and divide it into ten equal parts numbering the divisions as shown in the diagram, to correspond with the number of hours in the working day. Diagonals are then drawn connecting the division marks on the two axes, and the horizontal and vertical lines drawn as shown.

Fig. 2 represents simply a circular slide-rule constructed from the chart, consisting of two circular disks, pivoted at the center so that the inner disk may revolve within the other. The numbers designating time and hours elapsed are identical with those used on the chart and the results obtained are exactly the same. The straight slide-rule, Fig. 3, is evidently the best arrangement for obtaining the elapsed time, and in addition, contains on the lower part of the rule a reproduction of scales *C* and *D* of a standard 10-inch slide-rule, thus enabling the calculations connected with time-keeping to be performed directly on the rule. The material used should be seasoned wood, preferably cherry or walnut, and care should be exercised to obtain a nice working fit where the slide is dovetailed in the body of the rule.

Camden, N. J. J. B. Conway

DIES FOR DRAWING AN AIR PUMP PART

In the manufacture of a combination piston and cylinder furnished in an air pump used for pumping up automobile tires, the dies described in the following article are required. The pump is attached to one of the spark plug holes of an automobile engine while in use. The various dies that are employed in producing this part are illustrated in the order in which they are used, and the dimensions of the shell after each operation are also given.

The shell is made from cold-rolled strip steel, 0.065 inch thick, the blank being 5 13/16 inches in diameter. The die shown in Fig. 1 is a combined blanking and drawing die which cuts the blank and performs the first forming operation. This die is of the standard type and is used on a press having the usual rubber buffer attachment and plates for pins *A*. The steel strip is laid upon the cutting ring *B*, and as the edge of the punch face ring *C* passes the edge of the cutting ring when the punch descends, the blank is cut to size. As the punch continues its descent, the shell is drawn upon the forming die *D*. The knock-out pad *F* ejects the shell from the punch on the return stroke of the press ram.

A reduction is made in the diameter of the shell by the die illustrated in Fig. 2 which also commences to form the flange. When ring *A* is in the normal position, the upper end of the ring is flush with the upper end of the forming die *B*. The shell is placed over ring *A*, and as the punch descends, the ring is pushed downward until it reaches the position shown, at which point this operation upon the shell has been completed. The pins *C* push the ring *A* back to its original position upon the return stroke of the press ram and at the same time force the shell from the forming die.

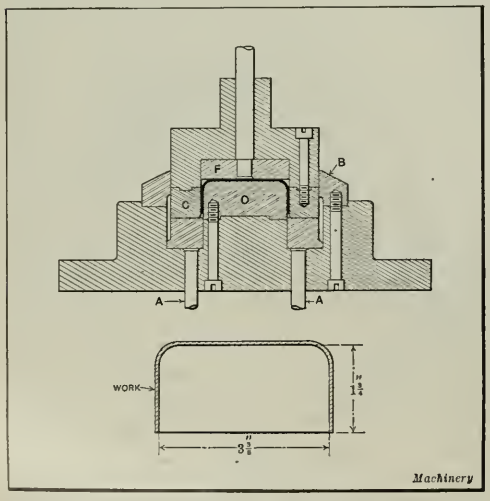


Fig. 1. Combination Blanking and Forming Die for performing First Operation on Shell

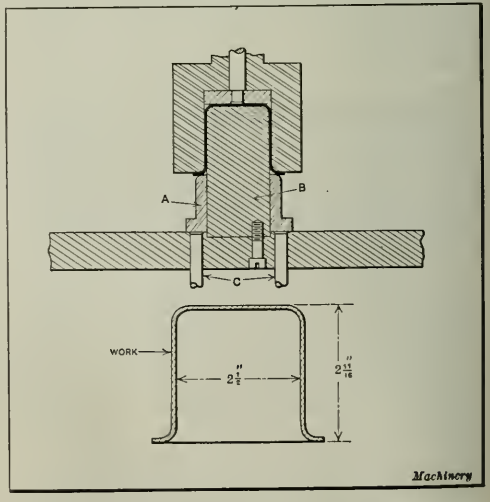


Fig. 2. Die employed to reduce the Diameter of the Shell and start forming Flange

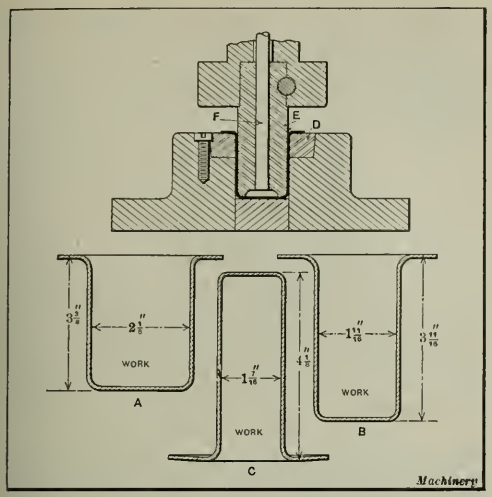


Fig. 3. Type of Die used to make Three More Reductions of the Diameter of the Shell

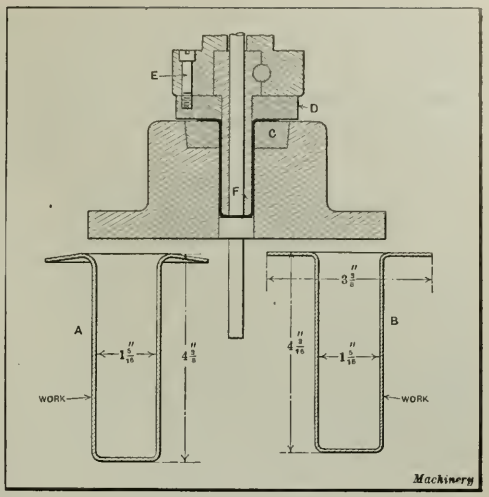


Fig. 4. Die which makes the Final Reduction of the Shell Diameter and flattens the Flange

Three different sizes of dies of the construction shown in Fig. 3 are used to further reduce the diameter of the shell. The shell is first reduced to the size shown at *A*, then to the size shown at *B*, and finally to the size shown at *C*. In each case the shell is forced into the die only until the flange comes in contact with the forming die *D*. If an attempt were made to draw the shell any deeper, the bottom would be forced out, because the flange cannot be reduced at the same time as the body. The punch *E* is inserted and held in the press in such a manner that it is not pushed from the press when the rod *F* forces the shell off the punch.

Fig. 4 shows the die that makes the final reduction in the diameter of the shell to the dimensions shown at *A*, and also flattens the flange as shown at *B*. Two operations are performed to attain this end. When the shell is being formed to the shape illustrated at *A*, the ring *D* and screws *E* are removed from the punch. As in the preceding dies, the shell is forced into the die only until the flange touches the die-ring *C*. After a certain quantity of shells has been drawn to the shape shown at *A*, the ring *D* is secured in place as shown and a second operation is performed upon the same pieces, flattening the flange as shown at *B*. The die illustrated in Fig. 5 trims the flange of the shell and cuts a hole in the opposite end. The flange is trimmed as the cutting ring *A* passes the edge of ring *B* on the downward stroke of the press ram, the scrap being forced down on the cutter *C* which cuts the scrap into two pieces, permitting it to fall away from the die. The hole is cut in the end of the shell as the face of punch *D* passes the edge of the cutting ring *E*. A detail of the knock-out pad *F* is shown at *G*.

The final operation on the shell consists of "edging up" the flange by the die shown in Fig. 6. When ring *A* is in the normal position, the upper face is on a level with the upper surface of the die-ring *C*. The shell is then placed on plug *B* and ring *A* and as the punch descends the edge of the flange is forced back and the face is flattened. The plug *B* is 0.007 inch larger in diameter than the punch *F* in Fig. 4 which makes the final reduction in the shell diameter. This increased size permits the barrel of the shell to be expanded at certain points and upset at other points, thus causing the sides of the barrel to become parallel. After the operation has been performed, the shell is forced from plug *B* by means

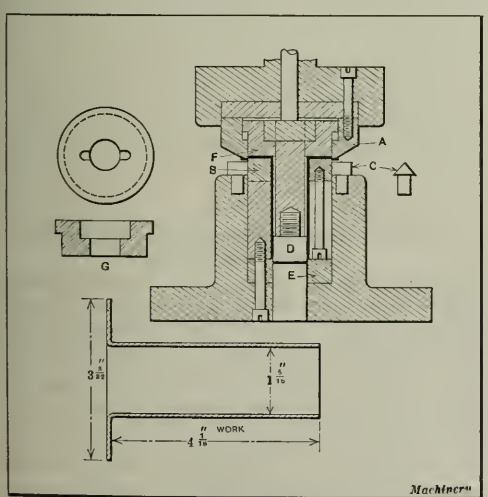


Fig. 5. Method of trimming the Flange and cutting the Hole in the End of the Shell

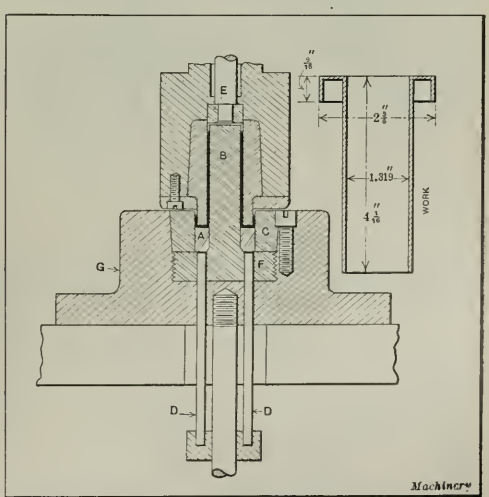


Fig. 6. Die for performing Final Operation which consists of edging up the Flange

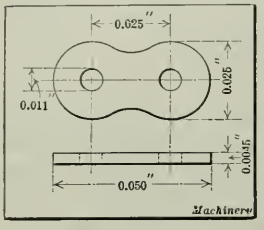
of the pins *D* which force the ring *A* upward, while the knock-out pad *E* ejects the shell from the punch. The tool-steel plug *F* which is screwed into the die-block *G* serves as a bumping block for ring *A* and as a guide for pins *D*. All parts of the different dies are hardened and ground.

The dies described were made while the writer was superintendent at the Acklin Stamping Co., Toledo, Ohio.

Toledo, Ohio J. BINGHAM

FLAT-LINK CHAIN OF MINUTE PROPORTIONS

A flat-link chain has been found to be the best medium for transmitting the motion of an altimeter diaphragm to the indicating hand. It is evident that the chain for such a sensitive instrument must be exceedingly small as compared with the usual machine shop dimensions. Previous to the outbreak of the war, this chain was obtained from Swiss manufacturers, but owing to the fact that the war both increased the demand and cut off the supply to a great extent, it became necessary to make these chains in this country. The separate links are first punched out on a small, specially designed press. The accompanying illustration shows the dimensions of one of these links, which at first were assembled by hand until finally an automatic machine was developed. After the chain has been assembled, it is put into what is known as a "suppling" machine. This machine detects and loosens tight rivet joints which may cause kinks in the chain and which would seriously affect the accuracy of the instrument. This is so serious a factor in the efficiency of the instrument that the Bureau of Standards has also built a special machine for this purpose. A graphic idea of the minuteness and cost of this chain may be gained from the statement that a double handful of the links contains about 250,000 pieces, valued at $4000. L. L. T.



Proportion of Links for Chains used on Altimeters

MICROMETER FOR SETTING CUTTER IN BORING-BAR

The large micrometer shown in the accompanying illustrations has been of value in setting the cutter in boring-bars when machining holes of large diameter. Fig. 1 shows the instrument being utilized in setting the cutter to bore a hole 9½ inches in diameter, the boring-bar, cutter, and the hole to be bored being indicated by dot-and-dash lines. The micrometer has two anvils which are held against the body of the boring-bar when a measurement is being taken to the cutting edge of the cutter. A special head was made for this micrometer, but a regular head could also be used. It is obvious that twice the distance *X* must be added to the diameter of the boring-bar in order to determine the diameter of the hole that will be bored by the cutter. A detail of the steel frame is shown in Fig. 2. NORMAN MCCLEOD

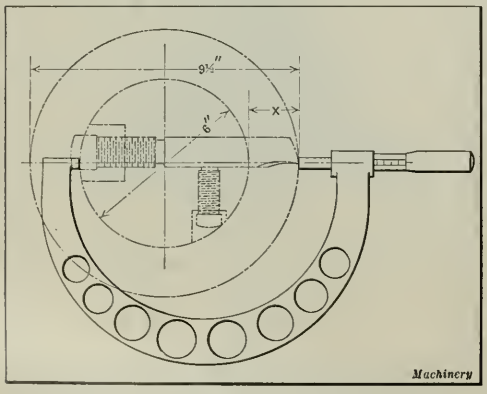


Fig. 1. Method of using Micrometer for setting Boring-bar Cutters

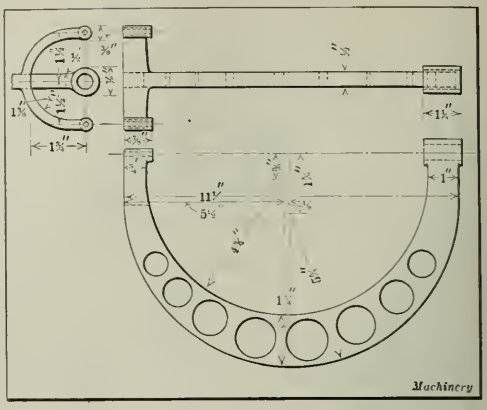
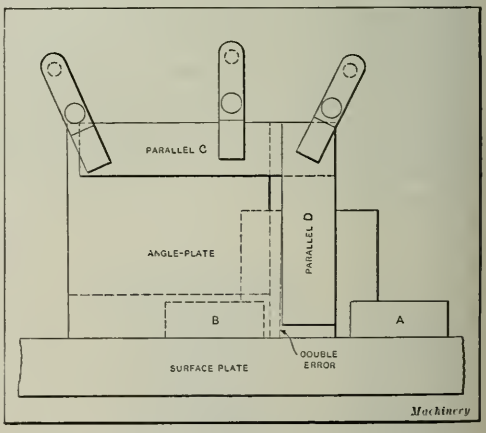


Fig. 2. Detail of Micrometer Frame

TESTING A SQUARE

The method described in this article for testing a square requires only the use of a surface plate, an angle-plate, a pair of parallels, and three small clamps, all of which are in common use in the average tool-room. The advantage of this method is that it shows a double error, thus allowing the error to be readily located and a more accurate adjustment to be made with less effort than by ordinary methods.



Set-up for testing a Square

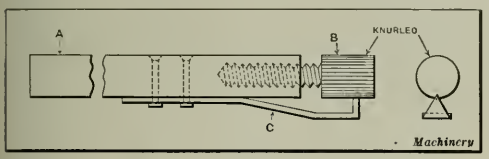
To test the square, an angle-plate is placed on a surface plate. A parallel is clamped to the angle-plate, as at *C* in the accompanying diagram. This parallel acts merely as an arm to which the parallel *D* is clamped perpendicular to the surface plate, and it need not therefore be accurately located. This parallel should overhang from the side of the angle-plate enough to admit light freely. The square to be tested is placed on the surface plate in position *A*, and the parallel *D* is adjusted until it shuts out light between the edge of the square and the side of the parallel. The square

is then moved to the opposite side of the parallel, as shown at *B*. It is evident that if any error exists, it will be indicated by the admission of light between the two adjacent edges, and that the space admitting the light will be twice as great as the actual error. Both the outside and inside edges of the square may be tested in this manner, the accuracy of the test being limited only by the accuracy of the tools used and the care taken in making the test.

Seattle, Wash. CARL E. SCHINMAN

ADJUSTABLE STOP FOR HAND SCREW MACHINES

The illustration shows an adjustable stop that has been advantageously used on a 2-inch Pratt & Whitney screw machine producing electric drill spindles, the lengths of which were held within a limit of 0.005 inch, plus or minus. When the regular stops were used, a large amount of time was spent in adjusting them because it was necessary first



Method of providing Adjusting Feature on Ordinary Stops

to loosen the set-screw on the stop-holder and then strike the stop lightly with a hammer or wrench in order to move it backward or forward until the correct position was obtained, after which the set-screw was again retightened. Often the point of the set-screw marred the surface of the bar, and when the screw was retightened, this would cause the bar to return to its original position.

All of this trouble was eliminated when the machine was equipped with the type of stop illustrated. A hole was drilled in one end of the regular bar stop *A* which was then tapped to a depth of about 1 inch with a ¼-inch tap having 32 threads per inch. The set-screw *B* was made from a piece of cold-drawn steel of the same diameter as the bar stop. A straight knurl was cut on the head of the screw, which was then casehardened. The spring *C* was made of ¼- by 1/32-inch spring steel, and was offset about 3/16 inch. The end of the spring which makes contact with the screw head, was machined to fit the knurls on the screw and thus hold it in place. The spring was secured to the stop by two 1/16-inch rivets. It was riveted in such a position that the contact point of the spring was central on the screw head when the screw was in the mean position, and as the head was ½ inch long, an adjustment of ¼ inch was obtainable in either direction. By the use of these stops, an operator can set up his machine fairly close in the usual manner and then make accurate settings by means of the adjusting feature.

Cicero, Ill. J. J. BORKENHAGEN

PRINTED FORMS FOR STANDARD GAGE DRAWINGS

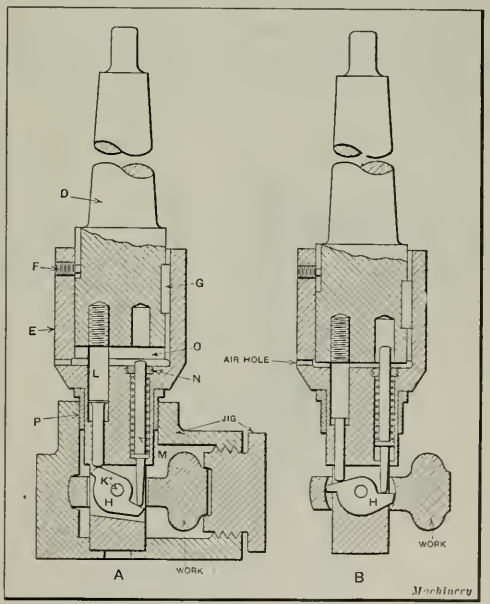
The following is a convenient method of making drawings of standard plug and snap gages. A printer's plate is made for each style gage, the variable gaging dimensions being left blank. Then as many copies as desired can be printed on tracing cloth or thin paper. The plate is made with heavy lines so that a good blueprint may be assured. With this method it becomes necessary only to fill in the "Go" and "Not Go" sizes and suitable title data on a copy in order to produce a working drawing of a gage, after which as many blueprints may be printed as desired.

The two following methods of making these drawings can also be used: (1) A master tracing is first made, from which "Van Dyke" prints are produced. The Van Dyke copy has blank spaces similar to those on the printed forms, and after these are filled in, blueprint copies are made for the tool-room, just as would be done with the original tracing-cloth drawing. This method, however, is expensive, and the resulting blueprints are frequently poor. (2) Copies from a master tracing are made by blueprinting. The blueprint copy serves as the original from which copies are made on the photostat machine. After the blank spaces are filled in on the photostat copies they are used for shop purposes. In view of the fact that the photostat method is also expensive, the printed drawing system seems to be preferable, and as it has given excellent results, it is almost sure to appeal to those chief draftsmen who handle large quantities of small gage drawings.

Syracuse, N. Y. ELMER C. COOLEY

TOOL FOR DRILLING A SPHERICAL HOLE

The accompanying illustration shows a device designed for drilling a 1-inch spherical hole in brass pieces, ½ inch thick, which were produced in large quantities. The taper shank of the body *D* is held in the spindle of a drill press. The socket end of the blade-holder *E* is fitted over the lower end of the body and is attached to it by means of the set-screw *F*, the point of which operates in a slot which allows for vertical movement of the body. Key *G* permits the body to drive the blade-holder. The swiveling blade *H*, is secured in the lower end of the blade-holder by stud *K*. Finger *L*, which bears against one end of the blade, is



Device used to drill Spherical Hole in Brass Pieces

screwed into body *D*, while finger *M* which bears against the other end of the blade, is held in a vertical hole in the blade-holder. This finger is forced downward by an expansion coil spring that it held between a shoulder on the lower end of the finger and the threaded bushing *N*.

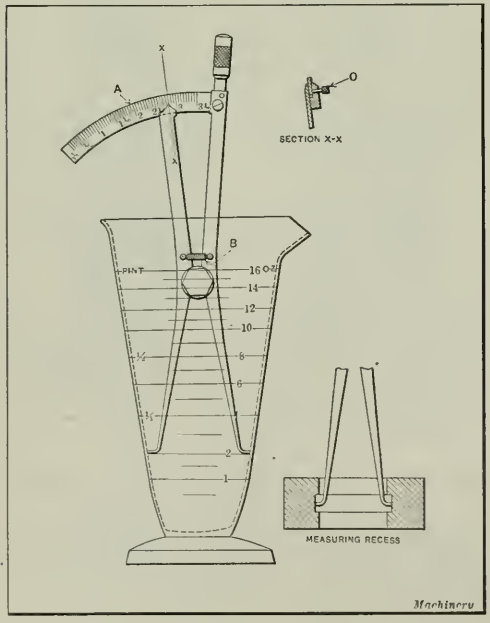
Before using this device, the work is placed in a jig and a straight hole is drilled through it, the diameter of which is about equal to the smallest diameter of the final spherical hole. After this operation has been completed the jig is located on the machine on which the spherical drilling operation is to be performed. The spindle of the machine is then lowered until the bottom end of the blade-holder *E* reaches the position in the jig that is illustrated at *A*. Up to this point the blade is held in the upright position illus-

trated at *A*, so that it can be inserted in the hole in the work. This is accomplished by the finger *M* pushing down on one end of the blade through the force exerted by the expansion spring. When this position has been reached, however, the blade-holder can no longer be lowered, and as the body *D* continues to descend by reason of the movement allowed by space *O*, the finger *L* acts upon the other end of the blade and overcomes the force exerted by the spring, thus causing the blade to swivel around stud *K*. In this manner, both ends of the blade are permitted to cut the sides of the hole as the blade revolves, until they reach the position shown at *B*, when the work is completed. As soon as the operator commences to raise the spindle of the machine, pressure is no longer exerted on the blade by finger *L*, and owing to the force exerted on the blade by the expansion spring through finger *M*, the blade is returned to the normal position as shown at *A*, before the blade-holder is withdrawn from the jig. Sleeve *P* is provided to guide the blade-holder into the opening in the jig. An average of two minutes was required for an unskilled workman to drill the straight and spherical holes in one piece, and only three blades were necessary to produce 10,000 pieces.

Ivry-Port, (Seine), France P. ROUQUET

INSIDE CALIPER OF SPECIAL DESIGN

The accompanying illustration shows an inside caliper which was originally designed for use in testing druggists' graduates, but which has also proved valuable as a tool for the machine shop. The proportions of the caliper are such as to provide a wide range of use, and the design is so simple as to require little skill to operate. By inserting the tool to the desired depth, the reading is taken directly on the attached bar *A*, one side of which may be graduated



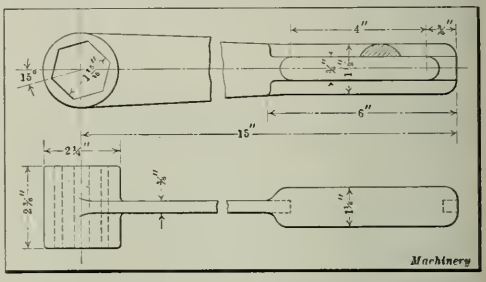
Inside Caliper with Graduated Arm and Indicator Arm

in units of English measurement and the opposite side in units of metric measurement. The compression coil spring *B*, as is apparent from the illustration, will keep the points spread when not in use, and will exert a certain amount of pressure on the internal walls of the work when taking the measurements. The screw *C* is provided to clamp the indicator hand in position so that duplicate measurements can be taken readily and quickly. In overhauling gas engines, this tool has been found very useful. The cylinders are usually worn in spots, and it becomes necessary to know the extent of this wear in order to determine whether reboring is required or not. For any boring or recessing job, in fact, this caliper will be found of especial value.

Beverly, Mass. V. G. TERRY

SOCKET WRENCH FOR LARGE COUPLING

The socket wrench shown in the accompanying illustration was made especially for use in connecting and disconnecting a large compression coupling used on heavy shafting. As the shafting was too heavy to be turned by hand, some difficulty was experienced in using an ordinary single-sided wrench having two sides of the hexagonal hole parallel with the handle. The special socket wrench shown, being



Double-sided Socket Wrench for tightening and removing Coupling Nuts in Inaccessible Positions

double-sided and having the hexagonal hole at 15 degrees, enabled the coupling nuts to be tightened or removed even when the coupling was in very inaccessible positions.

Watervliet, N. Y. MARTIN H. BALL

REDUCING INITIAL COST OF STRADDLE-MILLING CUTTERS

Two side milling cutters were required for a certain straddle-milling operation which it was desired to carry on almost continuously. The cutters were of large size and cost nearly two hundred dollars each; the purchase of two extra cutters so that one set could be ground while the other was in use was an expense out of proportion to the returns for the work, yet the time lost in sharpening after both sides of each cutter became dull was an item too large to be overlooked.

The scheme adopted was to buy one extra cutter. The two cutters on the machine could then be kept in operation while the third was being ground. When the opposing edges of the running pair became dull, instead of reversing these two as is customary, one cutter was removed and the other reversed and set up with the sharp cutter. Following this practice, there was never any delay in changing cutters more than that which occurs in changing to another set of cutters or at a change of position. The more frequent grindings were not a source of extra work as the operation was performed on a cutter grinder regularly employed on this class of work. By this simple method, which could be applied to similar work, the required number of cutters is reduced and a saving in cost effected.

Middletown, N. Y. DONALD A. HAMPSON

* * *

The most important developments in Australian industry during the war were in connection with engineering and associated trades. Factories were started for building a great many classes of machines and supplies not previously made in that country, including high-speed steam engines, piston-rods, airplane engines, gas engines, Diesel engines for marine work, hydraulic machinery, machine tools, etc.

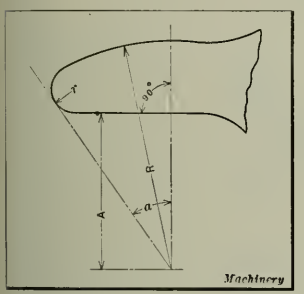
HOW AND WHY

QUESTIONS ON PRACTICAL SUBJECTS OF GENERAL INTEREST

UNITED STATES STANDARD OF LENGTH

J. C. N.—Is it true that the meter is the legal standard of length in the United States?

A.—While the yard is the commonly accepted standard, the meter is the legal standard of length. The original standard is kept at the International Bureau of Weights and Measures in France. This standard is a platinum-iridium bar having three exceedingly fine lines at each end. When the temperature of this bar is 0 degrees C. (32 degrees F.), the distance between the middle lines of each end is equivalent to one meter by definition. The United States Bureau of Standards has two copies of this original or primary standard. The legal equivalent of the meter for commercial purposes is 39.37 inches, this value being exact within the error of observation. These standard bars at Washington are the ultimate standards of reference for manufacturers of precision measuring instruments, etc., and working standards or duplicates have been made for their use.



MATHEMATICAL PROBLEM

W. G. W.—The accompanying illustration shows a problem encountered in designing a field pole tip which is submitted to the readers of MACHINERY for solution. The only known dimensions are the radius R, distance A, and the size of angle a. It is required to find radius r of the arc as shown.

HEAT-TREATMENT FOR GEARS

P. H. B.—The following heat-treatment was given to clashing tractor transmission gears cut from bar stock containing 0.15 to 0.25 per cent carbon, 0.35 to 0.65 per cent manganese, 0.30 to 0.65 per cent chromium, 1 to 1.5 per cent nickel, and not over 0.04 per cent sulphur and 0.04 per cent phosphorus:

1. Carburized nine hours in E. F. Houghton & Co.'s "quick light A" at 1500 degrees F.
2. Allowed to cool slowly in carburizer.
3. Reheated to 1200 to 1250 degrees F.
4. Quenched in water at about 50 to 60 degrees F.

The above treatment was according to advice given by the steel manufacturers. However, the gears were too hard for practical use, giving a hardness test of 100 to 125 on the scleroscope.

Another treatment was given the gears as follows:

5. Annealed by heating to about 1350 degrees F.
6. Reheated to 1350 degrees F.
7. Quenched in oil at room temperature.

The gears were still too hard, an analysis showing 0.61 per cent carbon, with a case existing apparently throughout. However, it is desired to have a hard wearing surface with a tough core for strength. Can these gears be made usable by any further treatment? Would it be possible to draw out the carbon without introducing other impurities, by reheating them in the presence of slag, silicon, sand, or some other non-carburizing substance?

If the steel were 0.40 per cent carbon, instead of 0.20 per cent to begin with, would the carburizing treatment given above produce only an average of 0.61 per cent carbon? Assuming they were from 0.40 per cent carbon alloy steel, with all other percentages the same as given, what further treatment would make them fit for use as clashing tractor transmission gears? The gear is small and was machined to the following dimensions: 4 inches pitch diameter; 8 diametral pitch; 2 inches face; 1¼ inches bore. The hub is 2½ inches diameter and 4 inches long.

TRIGONOMETRIC PROBLEM

F. E. M.—The diagram shows a disk which is laid against the two surfaces AE and AF, located at right angles to each other. If a size block of known dimensions is placed as shown, how can the diameter of the disk be calculated which will be tangent to both sides and to the corner of the size block?

ANSWERED BY GUY H. GARDNER, NEW LONDON, N. H.

Assume the dimensions of the size block to be ¼ by ½ inch, the length being arbitrary; then the diameter of the disk may be found in the following manner.

By geometry, if from a point without a circle, a secant and a tangent are drawn, as AC and AD, the tangent is the mean proportional between the whole secant and its exterior section. Hence

$$AC = \frac{AD^2}{AB}$$

But $AD = R$ = radius, and by trigonometry $AC = \frac{R \sin COA}{\sin OAC}$; therefore:

$$\frac{R^2}{AB} = \frac{R \sin COA}{\sin OAC}$$

Simplifying,

$$R = \frac{AB \sin COA}{\sin OAC}$$

Angle $OAD = 45$ degrees; tan angle $DAB = \frac{0.25}{0.50}$; $DAB = 26$ degrees 33 minutes 55 seconds; angle $OAC = 45$ degrees — 26 degrees 33 minutes 55 seconds = 18 degrees 26 minutes 5 seconds.

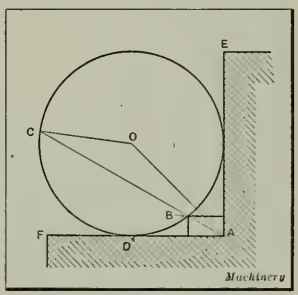


Diagram used in Connection with solving a Trigonometric Problem

$OA = 1.414R$; then by the law of sines,

$$\frac{1.414R}{R} = \frac{\sin OCA}{\sin OAC}$$

$$\text{Sin } OCA = 1.414 \sin OAC = 1.414 \times 0.31622 = 0.44714$$

$$OCA = 26 \text{ degrees } 33 \text{ minutes } 37 \text{ seconds}$$

$$COA = 180 \text{ deg.} - (OAC + OCA) = 180 \text{ deg.} - (18 \text{ deg. } 26 \text{ min. } 5 \text{ sec.} + 26 \text{ deg. } 33 \text{ min. } 37 \text{ sec.}) = 135 \text{ deg. } 18 \text{ sec.}$$

$$AB = \sqrt{\tfrac{1}{4} + \tfrac{1}{2}} = 0.559 \text{ inch}$$

Therefore

$$R = \frac{0.559 \times 0.70705}{0.31622} = 1.250 \text{ inch}$$

and the diameter of the disk equals 2×1.25, or 2.50 inches.

TO DRAW A CIRCLE TANGENT TO THREE GIVEN CIRCLES

M. A. C.—Is there any exact geometrical construction for drawing a circle tangent to three circles that are tangent to each other? For example, if the diameters of three circles are 2, $1\frac{7}{16}$, and $1\frac{7}{8}$ inches, what is the smallest circle that will include them?

ANSWERED BY C. N. PICKWORTH, MANCHESTER, ENGLAND

An answer to this problem was given in the March, 1917, number of MACHINERY in which the center of a circumscribed circle was found by modern or projective geometry. This method is very complicated: it requires a large number of operations, but gives no means of calculating the diameter

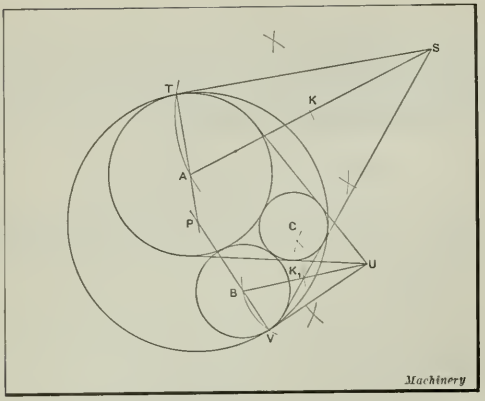


Fig. 1. Diagram illustrating Method of drawing a Circumscribed Circle Tangent to Three Given Circles

of the circumscribed circle. The following solution is based upon the following geometric theorem: If three circles are mutually tangential, a line drawn from the center of similitude of two of the circles tangent to the third circle, is also tangent to a circle which is tangent to the three circles.

The meaning of this somewhat involved statement will be more readily understood by referring to the diagram Fig. 1, in which the center of the circumscribed circle is found in the following manner: Draw two lines tangent to circles B and C which intersect at S, their center of similitude. Draw TS tangent to circle A, and at the point of tangency erect a perpendicular, which will pass through the center of circle A. Next draw two lines tangent to circles A and C, which will intersect at U, their center of similitude, and draw line VU tangent to circle B. From this point of tangency also erect a perpendicular, which will pass through the center of circle B. The point of intersection of this perpendicular and the line perpendicular to TS will be the center, P, of the circumscribed circle. The radius of this circle can be solved by the following formula:

$$R = \frac{abc}{2\sqrt{abc\,(a+b+c)} - (ab+bc+ac)}$$

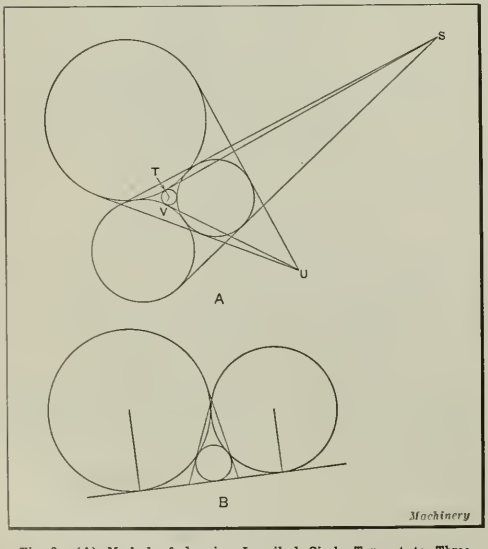


Fig. 2. (A) Method of drawing Inscribed Circle Tangent to Three Circles. (B) Diagram illustrating Case in which a Common Tangent to Three Circles is a Straight Line

in which

R = radius of circumscribed circle;
a = radius of circle A;
b = radius of circle B;
c = radius of circle C.

If A is 2 inches in diameter; B, $1\frac{7}{16}$ inches; and C, $1\frac{1}{16}$ inches; then $a = 1$ inch; $b = 23/32$ or 0.71875 inch; and $c = 17/32$ or 0.53125 inch. Substituting these values in the above formula the following is obtained:

$$R = \frac{0.38184}{1.85378 - 1.63184} = 1.720 \text{ inches}$$

Therefore the diameter of the circumscribed circle is $2 \times 1.720 = 3.440$ inches.

As accuracy is required in laying out this diagram, in order to locate the center of the circumscribed circle exactly, perpendicular TP should be erected in the following manner, which eliminates the necessity of drawing TS and reduces the chance of errors. Draw AS from the center of similitude to the center of the circle and bisect this line at K as shown. Then with KA as a radius, draw an arc intersecting the circumference of the circle at T, after which line TP can be drawn by intersecting point T and center A. The same method should also be used in drawing perpendicular VP.

If the tangent lines TS and VU had been drawn to the opposite points of tangency, as shown at A in Fig. 2, the intersection of the two perpendiculars erected from this point of tangency would have been the center of an inscribed circle tangent to the three circles. In cases where the line tangent to three circles is a straight line, the perpendicular lines erected by the first method will not intersect but will be parallel as shown at B, Fig. 2. When one of the circles is so small that it is within a line tangent to the other two circles, as shown in Fig. 3, the perpendiculars erected by the first method described give the center of a circle which is tangent to the three circles but which does not circumscribe the circles. The formula for finding the radius of such a tangential circle is as follows:

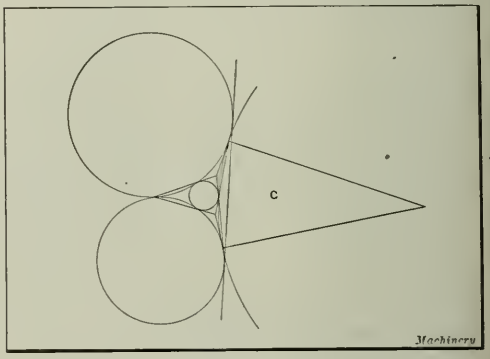


Fig. 3. Case in which the Smallest of Three Tangent Circles is within a Line Tangent to the Other Two Circles

$$R = \frac{abc}{ab+bc+ac-2\sqrt{abc\,(a+b+c)}}$$

in which the various letters represent the same elements as in the previous formula. The writer is indebted to C. V. Durell for the evolution of these formulas.

* * *

In order to improve the facilities of the United States in obtaining reliable information relating to foreign trade, the National Civil Service Reform League has issued a statement relating to foreign service requirements, with suggestions for improvements in the personnel and organization of the consular and other foreign service, with the view, particularly, of taking this important branch of our government out of the political patronage domain.

STANDARD TIME IN CONNECTION WITH TIME-STUDY WORK

By J. B. CONWAY

In adopting time-study methods, the first question that arises concerns establishing a basis from which to determine the standard time allowance after the actual or average time has been obtained. There are several methods for obtaining this standard. On account of the misunderstandings which obtain regarding methods of computing standard time, the accompanying chart has been prepared by the writer, to assist in clarifying the subject. It must not be inferred, however, that this is in any sense a "short cut" in the actual making of a time study. It is only for the purpose of comparison and of simplifying the work of establishing the standard time.

Use of a Constant in Establishing Standard Time

There are several methods in use for computing standard time after the time study has been made. The one which is perhaps the most widely used consists of dividing the average time taken from the study by a constant. This constant varies with the nature of the work and is governed by variable factors which enter into the performance of the task. The result obtained is the standard time, or, expressing this as a formula:

$$\text{Standard time} = \frac{\text{Average time}}{\text{Constant}}$$

Assume, for example, that we have an average time of 3.2 minutes, and that the constant to be used is 0.70; then according to the formula, the standard time would be 4.57 or approximately 4.6 minutes. Referring to the chart, the same result may be obtained with much less effort. Entering the chart at the left on a line representing the average time of 3.2 minutes, and following it across to the point where the line intersects the line of the constant 0.70, then upward to the standard time line, we find the standard time to be 4.6 minutes. This procedure is reversed where the standard time is given in order to obtain the average or base time. This method, if a constant of 0.70 is used, increases the standard time a trifle more than would be obtained by adding 30 per cent to the average time.

The diagonal lines in the lower left-hand corner of the chart merely extend the range. It will be observed that the same horizontal lines on which the diagonal lines end at the right, are the lines from which the diagonal lines commence again from 5 to 10 at the left of the chart. It is not necessary to mark these diagonals on the bottom line, as the index numbers at the left can be made to serve as indices for the diagonals as well. As an example of the use of these diagonals, assume the average time to be 8.40 minutes. Entering the chart on the left, on the 8.40 minute line and traveling across until this line intersects the diagonal representing the allowance to be made, in this case 0.70, then downward to the bottom of the chart, the standard time is found to be 12 minutes.

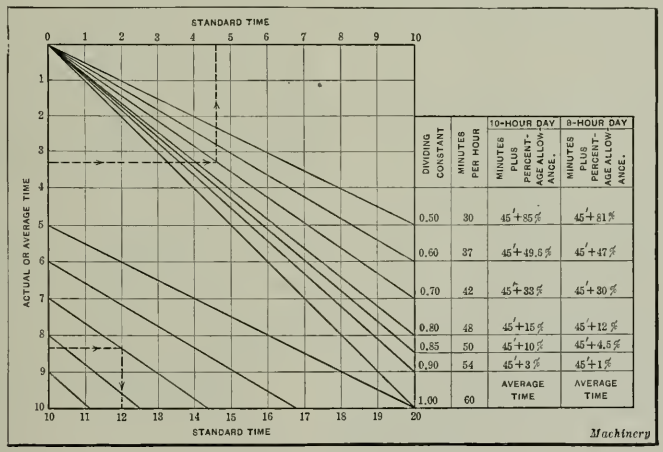


Chart for determining Standard Time in Time Studies

Method which Uses Percentages for Various Factors

Another method for establishing the standard time is to analyze the various operations, conditions, and other elements entering into the work, and allow a definite percentage for such factors as fatigue, personal care, and machine and tool troubles, with another percentage added as an incentive to the operator. The formula for this method is somewhat involved and is as follows: First, from the total working minutes in a day, subtract the machine, tool, and miscellaneous allowance, to obtain the net working minutes. Second, divide the number of net working minutes by the net average time per piece, obtaining the number of units completed per day. Third, divide the total working minutes by the number of units per day, giving the time allowance per piece. Fourth, multiply the time allowance by 1 plus the percentage allowed as an incentive to the operator; the result is the standard time. The standard time, then, is the sum of all allowances added to the average time required to machine one piece.

Thus, for a ten-hour day, again using 3.2 minutes as the average time per piece and the above formula,

$$10 \times 60 - 45 \text{ (machine, tool and miscellaneous allowance)} = 555 \text{ minutes} \quad (1)$$

$$\frac{555}{3.20} = 173 \text{ pieces per day} \quad (2) \qquad \frac{600}{173} = 3.46 \text{ min. per piece} \quad (3)$$

$$3.46 \times (1 + 0.33) = 4.6 \text{ minutes, standard time} \quad (4)$$

To obtain the same result from the chart, it will be noted that the line representing the constant 0.70 is marked 45 minutes + 33 per cent, under the heading "Minutes plus Percentage Allowance, 10-hour Day." This constant is, therefore, the one to employ, and following it through in the same manner as in the first example, we get the same standard time, or 4.6 minutes.

Another method is one in which the base is established as a certain number of minutes per hour, making an allowance which is supposed to include all necessary time such as cited in the second method. This allowance also varies, but not to the extent that the other allowances vary, and is therefore not as flexible. However, it may be made so, as is shown by the chart. To the right, in the column marked "Minutes per Hour" is given a time which is the equivalent of that obtained by dividing the actual number of minutes per hour by the constant. Thus, again using the same average time as before, 3.2 minutes, and the same time allowance, we find the standard time, 4.6 minutes per piece, and then applying the formula

$$\frac{\text{Average time} \times 60}{\text{Net working time}} = \text{Minute-hour}$$

This gives $\frac{3.2 \times 60}{4.6}$ or 42-minute-hour, which if divided by 3.2 equals 13.1 pieces per hour, and this divided into 60 minutes gives the standard time, 4.58 minutes, which if expressed to the nearest tenths is 4.6 minutes; or the same result may be obtained by dropping the decimal and calling 13 pieces correct for an hour's work. Either of these results

is close enough for general work. For an 8-hour day, using the same allowance in minutes, the percentage changes slightly. If fractional percentages occur it may be found advisable to decrease or increase the percentage to the next whole figure.

Recognized Factors Entering into the Subject of Time Study and Forming the Basis upon which the Chart is Constructed

The chart is indexed with whole numbers from 0 to 10; but, of course, these values may be multiplied or divided by 10 or any multiple thereof; for example 3.2 may be assigned values thus; 0.032, 0.320, 3.2, 32.0, 320, etc., the results obtained depending, of course, upon the value given these index numbers at the left margin. A little practice will enable anyone to use the chart intelligently and with slight chance of error. The original for the chart here shown was 5 inches square, and therefore fractional times are more or less difficult to read. The larger the chart can be made, to be used with convenience, the greater accuracy will be obtained. If a chart is made 20 inches square, it will be found to be about the right size.

It will perhaps be helpful to present here some of the factors and percentage allowances used by Frederick W. Taylor in his well-known time-study work.

1. Light work, calling for no special fatigue, such as ordinary shop practice, 30 per cent.

2. Ordinary labor, calling for severe bodily exertion and strength with resultant fatigue, 50 to 80 per cent.

3. Special skill or brain power, with close application but requiring no bodily exertion, 70 to 80 per cent.

4. Skill, brain energy, close application, and extreme bodily exertion, such as running a steam hammer, 80 to 100 per cent.

Other industrial engineers agree approximately on these figures, and Mr. Taylor has pertinently remarked that these factors are not to be theorized over, but are facts obtained by costly experiments.

The manner in which these percentages may be employed has been shown to some extent in this article, and other combinations may be obtained if one cares to go deeply enough into the subject, but those chosen will meet ordinary requirements. Attention is called to the method of establishing a definite "minute-hour" such as is shown in the chart. If a definite time is made to suit all classes of work in the shop, it will be found to work to disadvantage. Let us assume a case where the work in the machine shop is of such a type that an allowance of, say, 30 per cent is found suitable, whereas the work in the foundry of the same concern is of a considerably different type, and the element of fatigue is of more importance. If an allowance of 30 per cent for the machine shop should be made, it would probably develop that a greater amount than this should be allowed those operators in the foundry who do heavier work. Possibly from 50 to 80 per cent would be found justifiable in the latter case. Therefore, in adopting this method, by the use of the chart one may obtain the desired percentage as well as the minute basis per hour, and yet maintain the original dividing constant basis. A careful study of the foregoing will enable one to select the method best suited to his particular requirements.

* * *

At the convention of the Iron and Steel Electrical Engineers in St. Louis, Mo., a report presented by the electric-furnace committee of the association outlined the present status of electrical furnaces in the steel industry. The discussion brought out the insufficiency of the available technical literature on electric-furnace reactions. Concerning furnace-lining thicknesses, the opinion was expressed that too thin a lining wasted heat, while an abnormally thick lining limited the capacity of the furnace. The careful training of the operator was considered to be of paramount necessity for securing the successful operation of any electric furnace. It was stated that the furnace body should be of such shape as to give equal heat at every point.

DEVICE FOR RAISING PLANER TOOL DURING RETURN STROKE

By D. R. GALLAGHER

The device shown in Fig. 1 has been used successfully to prevent the cutting edge of a planer tool from dragging on the work during the return traverse of the table. It is well known that the cutting edge of a planer tool is often worn off by dragging on the work during the return traverse quite

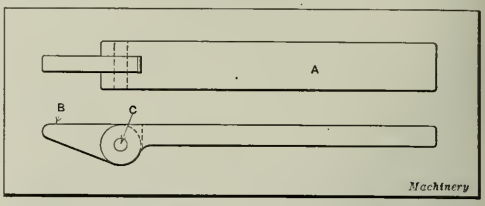


Fig. 1. Device which prevents Planer Tool from dragging on Work during Return Traverse of Planer Table

as rapidly as it is while taking a cut. For this reason, the device shown is particularly useful when planing long pieces of work in which wear on the cutting edge, from this source, is most objectionable. As shown in Fig. 1, the device consists simply of a shank *A*, made from mild steel about the width of the planing tool, and the tongue *B* which swings easily on pin *C*.

At *D*, Fig. 2, is shown the device in the position which it occupies during the forward or cutting traverse. It will be seen that the shank is clamped between the planer tool and the clapper-box with tongue *B* dragging on the work. At *E* the device is shown in operation as it appears on the return traverse of the table. It will be seen that the tongue, when it comes in contact with the work, serves to rock the clapper-box forward, thus raising the tool from the work. The tool is supported in this position during the return of the table, but again comes in contact with the work when the motion of the table is reversed, and the tongue is swung in the opposite direction so as to drag on the surface of the work again, as shown at *D*. A similar result may be obtained by placing a spring under the clapper-box and thus raising the tool from the work during the return of the table; but, if this arrangement is employed, the depth of cut should be greater than the distance through which the

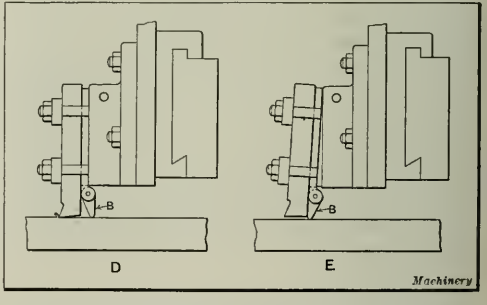


Fig. 2. Illustration which shows Operation of Protecting Device during Forward and Return Traverses of Planer Table at D and E, respectively

spring raises the tool, otherwise the tool would not come into proper contact with the work on the forward traverse. The device shown in Fig. 1, however, will function satisfactorily when the cut is only a few thousandths inch deep.

* * *

The Westinghouse Electric & Mfg. Co., East Pittsburg, Pa., has recently developed an electric automobile engine heater, to keep the engine warm while standing in the garage and to insure easy starting. It is said to have a power consumption of only 100 watts.

Combined Stresses

By VICTOR M. SUMMA, Engineering Examiner, American Brake Co., St. Louis, Mo.

ST. Venant's formulas for the analysis of shear and tension or compression stresses in machine parts (when these stresses are acting simultaneously and normally to each other) can be conveniently expressed in the following forms:

$$P_1 = \frac{S}{2} + \sqrt{\left(\frac{S}{2}\right)^2 + S_s^2} \qquad (1)$$

$$P_2 = \sqrt{\left(\frac{S}{2}\right)^2 + S_s^2} \qquad (2)$$

in which S is the tensile or compressive unit stress, S_s the shear unit stress, and P_1 and P_2 their maximum resultants in tension, or compression, and in shear, respectively, remembering that P_1 is tension if S is tension, and compression if S is compression.

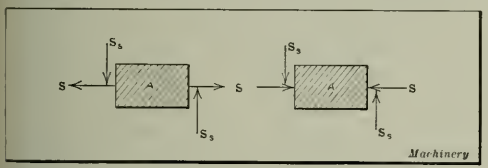
These original and fundamental equations (1) and (2) admit of many transformations, some of which are very useful. Unfortunately, however, the derived formulas are sometimes misapplied and it is not uncommon to hear engineers speak of them as antiquated and incorrect.

It is the purpose of this article to explain the use of two of the most familiar derivations of St. Venant's formulas, namely:

$$M_e = \tfrac{1}{2}M + \tfrac{1}{2}\sqrt{M^2 + T^2} \qquad (3)$$

$$T_e = M + \sqrt{M^2 + T^2} \qquad (4)$$

where M and T represent the bending and twisting moments to which a round shaft is simultaneously subjected, and M_e and T_e their equivalent moments, that is, the so-called "equivalent" bending moment and the "equivalent" torsional moment, respectively.



Diagrams showing how Tension and Compression Forces S and Shear Stresses Ss act simultaneously on an Infinitely Small Portion of a Body subjected to these Combined Stresses. The Diagram at the Left shows S in Tension and the One at the Right shows S in Compression

If an infinitely small portion A of a strained body is under stresses as shown in the accompanying diagrams, that is, if the tension or compression stress S and the shear stress S_s are acting at the same instant and normally to each other on a certain material point A, then there exists a definite plane in which their combined effect in tension, or compression, is a maximum, expressed by formula

$$P_1 = \frac{S}{2} + \sqrt{\left(\frac{S}{2}\right)^2 + S_s^2}$$

and another plane as definitely fixed as the first, in which their maximum combined effect in shear is

$$P_2 = \sqrt{\left(\frac{S}{2}\right)^2 + S_s^2}$$

Should it be necessary we could even determine the position of these planes, though the intensity rather than the direction of the stresses P_1 and P_2 is ordinarily required.

Hence, if a shaft 5 inches square in cross-section is subjected to a twisting moment $T = 200{,}000$ inch-pounds and at the same time to a bending moment $M = 260{,}000$ inch-pounds, the problem of ascertaining the greatest stresses in the material is wholly within the scope of the Formulas (1) and (2). In fact, if Z and Z_p represent the rectangular and polar moduli of section respectively, then

$$Z = \frac{5^3}{6} \text{ and } Z_p = \frac{2}{9} \times 5^3;$$

and since

$$S = \frac{M}{Z} \text{ and } S_s = \frac{T}{Z_p}$$

we have, by substitution,

$$S = \frac{260{,}000 \times 6}{5^3} = 12{,}500 \text{ pounds}$$

$$S_s = \frac{9 \times 200{,}000}{2 \times 5^3} = 7200 \text{ pounds}$$

$P_1 = 6250 + \sqrt{6250^2 + 7200^2} = 15{,}800$ pounds per square inch in tension or compression

$P_2 = \sqrt{6250^2 + 7200^2} = 9550$ pounds per square inch in shear.

In a similar way, if the shaft were round instead of square and its diameter was, say, 5 inches, we would have:

$$Z = \frac{5^3}{10.2} \text{ and } Z_p = \frac{5^3}{5.1}$$

$$S = \frac{260{,}000 \times 10.2}{5^3} = 21{,}220 \text{ pounds}$$

$$S_s = \frac{200{,}000 \times 5.1}{5^3} = 8150 \text{ pounds}$$

$P_1 = 10{,}610 + \sqrt{10{,}610^2 + 8150^2} = 24{,}000$ pounds per square inch in tension or compression.

$P_2 = \sqrt{10{,}610^2 + 8150^2} = 13{,}400$ pounds per square inch in shear (B). Thus it is seen how St. Venant's original and fundamental equations apply equally well to square and round shafts; indeed, they can be applied to any bars of which the rectangular and the polar moduli of section are known.

We will now see how Equation (1) may be transformed into (3) and (4), namely the formulas for the specific and limited case of round bars, and why these derivations should be used in connection with nothing but round bars.

Remembering that for round cross-sections the modulus of section for torsion is twice that for flexure, that is, that Z_p is equal to $2Z$, we have as unit stresses

$$S = \frac{M}{Z} \text{ and } S_s = \frac{T}{2Z}$$

Substituting above values in formula for P_1

$$P_1 = \frac{M}{2Z} + \sqrt{\frac{M^2}{4Z^2} + \frac{T^2}{4Z^2}} = \frac{1}{2Z}\left(M + \sqrt{M^2 + T^2}\right)$$

$$P_1 = \frac{M + \sqrt{M^2 + T^2}}{2Z} = \frac{\tfrac{1}{2}M + \tfrac{1}{2}\sqrt{M^2 + T^2}}{Z} \qquad (a)$$

Calling the numerator of the first fraction by the symbol T_e and the numerator of the second by M_e, we have, since $2Z = Z_p$,

$$P_1 Z_p = T_e \text{ and } P_1 Z = M_e$$

In other words, since stress P_1 is multiplied by Z_p—the polar modulus of section for twisting—the symbol T_e is simply an imaginary twisting moment equivalent to $M + \sqrt{M^2 + T^2}$; since P_1 is multiplied by Z—the plain modulus of section

for bending—the symbol M_e is an imaginary bending moment equivalent to $\frac{1}{2}M + \frac{1}{2}\sqrt{M^2 + T^2}$. Hence the well-known expressions:

$$M_e = \tfrac{1}{2}M + \tfrac{1}{2}\sqrt{M^2 + T^2} \quad (3)$$

$$T_e = M + \sqrt{M^2 + T^2} \quad (4)$$

But, whether M_e or T_e, these symbols refer only and always to P_1 the tensile (or compressive) stress, and not at all to P_2, namely, the shear, as is generally thought when the formula for the equivalent twisting moment is used. Indeed, we can, in a measure, appreciate the necessity of discriminating between the two sets of formulas by comparing the change in result when any of the derivations (3) and (4) is used to solve the previous problem of the 5-inch square shaft, as we would then have

$$P_1 = \frac{T_e}{Z_p} = \frac{260{,}000 + \sqrt{260{,}000^2 + 200{,}000^2}}{2 \div 9 \times 5^3} = 21{,}160 \text{ pounds}$$

which of course is too great a value, the more exact answer being 15,800 pounds as determined by the first solution.

Now that the equivalent bending moment and the equivalent twisting moment have been considered, we can go one step farther (in fact, since Formulas (3) and (4) give only tension or compression stresses, it is necessary to take another step if the *shearing* stresses are to be determined), and transform the general equation (2) at the beginning of the article into new formulas for the specific and limited case of round bars.

This is readily done, since the only difference in form between the expressions of the values of P_1 and P_2 is the term outside the radical in Equation (1), and the transformation of the radical is naturally the same in both cases. So, the fractions in Formula (a) of P_1 are readily changed to

$$P_2 = \frac{\sqrt{M^2 + T^2}}{2Z} = \frac{\frac{1}{2}\sqrt{M^2 + T^2}}{Z} \quad (b)$$

Or, using the symbols M_{es} and T_{es} to indicate $\frac{1}{2}\sqrt{M^2+T^2}$ and $\sqrt{M^2+T^2}$ respectively, we have (remembering that $2Z=Z_p$):

$$T_{es} = P_2 Z_p, \qquad M_{es} = P_2 Z$$

which show that T_{es} is simply another imaginary twisting moment, and that M_{es} is another imaginary bending moment; but, since we are dealing with P_2, they will give shearing stresses only.

Hence we can write down the following important results:

$$M_{es} = \tfrac{1}{2}\sqrt{M^2 + T^2} \quad (5)$$

$$T_{es} = \sqrt{M^2 + T^2} \quad (6)$$

These new derivations of St. Venant's, then, are as definite and distinct as the old Formulas (3) and (4), and like them are only good for round shafts, or any bars, the cross-sections of which are circular in shape.

Formula (6) is known as Guest's formula, but Guest used it to find the tensile stresses only, thus making an empirical formula out of an otherwise thoroughly theoretical derivation.

In order to check the correctness of the above formulas, we might use them to find the maximum stress P_2 in the preceding example of the 5-inch round shaft, and see whether it gives the same value as Formula (B), namely, 13,400 pounds derived by the use of Formula (2).

Referring to Formula (5) it will be seen that

$$P_2 = \frac{M_{es}}{Z} = \frac{1}{2} \times \frac{\sqrt{260{,}000^2 + 200{,}000^2}}{5^3 \div 10.2} = 13{,}400 \text{ pounds}$$

or, by (6)

$$P_2 = \frac{T_{es}}{Z_p} = \frac{\sqrt{260{,}000^2 + 200{,}000^2}}{5^3 + 5.1} = 13{,}400 \text{ pounds}$$

In summing up it may be convenient to group the two sets of formulas on round members under combined bending and twisting moments as follows:

Equivalent bending moment for *tension and compression* equals

$$\tfrac{1}{2}M + \tfrac{1}{2}\sqrt{M^2 + T^2} = M_e = P_1 Z$$

Equivalent twisting moment for *tension and compression* equals

$$M + \sqrt{M^2 + T^2} = T_e = P_1 Z_p$$

Equivalent bending moment for *shear* equals

$$\tfrac{1}{2}\sqrt{M^2 + T^2} = M_{es} = P_2 Z$$

Equivalent twisting moment for *shear* equals

$$\sqrt{M^2 + T^2} = T_{es} = P_2 Z_p$$

It must be apparent from these considerations, that there is nothing wrong with Formulas (3) and (4), and, that with the understanding that they must be limited in their application to circular cross-sections, they are as correct as St. Venant's original Formula (1) from which they are derived.

The introduction of the factor of lateral contraction (the so-called Poisson's ratio) into St. Venant's equations should not go unnoticed by those whose work demands exceptional care and exactness, as is necessary, for instance, in the manufacture of guns. Formulas (1) and (2) could, in the case of steel, be written

$$P_1 = (1 - R)\frac{S}{2} + (1 + R)\sqrt{\left(\frac{S}{2}\right)^2 + S_s^2}$$

$$P_2 = (1 + R)\sqrt{\left(\frac{S}{2}\right)^2 + S_s^2}$$

where R is Poisson's ratio, or the ratio of the unit transverse deformation to the unit axial deformation, (about 1/3 for ordinary steel), and the *true* stress P_1 is tension if S is tension, and compression if S is compression.

* * *

MANGANESE INDUSTRY IN AMERICA

There has been a great reaction in all the "war mineral" industries during the past year. There were many minerals that became valuable only because of their uses in connection with the manufacture of war materials, and many industries grew up in the effort to supply these minerals. As soon as the demand for war material ceased, these overgrown or newly established industries faced a serious condition. The manganese industry was one of these. During the first nine months of 1919 the production of manganese ore containing 35 per cent or more manganese was only 53,800 tons as compared with 229,900 tons, or more than four times as much, during the corresponding period in 1918. During the last three months of the period mentioned in 1919, less than 10,000 tons were produced, which indicates the tremendous falling off in the industry.

The cost of mining manganese in the United States is much higher than the cost in foreign countries, and the grade of the domestic ore, in general, is lower than that of the foreign ore. Hence, production of manganese ore can be expected in the United States only in case there is a high protective tariff on this mineral. An effort is now being made to obtain a tariff which will give this industry an immediate prosperity, but it is stated by the United States Geological Survey that in a few years of normal steel production—four or five years at the most—the known manganese resources of this country will be exhausted. In the event of another war after the domestic manganese deposits had thus been practically exhausted, or at least seriously depleted, the country would face a much greater shortage than it did in 1917 and 1918.

* * *

The scarcity of coal in France has again brought the question of the use of the Alpine water powers to the forefront. In the Alpine region 6,000,000 horsepower can be developed by the average water flow, and elsewhere in France 3,000,000 horsepower can be obtained by hydraulic development to various streams. At the close of 1915, 738,000 horsepower had already been developed from installations in the Alps, but this amount has been considerably increased during the war period.

The Machine Tool Trade

REPORTS from machine tool builders both in New England and in the Middle West indicate continued activity. The foreign trade has been considerably curtailed by the present condition of the foreign exchange, but the domestic trade has so far absorbed all the capacity thus made available for the home market. Some machine tool builders in the middle western states were temporarily affected by the coal shortage due to the miners' strike and the orders for shutting down industrial plants that followed; but the strike now being practically settled, the industry has resumed its activity. There have been some further increases in the prices of certain types of machine tools, and in some instances prices are now quoted that are higher than the prices during the war period. This refers particularly to certain lines of machine tools, the advances on which during the war period were very moderate and a considerable percentage less than the general advances in the cost of raw materials and labor.

The scarcity of steel is making itself felt, and higher steel prices are anticipated. This increase in price is a direct result of the disorganized conditions in the steel trade caused by the strike. As steel advances in price, the products made from steel will doubtless also advance, and this, in turn, will affect the products manufactured by machinery, and consequently increase the cost of living; so that further advances in living costs may be anticipated as a direct result of the strikes in the steel industry and in the coal mining field. Foreign makers of high-grade steels—high-speed and tool steels—are active in introducing their products into the United States or in pushing the sales of brands already introduced, the conditions of the foreign exchange as well as the state of the steel market here both being favorable to this. It is even reported that European-made small tools will soon be placed on the market in the United States, because with all European money worth only from 45 to 80 per cent of its normal value, it is possible to pay transportation charges and tariff duties, and yet sell at a price lower than that now prevailing in the American market. The only way that these conditions can be remedied is by stabilized labor and increased production, matters which are very largely in the hands of labor itself. An educational campaign is needed to thoroughly impress the whole nation with the fact that prosperity is based upon goods produced and can be had in no other way.

EXPORTS OF METAL-WORKING MACHINERY FROM THE UNITED STATES, OCTOBER, 1919

Countries	Lathes, Dollars	Sharpening and Grinding Machines, Dollars	Other Machine Tools, Dollars	All Other Metal-Working Machinery, Dollars
Austria-Hungary	.....	.....	.....	64
Belgium	68,215	45,238	6,666	146,565
Denmark	1,034	620	3,760	29,452
Finland	.....	1,902	4,685	.....
France	263,383	106,416	200,487	1,496,506
Germany	.....	272	.....	6,980
Italy	17,549	16,806	45,943	117,305
Netherlands	2,035	1,334	4,049	9,116
Norway	7,144	3,123	16,853	14,773
Portugal	2,125	225	1,589	1,023
Roumania	4,866	.....	.....	.....
Russia in Europe	.....	.....	571	.....
Spain	31,204	25,084	29,241	86,538
Sweden	14,948	23,421	14,842	21,558
Switzerland	.....	475	10,549	1,385
England	167,868	80,272	236,221	457,495
Scotland	.....	.....	48,894	779
Canada	30,833	122,795	149,003	181,432
Costa Rica	.....	.....	1,038	.....
Guatemala	1,320	36	.....	.....
Honduras	3,933	.....	.....	2,959
Nicaragua	.....	.....	499	.....
Panama	2,858	206	241	4,135
Salvador	.....	20	.....	.....
Mexico	1,042	498	7,330	5,663
Newfoundland and Labrador	21	.....	67	336
Barbados	20	.....	.....	5,477
Jamaica	899	.....	304	.....
Trinidad and Tobago	1,725	837	32	.....
Other British West Indies	.....	4	.....	.....
Cuba	35,173	2,208	42,306	21,151
Danish West Indies	.....	22	.....	.....
French West Indies	.....	.....	414	.....
Dominican Republic	.....	.....	320	.....
Argentina	8,553	566	7,723	11,427
Bolivia	.....	.....	228	195
Brazil	18,804	456	12,234	5,575
Chile	7,140	689	3,235	42,525
Colombia	.....	43	161	1,814
Ecuador	.....	96	271	2,253
British Guiana	.....	.....	520	.....
Peru	928	141	877	9,772
Uruguay	.....	.....	912	2,461
Venezuela	1,950	.....	270	.....
China	8,752	574	2,107	13,085
Japanese China	.....	.....	.....	270
Chosen	.....	.....	285	259
British India	6,969	7,521	2,895	8,871
Straits Settlements	.....	70	595	37
Other British East Indies	.....	.....	40	.....
Dutch East Indies	5,105	1,224	9,628	8,677
Hongkong	421	.....	252	282
Japan	26,191	17,329	21,248	74,619
Russia in Asia	18,981	400	15,148	6,791
Siam	.....	56	53	130
Australia	7,407	857	11,841	82,248
New Zealand	650	2,355	2,776	4,758
French Oceania	.....	30	.....	.....
German Oceania	.....	.....	.....	10
Philippine Islands	9,738	210	3,369	3,834
Belgian Kongo	.....	.....	160	.....
British West Africa	960	176	.....	870
British South Africa	3,100	3,741	4,826	5,573
Morocco	.....	.....	.....	85
Portuguese Africa	.....	85	413	.....
Egypt	1,050	530	.....	665
Total	784,964	468,963	927,881	2,897,778

Machinery

Bulletins on Government Machine Tool Sales

The Machine Tool Section, Office of the Director of Sales, War Department, has prepared and is now distributing to dealers and users of machine tools through the various district selling offices of the War Department, a comprehensive bulletin, listing approximately 2500 machine tools, valued at about $4,000,000, which the government is offering for sale. The machine tools are listed in the bulletin according to their class, type, size and maker, together with the address of the district office having the tool for sale. A brief description of each tool is given, including its "service condition." This bulletin will be revised from time to time as sales are made or as additional machines are declared surplus. It is expected that new bulletins will be issued every fifteen days. Copies of this bulletin may be obtained from the following bureau district offices: Air Service, Materials Disposal Branch, at 811 Little Bldg. Boston, Mass.; 2050 Elmwood Ave., Buffalo, N. Y.; 230 E. Ohio St., Chicago, Ill.; Maxwell Motor Co., E. 1st St. and B. & O. R. R., Dayton, Ohio; Aviation General Supply Depot, Springwells, Detroit, Mich.; 360 Madison Ave., New York City; and Postal Telegraph Bldg., San Francisco, Cal. Copies may also be obtained from the Ordnance Salvage Board at Columbia Ave. and B. & O. R. R., Baltimore, Md.; 19 Portland St., Boston, Mass.; 945 Main St., Bridgeport, Conn.; 74th and Ashland Ave., Chicago, Ill.; and Walsh Bldg., 3rd and Vine Sts., Cincinnati, Ohio.

Government Machine Tools Sold to France

The War Department, with a view to assist in the rehabilitation of French industries, particularly those located in the devastated regions of France, has entered into a contract with the French Republic, under the terms of which the French government will purchase $25,000,000 worth of machine tools from the surplus stock of such tools held by the

War Department in the United States. The French government will pay for these machine tools with ten-year, 5 per cent bonds of the French Republic, which at maturity, are payable in dollars. The French government has appointed a commission consisting of ten members who have already left France to come to the United States for the selection of the machine tools. These representatives will select the tools to be purchased, and the French government is to accept them at the point of their present location and in the condition in which they now are. The tools purchased under this contract will be paid for at prices determined by the price-fixing chart adopted by the War Department last summer for arriving at prices to be charged for surplus machine tools.

Exports of Metal-working Machinery

The accompanying table shows exports of metal-working machinery, in general, and of machine tools during the month of October, 1919, which is the latest information published by the Department of Commerce. The effect of the depreciation of the foreign exchange had not made itself felt at this time, and the total exports of metal-working machinery amounted to over $5,000,000, out of which a sum of nearly $2,200,000 was represented by machine tools, corresponding to an annual rate of machine tool exports of over $26,000,000. France was the leader in imports of machine tools, having taken a total of about $570,000. England takes second place with imports amounting to nearly $500,000. During October, Germany entered the field as a buyer to a very small extent, the exports of metal-working machinery to Germany amounting to slightly over $7000. The exports to the Scandinavian countries decreased appreciably, not only because of difficulties with exchange, but also because of the very low prices at which German machine tools are offered in the Scandinavian market.

Causes of Depreciation of Foreign Exchange

The causes that have brought about the demoralized condition of the foreign exchange are many. In the first place, during and after the war there were huge increases in our exports to Europe, while there was a great decrease in our imports. Hence there came into the foreign exchange market a greater volume of checks and drafts on Europe than European drafts on America, resulting in a far greater supply of foreign exchange in this market than there was a demand on the part of Americans having remittances to make abroad. As always happens in the case of any commodity when supply exceeds demand, prices of the foreign exchanges fell. The depreciation of foreign exchange in the American market, therefore, is merely a normal expression of the law of supply and demand, and normal conditions can be expected only when our imports become large enough in proportion to our exports to stabilize the foreign exchange market.

During the war the foreign exchange on Europe was kept from depreciation to present levels by the great volume of gold sent from Europe to the United States in cash liquidation of the adverse European balance, and later, when America entered the war, our Government extended credits to our allies which kept a large volume of foreign exchange for European purchases out of the market. Now, however, Europe has practically sent here all the gold that can be spared, and the extension of government credit has ceased. Hence, there is nothing to prevent the foreign exchange from dropping to a low level from which it will return only as trade begins to flow from Europe to this country as well as in the opposite direction.

In addition to this, European exchange is further depreciated by the fact that foreign currencies are depreciated because of great issues of paper money by practically all of the European nations—certainly by all those engaged in the war. The redemption of these issues and the restoration of an actual gold standard in Europe will aid in correcting the depreciation of European currencies.

FOREMEN'S MEETINGS

By OSCAR E. PERRIGO
Pratt & Whitney Co., Hartford, Conn.

There has lately been a great deal of interest in foremen's meetings, shop committees, and similar plans for increasing the efficiency of manufacturing plants and creating a better understanding between employers and employes. The question of where and when this movement started and its progress up to the present time has been referred to by many writers. It is the object of the present article to add a few paragraphs to the history of this movement.

In the autumn of 1888 the writer was engaged to design special tools and machinery for the American Graphaphone Co., which had some time before taken over the principal building of the Elias Howe Sewing Machine Co. in East Bridgeport, Conn., for the purpose of manufacturing the graphaphone invented by Professor Taintor. In February, 1889, the writer was made superintendent of the factory, and it was shortly after that time that a plan was worked out for foremen's meetings. The factory building was long and comparatively narrow and contained several floors so that communication between the different departments and the superintendent's office was not very prompt or satisfactory. The first step toward a more systematic method of dealing with the foremen was to divide the day in such a manner that each class of business requiring the superintendent's opinion would be handled at a particular time. Requisitions and reports were presented from 8 to 9 in the morning; conferences with the two assistant superintendents were held between 9 and 10; the different departments in the shop were visited between 10 and 12; reports were again presented between 1 and 2, and a conference with the general manager was scheduled at 2 P. M.; the time between 5 and 6 P. M. was again spent in the shop. The working hours were from 7 to 12 A. M. and from 1 to 6 P. M. for five days in the week. On Saturdays the closing time was one hour earlier, or at 5 P. M., making a fifty-nine-hour week.

While this plan of dividing the time was an improvement upon the older custom of trying to "take things as they come" it was soon discovered that things often "came" much faster than they could be taken care of, and that some better plan was desirable. This resulted in a scheme in which, instead of "going after the foremen," the superintendent had the foremen come to him. In this way what came to be called the "Foremen's Meeting" was organized. This meeting was held at 2 P. M. each day except Saturday, and was conducted as follows: The two assistant superintendents and the foremen were seated in the superintendent's office with a stenographer ready to take notes. "Complaints" were first in order, and each foreman was called upon, in turn, to present his difficulties. The other foremen were encouraged to give their opinions as to how the matter could best be handled. Then the assistant superintendents gave their opinions, and the superintendent finally gave such orders as seemed to meet the requirements in each case.

The next question in order was "troubles," which related generally to jigs or fixtures, or methods of performing certain machining operations. Usually several suggestions were offered by the other foremen, sometimes shedding a new and unexpected light on the matter, after which a final decision was made as before. Finally came "recommendations," which were handled in a similar manner. The superintendent and the assistant superintendents then made some general remarks relating to the progress of the work or asked for any needed information concerning it, after which the meeting closed. These meetings usually lasted from forty minutes to an hour. What had been said was written out and a copy handed, during the afternoon, to each man present at the meeting.

At the time these meetings were organized the writer had never heard of foremen's meetings. Generally speaking, more ideas are brought out by bringing men together in a meeting than by approaching the same men singly.

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW AMERICAN METAL-WORKING MACHINERY

Hartness Screw Thread Comparator. Jones & Lamson Machine Co., Springfield, Vt. 467
Rochester Safety Shaft Oiler. Ricker Mfg. Co., 239 N. Water St., Rochester, N. Y. 469
"Babbittrite" Compound. Products Sales Co., 606 Security Bldg., Milwaukee, Wis. 469
Gairing Counterbore. Gairing Tool Co., Inc., Detroit, Mich. 469
Inside Gages. Production Equipment Co., Inc., 1 Madison Ave., New York City 469
Strip Stock Oiler for Power Presses. Practical Device Mfg. Co., 257 Layton Blvd., Milwaukee, Wis. 470
Chicago Ball Bearing Pulleys. Chicago Pulley & Shafting Co., 32-38 S. Clinton St., Chicago, Ill. 470
Cruban Automatic Taper Turning Tool. Cruban Machine & Steel Corporation, 2 Rector St., New York City 471
National Boring and Tapping Machine. National Lathe Co., Cincinnati, Ohio 472
Barrett Three-way Facing Machine. Barrett Machine Tool Co., Inc., Meadville, Pa. 472
Toledo Toggle Drawing and Stamping Press. Toledo Machine & Tool Co., Toledo, Ohio 473
Reid Surface Grinding Machine. Reid Bros. Co., Inc., Beverly, Mass. 474
Barrett-Cravens Trailer Trucks. Barrett-Cravens Co., 171 N. Ann St., Chicago, Ill. 474
Burke Sensitive Drilling Machine. Burke Machine Tool Co., Conneaut, Ohio 474

Hartness Screw Thread Comparator

The Hartness screw thread comparator is a projection type of apparatus designed to show instantly the magnitude and kind of errors in screw threads. When the thread shadow is projected upon the standard tolerance chart, the relative positions of the shadow and chart not only show the resultant effect of lead errors, the pitch diameter, the finish and form of the thread, but also whether the tolerance is within the limits that are required in interchangeable manufacture.

WHILE the projection lantern has been used for sometime for inspecting screw threads of various kinds, it has been applied generally to the finer work, such as the inspection of thread gages and precision screws. The Hartness screw thread comparator, now manufactured by the Jones & Lamson Machine Co., Springfield, Vt., combines new features that make it possible to see instantly the resultant effect of all elements that affect the fit of a screw thread. This projection apparatus not only provides a means of determining in a practical way, the magnitude and kind of errors in screw threads, but enables screws of various classes to be inspected on the basis of dependability. Since a dependable screw fastening is one having a known depth of engagement of the threads of mating parts and a fairly uniform distribution of stress over the threads (or in other words, a good surface area in contact) this new basis of measurement is considered essential to the most satisfactory use of screws of various kinds. Screws which are to be dependable, either as a means of adjustment or for fastening purposes, must have well-formed flanks with a reasonable degree of accuracy in lead and pitch diameter. These elements are revealed instantly by the visual method.

This measuring machine, or comparator, is shown in use in Fig. 1. The lantern, work-holder, and lenses are all mounted upon a substantial column, and there is a bench-like frame for holding the tolerance chart upon which the thread shadow is projected. The work-holder contains the projection and magnifying lenses which are selected and designed for screw thread service.

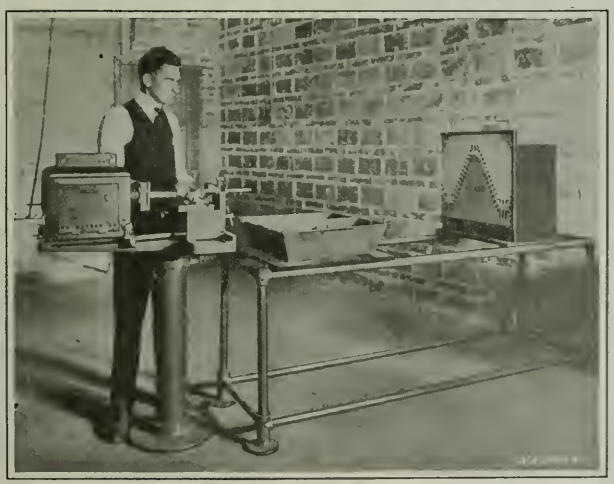


Fig. 1. Hartness Screw Thread Comparator consisting of a Projection Lantern and a Tolerance Chart upon which the Thread Shadow is projected

In addition, there are condensing lenses in the lamp house. It is neither necessary nor desirable to use this apparatus in a dark room, a moderate light being preferable.

The tolerance chart has two rows of dots, and the space between these rows of dots represents the allowable error for the screw thread. A detailed view of the type of work-holder commonly used for bolts is shown in Fig. 2. The bolt is placed in supporting cradles and it is held in position by a finger which is held lightly against the bolt by the operator's right hand. At the same time, the operator rotates the bolt with his left hand, partly to eliminate any foreign matter that may be on the screw or lodged in the cradles. This rotation of the bolt also reveals the general character of the thread, as regards roundness and "stagger." The thread in the cradle is cleared at the crest and root so that it bears on the sides of the thread being inspected, thus locating the work in relation to the flanks of the thread.

The machine is adjusted by the use of a standard threaded plug that is selected with reference to the particular work being inspected. The work-holder just referred to is the design used for most bolt work when the thread is comparatively short, and there is a cylindrical part that may be used as a supporting surface. When inspecting long screw threads, it is sometimes desirable to use two threaded "nests" or cradles, in which case only one of them is fixed and the other is allowed to slide parallel to the axis of the screw, to compensate for lead errors. A work-holder having two threaded cradles is shown in Fig. 3. One



Fig. 2. Work-holder of the Form generally used for Bolts

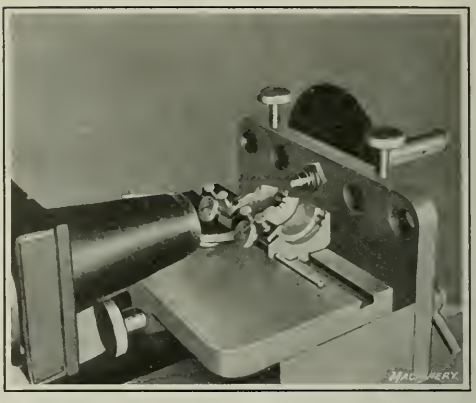


Fig. 3. Work-holder for Screws—Note the Two Threaded Cradles

of these cradles is clamped rigidly in position and the other is free to slide endwise. The fixed cradle is located at a distance from the projecting lens equal to the length of engagement of the screw, either in a nut or threaded hole. This location of the fixed cradle determines the extent to which the shadow will be shifted sidewise on the tolerance chart.

When the shadow of the thread to be inspected is projected upon the chart which has been adopted as a standard for that particular class of work, the position of the shadow relative to the two rows of dots representing the maximum and minimum sizes, shows errors in diameter, lead, angle, and contour. For example, when the shadow lies along the lower edge of the upper row of dots, this shows that the screw is of maximum size. On the contrary, if the screw is of minimum size, its shadow will coincide with the edges of the lower row of dots. Thus, the space between the dotted lines represents the range of variation in size that will be tolerated for the grade of work represented by the chart. Hence, the shadow of each screw tested must lie between these boundaries.

Since the lead error directly affects the apparent fit of the screw in the threaded hole, it has been found desirable for the average better grade of work to allow any lead error that will not shift the shadows outside of these boundaries. The shift of the shadow sidewise is due to the amount of lead error between the thread that rests in the thread nest and the thread that is projected on the chart. The distance between the threads referred to, for the average requirement, should equal the length of engagement of the thread in service. In the case of a bolt thread that is used with a nut, this length is made equal to the thickness of the nut. If a cap-screw, then the length should equal the length of thread that is engaged in the threaded hole. For the average run of work, the length of engagement may be considered equal to one and one-half diameters. If both the screw and nut are to be hardened, then this length must be fully equal to the length of engagement. If either or both the screws and nut or threaded hole are to be soft then for some grades of work a shorter length may be acceptable. The important point to be emphasized is that the lead plays a very important part in the fit of a screw and its importance varies with the class of service. The comparator makes it possible to gage screws within any degree of precision of lead that the work requires. Lengthening the distance between the threaded nest and the projecting lens increases the precision any amount desirable within the length of the screw.

Tolerance charts are easily made to suit different classes of work. By a comparison of the tolerance chart and shadow illustrated in Fig. 4, it will be seen that this particular thread has an error in lead, as the shadow is displaced to the left. Another example is shown in Fig 5; in this case the projected thread is very accurate as to lead, and its pitch diameter is the minimum size, as indicated by the fact that the shadow coincides with the inner row of dots on the tolerance chart. This screw and the one previously referred to is a U. S. standard, having a nominal diameter of $\frac{5}{8}$ inch. Since it is magnified two hundred times, the slight surface imperfections are readily seen when the image is projected on the chart. It will be noted that the root or bottom of the thread profile is rounded somewhat as the result of wear on the cutting dies. As there is seldom a full thread in the nut or threaded hole, this rounding can be tolerated.

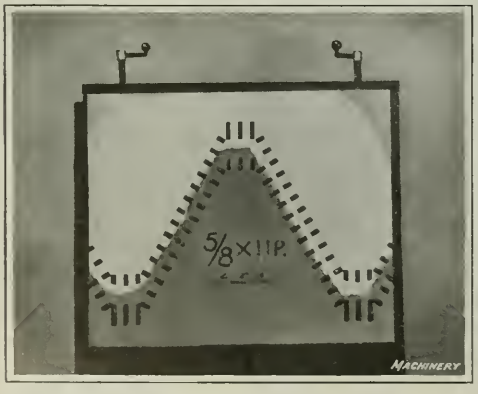


Fig. 4. Tolerance Chart and Shadow of Thread which has a Lead Error

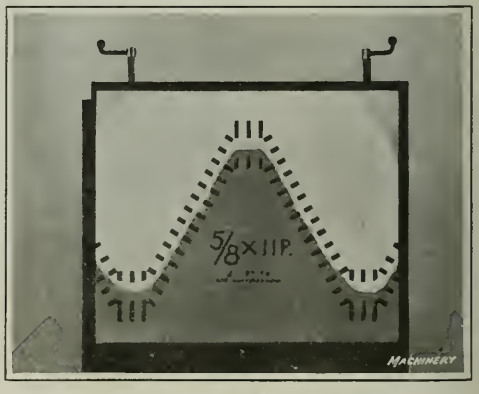


Fig. 5. Shadow of Thread of Minimum Pitch Diameter

This comparator reveals the essential characteristics of the thread, and indicates to what extent the thread surface will be in contact with a normal mating part. It has been found that screws measured before and after being subjected to wrench stress are materially different, which illustrates the accuracy and practical value of this visual method of testing, which not only shows the resultant effect of lead errors, the form of thread, the pitch diameter, and the smoothness of surface, but includes the tolerance measurement that insures interchangeability. This apparatus, unless otherwise specified, is provided with cradles and charts for U. S. standard screws varying from ⅜ inch to 1 inch in diameter.

"ROCHESTER" SAFETY SHAFT OILER

The Ricker Mfg. Co., 239 N. Water St., Rochester, N. Y., has recently developed a device known as the "Rochester" safety shaft oiler. It consists of two principal parts, namely, an oil-containing cylinder and a displacing plunger.



"Rochester" Safety Shaft Oiler made by the Ricker Mfg. Co.

The device is held in position at one side of a shaft hanger by means of a ⅜-inch iron suspension rod, the upper end of which is in the form of a hooked flange inserted beneath the regular lag screw that supports the hanger. An oil displacing plunger is mounted on an upright and operated by an 18-pitch traversing screw that runs in lugs cast integral with the two parts of the oiler. At the bottom of this screw, there is a wing-nut which is engaged by a socket at the end of a pole of sufficient length to enable the attendant to manipulate the oiler from the floor. In this way, danger of accidents is avoided by making it unnecessary for men to climb ladders to reach the bearings of moving shafting.

From the upper part of the oil container, two copper tubes emerge and lead to the oil-holes on either side of the bearing. To force oil from the container into the shaft bearing, it is only necessary to engage the wing-nut on the traversing screw with the forked pole and give the traversing screw one complete turn. This furnishes the desired amount of oil to the bearing, and the oiler contains a sufficient quantity of lubricant to last for one year. The oiler is furnished complete with a fork for the operating pole. In addition to the safety feature, it is claimed that this lubricator is the means of saving time, as the necessity of carrying ladders through the plant is eliminated; also, provision is made for supplying the correct amount of oil to the bearing without having a surplus dripping on the floor.

"BABBITTRITE" COMPOUND

"Babbittrite" compound has recently been placed upon the market by the Products Sales Co., 606 Security Bldg., Milwaukee, Wis., to be used in place of clay or putty that is frequently employed to hold babbitt metal while pouring journal boxes. Advantages claimed for this compound are that it is always ready for use because it does not show a tendency to harden when exposed to the air or to heat, and it is unnecessary for the compound to be worked or mixed in any way to prepare it for use. It is also claimed that when using this compound in babbitting a bearing, it is impossible to produce what is termed a "blow-out," because "babbittrite" does not absorb moisture and will adhere to the work under all conditions. Attention is called to the fact that the compound can be used over and over again, the same compound being suitable for use at least 100 times. In addition to the saving made possible in this way, there is a reduction in labor cost resulting from the fact that the compound is always ready for immediate use without mixing.

GAIRING COUNTERBORE

In the accompanying illustration there is shown a phantom view of a counterbore which is now being manufactured by the Gairing Tool Co., Inc., Detroit, Mich., and this illustration shows all features of the tool so clearly that only a brief description of the counterbore will be necessary. A hardened ball retains the cutter in place when either in a working or idle position, and also drives it. To release the cutter from the holder, it is necessary to turn it to the left, thereby compressing the spring and releasing the ball from its seat. The floating ball supported by spring tension adjusts itself so that the shoulder of the cutter remains squarely against the end of the holder which supports the cutting thrust, while the ball in its pocket prevents backlash of the cutter and eliminates chatter. A split nut holds the pilot in place, and where it is necessary to bore two or more holes and at the same time perform a spot-facing operation, a multiple tool is required. In such cases, the type of pilot which is used on this counterbore allows the nut to hold the cutters intact.

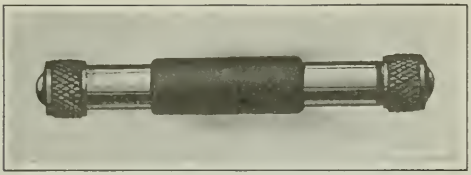


Counterbore made by the Gairing Tool Co., Inc.

The body of the holder is free of obstructions on its outer surfaces, which is an important factor in providing for the safety of the operator. Holders of this type are made in sizes known as Nos. 1, 2, 3, and 4, and they will take any sizes of cutters from ¼ to 3 inches. Sets of these spot-facing tools are made up to meet the requirements of various classes of work. For instance, there is a No. 2 fillister-head and flat screw set, which makes a useful combination of tools for use in jobbing shops, tool-rooms, and certain manufacturing plants. It includes two flat-head screw countersinks and a counterbore for each size of standard fillister-head screw from ¼ to ⅞ inch, inclusive; also a No. 2 holder which accommodates all of the cutters, and a wrench to fit the special pilot nut. As an example of one of the more complete sets, there is the No. 5 which comprises two countersinks, fifteen cutters, thirty-eight pilots, three holders, and an assortment of pilot nuts and wrenches. These more complete sets are adapted for use in large manufacturing plants.

INSIDE GAGES

For use in gaging the inside of cylindrical and other shaped work where the accuracy must be within 0.0001 inch, the Production Equipment Co., Inc., 1 Madison Ave., New York City, is selling a line of inside gages in which hardened steel balls are used for the contact points. These balls fit into sockets at the ends of the gage and are held in place

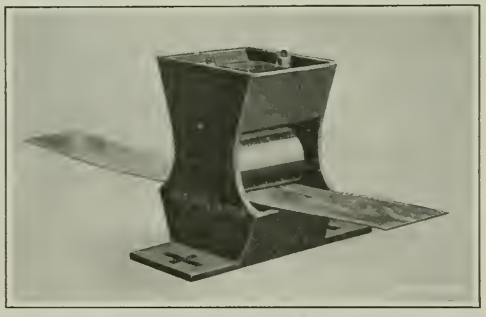


Inside Gage sold by the Production Equipment Co.

by caps which afford a positive method of clamping and still allow the balls to be turned if necessary, so that as soon as there is the slightest indication of wear at points where the balls have been used, the caps are loosened and the balls turned to new positions. It is on account of this method of adjustment that the name "never wear" has been applied to the gages. Another advantage claimed for gages of this type is the degree of accuracy with which the ball centers adapt themselves to the work. It is stated that they automatically find their own centers. Each gage is furnished with a rubber insulation which prevents the heat of the hand from being transmitted to the gage and affecting its accuracy. The gages are carried in stock in all sizes from 1 to 12 inches, and other sizes will be made to special order.

STRIP STOCK OILER FOR POWER PRESS

To provide for lubricating strip stock which is being fed to the dies mounted on a power press, the Practical Device Mfg. Co., 257 Layton Blvd., Milwaukee, Wis., has developed an automatic lubricator which effects a substantial saving in the amount of oil required for this class of service, and also saves time which the operator would otherwise spend in swabbing oil on the metal by hand. In addition to these two possible economies, several other beneficial conditions of operation are claimed by the manufacturers of this equipment, among which are the facts that an excess



Lubricator made by the Practical Device Mfg. Co. for oiling Strip Stock fed to Dies on a Power Press

of oil is not applied to the work and that the lubricant is uniformly distributed so that the best possible conditions of operation are attained. These conditions assist in keeping the press-room floor clean and in increasing production; also, no time is lost by having machines idle while the operator is swabbing oil on the stock by hand. The device consists of a single casting which forms upper and lower oil receptacles separated by a pair of steel rollers, between which the stock is passed. This lubricator may be used either directly on the punch press or as a separate equipment, and the rollers may be driven, if so desired. It will be apparent from the illustration that the design of this lubricator is simple and all of the parts are liberally proportioned, so that there is little possibility of a breakdown. Various sizes of lubricators of this type are made to meet the requirements of different classes of work. An oiler of this kind could also be used on wire working and other types of machinery.

CHICAGO BALL BEARING PULLEYS

For use in transmitting power to grinding machines, buffing lathes, swing saws, and other classes of high-speed machinery, the Chicago Pulley & Shafting Co., 32-38 S. Clinton St., Chicago, Ill., has recently developed a line of driving pulleys, clutch pulleys, and countershafts which are fully equipped with S K F ball bearings. Fig. 1 shows a partial cross-sectional view of the driving pulleys and clearly illustrates the arrangement of both the ball bearings with which this equipment is provided, and the way in which tight and loose pulleys and the large driving pulley are constructed.

A drive of this type is employed with a stationary shaft

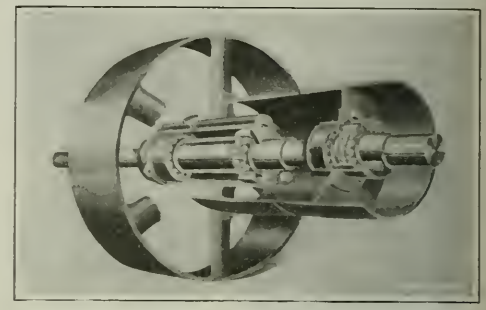


Fig. 1. Ball-bearing Driving Pulley manufactured by the Chicago Pulley & Shafting Co.

and it may be used to advantage in cases where it is desired to utilize an existing countershaft without the necessity of additional millwrighting. Where this plan is followed, the ball bearings are slipped over the shaft, after which the hanger boxes are tightened so that the shaft cannot turn. It will be apparent from the illustration that one of the small pulleys is secured directly to the driving pulley, while both of the small pulleys and the driving pulley are loose on the shaft. In order to transmit power to the machine it is merely necessary to shift the belt to the small pulley attached to the driving pulley. Fig. 2 shows a countershaft equipped with the type of pulleys that are illustrated in Fig. 1.

In Fig. 3 there is shown the friction clutch type of pulley. Important features claimed for this pulley include the ease with which it may be installed, its simplicity of construction and the fact that the pulley occupies very little space on the shaft. It will be evident to all engineers and mechanics who have had experience with the application of ball bearings, that several noteworthy advantages are secured through the use of S K F bearings in the overhead works for driving machine shop equipments. Obvious among these are the facts that ball bearings are practically free from frictional resistance, so that very little power is needlessly wasted; and if bearings of this type are properly cared for, they are also practically free from wear. The pulleys are so designed that provision is made for sealing the ball bearings in a

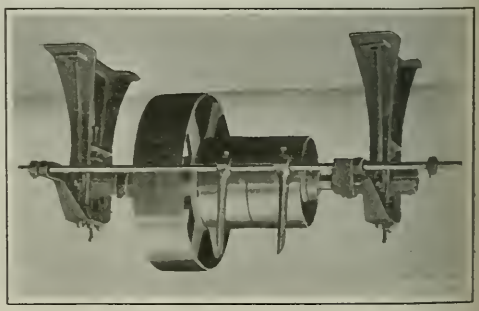


Fig. 2. Countershaft equipped with Driving Pulleys of the Type shown in Fig. 1

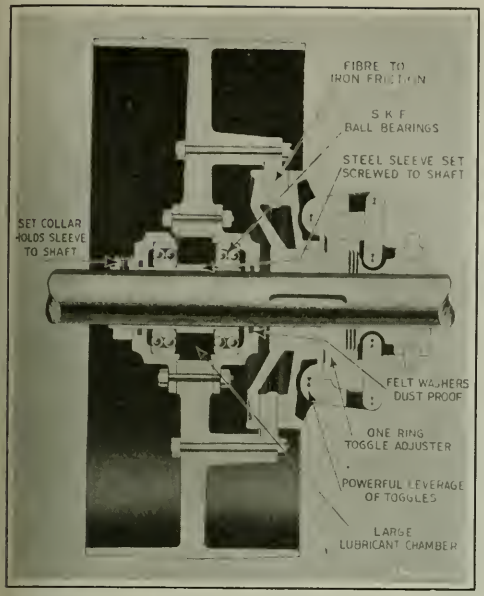


Fig. 3. Ball-bearing Clutch Pulley manufactured by the Chicago Pulley & Shafting Co.

chamber which may be filled with a sufficient quantity of lubricant to last for a considerable period of time without requiring further attention. Not only does this simplify the method of lubricating the bearings and save the expense of attendants and lubricating oil, but it also avoids danger of the work being neglected, with resulting bearing trouble.

CRUBAN AUTOMATIC TAPER TURNING TOOL

For use in performing taper turning operations on hand or automatic screw machines or lathes, the Cruban Machine & Steel Corporation, 2 Rector St., New York City, has recently developed a self-contained automatic tool which is here illustrated and described. Tools of this type are made for use on right-hand and left-hand machines and they provide for cutting tapers running from 1/16 to ¾ inch per foot by intervals of 1/16 inch. Two sizes of tools are made which have capacities for handling work of any diameter up to ¾ inch and ⅞ inch, respectively, at the large end of the taper, both tools being capable of handling pieces up to 6 inches in length. Two cutting tools are simultaneously employed, the first of which takes a roughing cut leaving 0.005 inch or less for the finishing tool, in this way imparting a very satisfactory finish to the work. The degree of taper obtained by the tool is governed by a lead-screw and nut, and these two members may be changed without removing the balance of the tool from the machine on which it is being used, so that the substitution of a different screw and nut is the means of providing for cutting a different degree of taper.

An adjustment is furnished to enable work having the given degree of taper to be turned slightly over or under size, according to the requirements of the job, on which the tool is operating. A micrometer adjustment also allows the two cutting tools to be accurately set to produce work of the required diameter. For instance, in setting up the tool for cutting pieces 0.250 inch in diameter at the large end of the taper, a trial cut will be taken after an approximate setting of the tools has been made. Suppose it is found that a micrometer measurement of the work is 0.270 inch; by means of the adjustment, the tools will be advanced 0.010 inch to provide for removing ten thousandths from the radius, thus reducing the diameter of the work to the required 0.250 inch. A micrometer collar is provided on the adjusting screw used for this purpose.

Having made this preliminary statement about the manner in which the Cruban automatic taper turning tool operates, we are in a position to give a detailed description of the arrangement of the mechanism. Regardless of the type of machine on which this tool is used, provision is made for feeding the tool to the work. Referring to Fig. 2, the bar on which the taper is to be turned is shown at *A*. As the tool advances, plunger *B* engages the end of this bar and a continuation of the feed movement causes the plunger and block *C*, by which it is carried, to slide back through the hollow shank of the tool. Secured to block *C* there is a flexible steel band *D* which is wrapped around drum *E* so that as block *C* slides back it pulls band *D* with it and imparts a rotary movement to drum *E*. This drum is mounted on a cross-shaft *F* at the forward end of which there is cut the thread of the lead-screw that fits into the master nut *G*, which is slotted at the side to receive trunnions carried by a yoke *H*. Yoke *H* is supported by a pivot, and at its lower end there is a pin at *I* which enters a slot in the slide *J* by which the two tool bits *K* are carried. The screw *F* occupies a fixed longitudinal position and as it rotates in nut *G*, the nut is caused to move inward thus causing yoke *H* to swing about its pivotal support. This swinging of the lower end of the yoke outward results in drawing back slide *J* at a predetermined rate established by the master lead-screw, which causes the tools to turn the required degree of taper on the work.

Use is made of the regular stops on the machine to control the feeding of the tool to the work, and when the cut has been completed and the tool is withdrawn, a spiral clock spring *L*, the tension of which has been increased by the backward movement of block *C*, causes all members of the tool to return to their starting positions. A simple adjustment is provided to enable the tension of this spring to be regulated, as necessary, in order to assure a prompt and positive return of all parts of the tool to their starting positions. Mention has already been made of the possibility of adjusting the tool to provide for cutting the taper slightly over or slightly under the specified amount. This result is obtained by means of two knurled nuts *M*, one of which is a clamp, while the other controls an adjusting screw that provides for moving pin *I* to a position slightly inside or slightly outside of the position at which it should be located in order to cut a taper of exactly the specified degree. It will, of course, be evident that this result is accomplished by varying the ratio between the distance from pin *I* to the pivot supporting yoke *H* and the distance from the pivot to the pins in yoke *H* that enter slots at the sides of nut *G*.

For setting the tool points to turn work to exactly the required diameter, use is made of a knurled nut *N* carried by an adjusting screw that enters slide *J* by which the tools

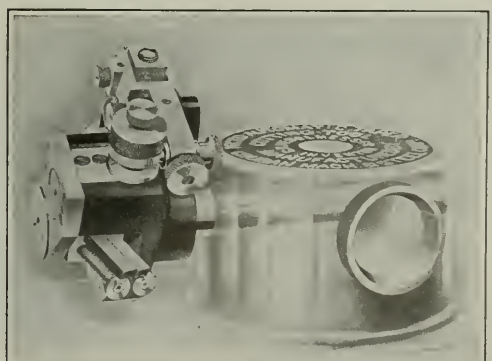


Fig. 1. Taper Turning Tool made by the Cruban Machine & Steel Corporation and sold by the Fairbanks Co.

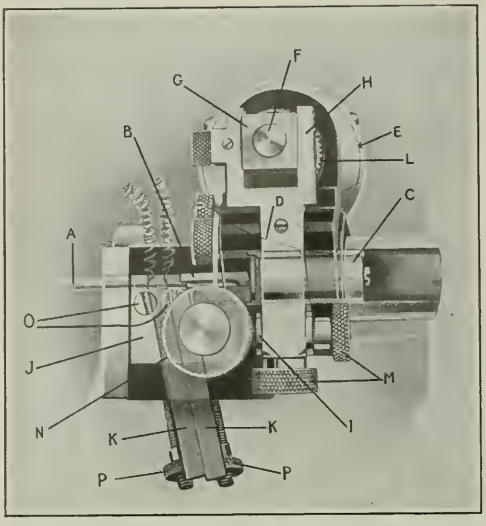


Fig. 2. Partial Sectional View of the Cruban Taper Turning Tool showing Method of Operation

are carried; and there is a micrometer collar provided on this screw to facilitate accurate setting of the tool points in the manner which has previously been mentioned. The tool bits *K* are clamped in place in slide *J* by means of the headless set-screws *O*. Each of the cutting tools has a slot milled in its under side to receive the knurled nuts *P*, and in order to set the tool points in such relative positions to each other that 0.005 inch is allowed for the finishing cut, it is merely necessary to adjust nuts *P* relative to each other before clamping the tools in place by tightening screws *O*. The Fairbanks Co., 416 Broome St., New York City, is the sole distributor of this taper turning tool.

NATIONAL BORING AND TAPPING MACHINE

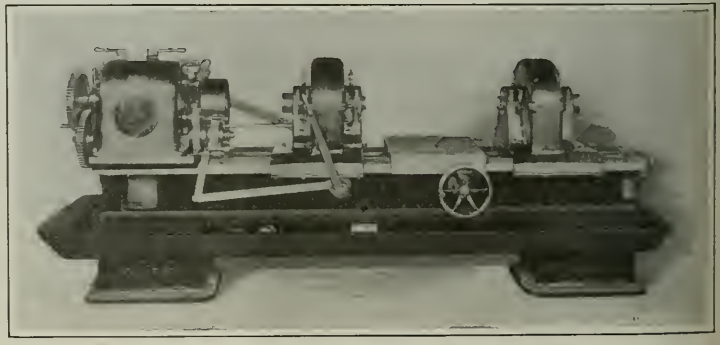
To meet the requirements of automobile manufacturing plants for a machine adapted for boring and tapping work simultaneously from opposite ends, the National Lathe Co., Cincinnati, Ohio, has recently developed a machine which forms the subject of the following description. Although especially suitable for the requirements of motor car factories, it could also be successfully employed on various other products where there is possibility of supporting the work on a jig plate and having two heads working simultaneously from opposite ends. One lever controls the complete operation of this machine after setting it up for any particular job. By means of this lever, the machine is started and stopped, and the quick return of the heads is obtained in the same way. No manual labor is required to bring the heads into position, except the movement of this lever which controls the power movements. The spindle is made of 50-point carbon crucible steel and has a 1⅜-inch hole extending through it, the front end being turned No. 5 Morse taper. The nose of the spindle has a 1¾-inch slot, ¾ inch deep, milled in it to provide for driving cutter-bars. Carried on the spindle there is a spur gear which is driven by a pinion on a 2 3/16-inch shaft running through the center of the bed, and both of the heads are attached to a lead-screw which also runs through the center of the bed. This screw is threaded right- and left-hand and its location at the center of the bed is said to be the means of affording a very smooth action.

The heads are arranged to swing 24 inches over the bed and 19 inches over the jig plate. A coolant pump and pipe can be furnished, but they are not included as a regular equipment. The gear-box is of the quick-change type and heavily constructed, all changes being made by two levers. The available rates for threading are 10, 12, 16, 20, 24, 32, 40, 48, and 64 threads per inch, and the rates of feed are 0.100, 0.083, 0.062, 0.050, 0.041, 0.031, 0.025, 0.020, and 0.015 inch per revolution. An automatic feed trip provides for disengaging the feed. The speed-box is of the patented forward and reverse type used by the National Lathe Co., which controls the forward and reverse speeds of the spindle. Both are operated by a single lever located at the front side of the machine, in the proper position so that the operator will not have to move from his working position. The quick return of the heads is controlled by the same lever that operates reversal of the machine, and the spindles do not revolve on the return motion. The bed of this machine is 10 feet long, and it has sufficient capacity to take work up to 4 feet between the spindles. The weight is 6000 pounds; but despite this fact, it is claimed that the machine is unusually sensitive and easy to operate.

BARRETT THREE-WAY FACING MACHINE

To provide for the simultaneous performance of facing operations on three surfaces of a valve, the Barrett Machine Tool Co., Inc., Meadville, Pa., has recently developed a three-way machine which is here illustrated and described. It will be seen that there are three facing heads that provide for operating on opposite ends of the work and on a surface at right angles to the first two. These heads have a capacity for covering surfaces from 5 to 25 inches in diameter. Each head is provided with a facing block designed to provide for the insertion of cutting tools in two or three different positions. Positive geared feed is provided for the facing blocks through an independent feed-box applied to each housing, the available rates of feed being 1/64 and 1/32 inch in each direction.

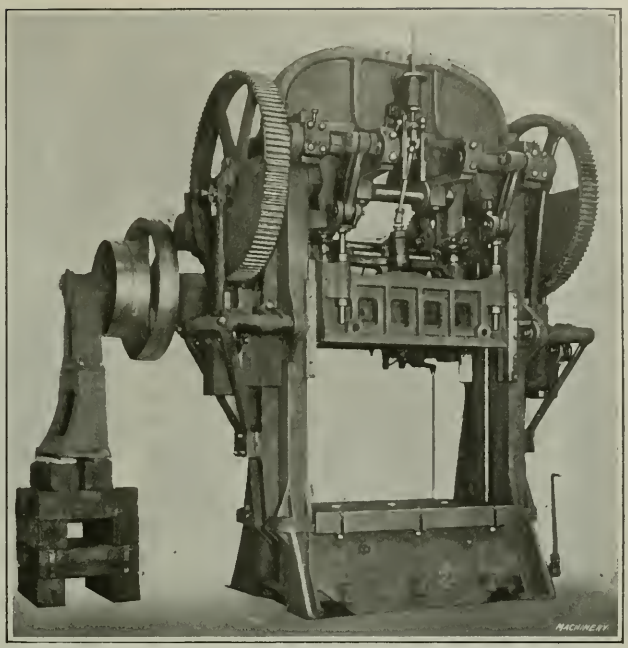
The gear-box is mounted at the right-hand end of the main bed and it contains two series of gears transmitting power to the main driving spindles. These gears have ratios of 5.2 to 1 and 20.8 to 1. A single speed countershaft is employed, that is equipped with a friction pulley and a four-step cone pulley. Through the use of this countershaft on the gear-box, eight changes of speed are obtainable to the main driving spindles and facing arms, which afford suitable



Duplex Boring and Tapping Machine built by the National Lathe Co.

cutting speeds while the machine is operating on from the smallest to the largest diameters that it is capable of handling. A cross-table is mounted midway between the pedestal housings, and a suitable chuck is carried on it to provide for holding the work. This table is provided with T-slots, the table being securely bolted to the bed. A hydraulic chucking device, not shown in the illustration, can be supplied, and it is located midway between the front and back housings at the center of the bed.

The front housings close to a minimum distance of 9½ inches between the facing head tools and open to a maximum capacity of 36 inches. The back housing closes to within 5½ inches of the center line of the bed and opens to provide a capacity up to 30 inches from the point of the tool. The facing heads have a radius swing ranging from 2½ to 12½ inches, thus providing a capacity for facing diameters from 5 to 25 inches as previously mentioned. The pedestal housings which carry the facing head equipments are movable in either direction through the use of handwheels transmitting motion through miter gears to the screws. Handwheels are so placed that they are easily accessible for the operator. Power is provided for driving the spindle through spur gearing having a ratio of 5.2 to 1, the power for this purpose being taken from a main driving shaft from which power is transmitted to the cross-shafts through miter gearing.



Double Crank Toggle Drawing and Deep Stamping Press built by the Toledo Machine & Tool Co.

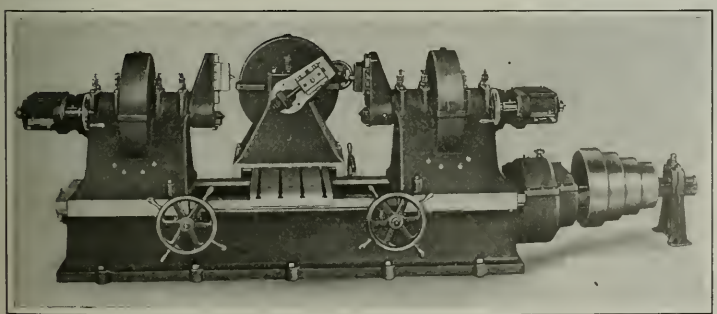
TOLEDO TOGGLE DRAWING AND STAMPING PRESS

The Toledo Machine & Tool Co., Toledo, Ohio, is now building a double crank toggle drawing and deep stamping press which is particularly adapted for use in the manufacture of automobile bodies, crown fenders, hoods, radiators, cowls, engine pans, front seats, rear panels, and for the performance of a variety of other deep stamping and forming operations. The frame of this machine is of this company's four-piece steel tie-rod construction, comprising a base, two uprights, and a crown held together by four large steel tie-rods that are shrunk into place. All of the stress is taken by the four rods. The uprights are heavily constructed to withstand lateral stresses which might occur when the slides are unevenly loaded. It is stated that presses with this type of frame construction are capable of economically operating dies for the heaviest kinds of power press work, such as is met with in automobile construction.

An improved type of blank holder control mechanism is employed, which consists essentially of two complete and independent units combined in a single frame. There are two pairs of rocker shafts operated from each end, which are carried by substantial bearings to withstand the blank holding pressure. The function of this blank holder control mechanism is such that it not only insures an absolutely perfect dwell of the blank holder during the entire drawing operation but also exerts the necessary power; furthermore, the timing in relation to the other moving parts of the press is such as to admit of effective balancing of the entire mechanism, so that smooth running is assured with a press under complete control of the operator.

Very little effort is required to either stop or start the press at any point of its stroke. The entire blank holder pressure is transferred directly to the frame of the press from the straightened toggles. When so desired, provision can be made for conveniently disconnecting the toggle mechanism from the blank holder and attaching the outer slide to the inner slide, thereby converting the press into a single action machine, which adapts it for blanking and forming operations within its capacity. This arrangement is said to be particularly useful when there is not sufficient work to keep the press engaged at all times on the performance of drawing operations. Spring pressure attachments may be fitted in the bed in order to convert the press into a triple action machine.

This company's improved method of supporting the gearing is employed on this machine, for which the features of compactness and rigidity are claimed, allowing a free space all around the press to afford ready access and freedom in handling material. It is the general practice to drive this press by an individual electric motor mounted on a special foundation on the wall or ceiling, the motor being belted directly to the flywheel. Ample die space is provided to take care of the requirements of a wide



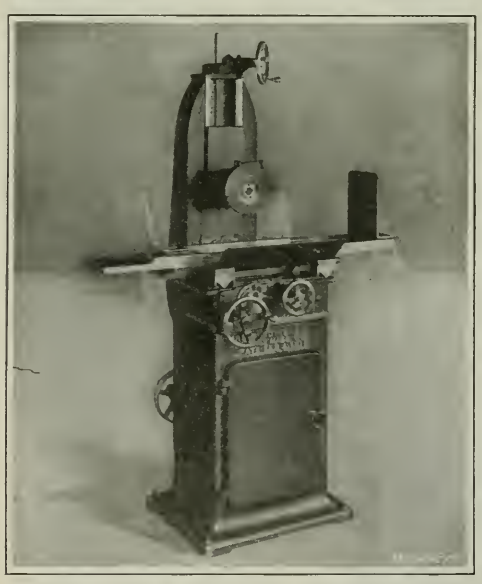
Three-way Facing Machine built by the Barrett Machine Tool Co.

range of work for which a machine of this type is adapted. These presses are made in a number of different sizes to meet the requirements of the various classes of work referred to at the beginning of this article.

REID SURFACE GRINDING MACHINE

In the design of a No. 2 surface grinding machine recently developed by Reid Bros. Co., Inc., Beverly, Mass., there are two features to which the manufacturers call especial attention; namely, the provision of a simple feed mechanism that can be disconnected by a throw-out, and the application of a compact spring curtain that rolls up and unrolls with the travel of the head and keeps the slides free from dust. The head is fitted to the back arm and controlled by a vertical feed-screw. Accumulation of grit and other foreign matter on the bearing surfaces is prevented by the spring curtain just mentioned. Lowering of the head is accomplished by gravity and the downward pull of the belt. Due to its weight and the belt tension, the head simply rests on a plate attached to the elevating screw. This screw does not push the head into the work, but merely permits it to drop and acts as a limit for the head movement. The hardened steel spindle runs in adjustable bronze boxes, and vertical adjustments are obtained by a handwheel graduated to 0.0005 inch.

This machine will take grinding wheels up to 7 inches in diameter by ½ inch face width. The table is 46 inches long by 8 inches wide, with a working surface 18 by 6 inches, and it has three T-slots. Automatic table travel is provided in both directions, and it is controlled by dogs operating against a reversing lever which can be disengaged to permit movement of the table beyond the reversing point without changing the dogs. The quick starting and stopping of the longitudinal feed movement is accomplished by a centralized

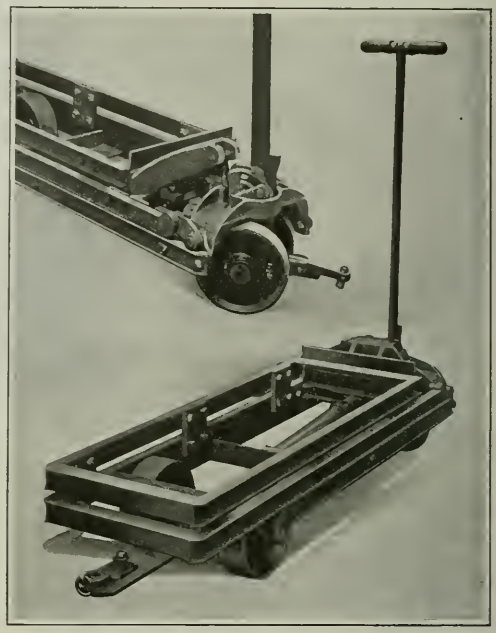


Surface Grinding Machine built by Reid Bros. Co., Inc.

control in the handwheel shaft. The cross-feed is also automatic in both directions, and it has a range of 0.007 to 0.084 inch at each reversal of the table. By a simple movement of an adjusting screw, all of the cross-feed mechanism may be disengaged to facilitate feeding by hand. This machine has sufficient capacity for grinding work up to 18 inches in length by 6 inches in width by 11½ inches in height. It occupies a floor space of 65 by 30 inches.

BARRETT-CRAVENS TRAILER TRUCKS

To provide for their use as trailers behind power units, the Barrett-Cravens Co., 171 N. Ann St., Chicago, Ill., has recently developed a line of trailer trucks which have the elevating feature, so that a trailer can be disconnected from the train and drawn away as an ordinary hand-operated lift truck. These trailer trucks are built in all models in which the lift trucks of this company's manufacture are made. They are available in capacities of 2000, 3000, and 5000 pounds, with carrying frames ranging from 17 ⅝ to 27

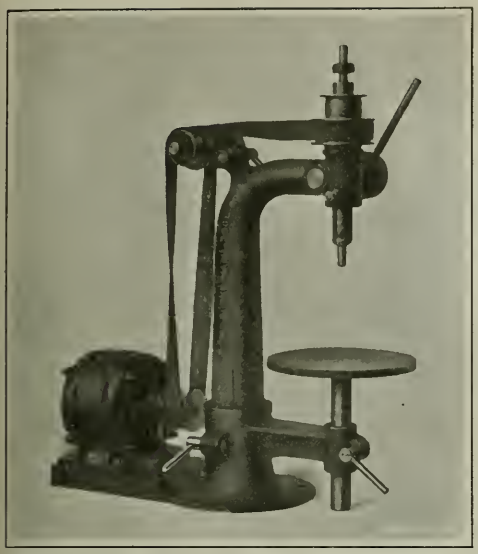


Front and Rear Views of Trailer Trucks made by the Barrett-Cravens Co.

inches wide, and from 30 to 72 inches long. A string of these trailer trucks may be coupled together behind the power unit, and when used in this way the handle of each truck remains erect, being automatically locked in an upright position. Upon reaching the destination, the trucker only has to release the handle and draw the truck away just as he would handle one of ordinary design. Coupling links are furnished at the front and back of each truck, which are made of rolled and flat bar steel, the rear link being directly connected to the rear axle while the front link is built into the turntable in such a way that the ability of the truck to turn through any angle up to 180 degrees is not restricted. Parts may be obtained to equip Barrett-Cravens trucks that are already in use for operation as trailers.

BURKE SENSITIVE DRILLING MACHINE

A No. 1 sensitive drilling machine equipped with individual motor drive has recently been added to the line of machinery built by the Burke Machine Tool Co., Conneaut, Ohio. It will be seen that this drill has a double flanged cone pulley that is mounted on a bearing through which the spindle runs, and the design has been worked out in such a way that there is no pressure on the spindle from the belt tension. The spindle thrust is taken by a ball bearing. A General Electric motor is used, which may be furnished for 110 or 220 volts, 60 cycle, single-phase alternating current, or for direct current of 110 or 220 volts. The spindle



Sensitive Drilling Machine built by the Burke Machine Tool Co.

is tapered to fit a 5/16-inch Almond, Jacobs or a No. 2 ⅜-inch Parker chuck. The drilling capacity of the machine is up to ⅜ inch.

NEW MACHINERY AND TOOLS NOTES

Cutter and Reamer Holder: S. & C. Mfg. Co., Detroit, Mich. A quick-acting holder which is so designed that the tool is held securely and may be quickly released by hand, without requiring the use of a wrench or other mechanical assistance.

Tool-holder: Universal Tool & Mfg. Co., Inc., 680 S. 11th St., Newark, N. J. This tool-holder is convertible to a right-hand turning, left-hand turning, or boring tool, and for that reason it is said to be "universal." Tool bits made from either square or round stock may be used in this holder.

Reversing Gear: Snow & Petrelli Mfg. Co., New Haven, Conn. A reversing gear especially adapted for use in marine work, although it could be adapted for use in any classes of service in machine construction. This gear is built in four sizes with capacities ranging from 9 to 52 horsepower.

Tool Chest: Union Tool Chest Co., Inc., Rochester, N. Y. A mechanics' tool chest, the frame of which is constructed of kiln-dried oak with the joints lock-cornered. It has a tray of similar construction, which is fitted with movable partitions. The top and bottom of the chest are rabbeted, nailed, and glued.

Offset Center Head: A. Verwys Tool Co., 629 Leonard St., N. E., Grand Rapids, Mich. Adjustable offset center head which can be used in connection with a mechanic's scale in laying out squares, hexagons, triangles, and other desired outlines on round work. This tool also finds application in laying out keyseats.

Air-operated Arbor Press: Manufacturers' Equipment Co., Waller & Fillmore Sts., Chicago, Ill. An Arbor press equipped for operation by compressed air. It is made in two sizes, the smaller of which is known as a No. 11 and has a maximum stroke of 6 inches, while the larger press is known as a No. 12 and has a maximum stroke of 7 inches.

Double Punch Attachment: Cleveland Punch & Shear Works Co., Cleveland, Ohio. A double-gagged punching attachment fitted with a spring to lift the punch clear of the material when the gag is withdrawn. Each gag is individually operated and has a long taper, so that when it is inserted the tapered end acts as a wedge and forces the punch stem down.

Tool-holder: Western Tool Mfg. Co., Springfield, Ohio. A drop-forged tool-holder which has a combination wedge and cam locking mechanism for holding the cutter in place. It is stated that the cutter is gripped for its full length and is securely held without danger of slipping. Extremely short cutters can be used in this holder. Holders of this type are made in four standard sizes.

Electric Drill, Screwdriver and Wrench: H. Hollingshead, 55 Liberty St., New York City. A portable electric tool which is adapted for use either as a drill, screwdriver, or wrench. It is furnished with a motor that will run on either alternating or direct current of 110 to 120 volts. Power is transferred from the motor to the spindle through worm gearing carried by ball bearings.

Valve Grinding Machine: D. F. Dunham, 830 W. 37th St., Los Angeles, Cal. A valve grinding machine which is especially adapted for valve facing, although it may be equipped with an extra hub and wheel to provide for grinding small tools. It is driven by a 1/12-horsepower Westinghouse motor that may be connected to any lamp socket, a single snap switch being used to start the motor.

Quenching Compound for Hardening Steel: Wheelock, Lovejoy & Co., Cambridge, Mass. Two kinds of salts for use in making hardening baths. These were developed in Great Britain during the war and were adopted by the British Ministry of Munitions. They are known as "Quenchoid" and "Feusalt," the former being used for hardening carbon steel and the latter for hardening high-speed steel.

Tiering Truck: Elwell-Parker Electric Co., Cleveland, Ohio. A combination truck for transporting and lifting materials and finished product in industrial plants. It is driven by an electric motor which obtains power from a storage battery, the drive being through single reduction worm gearing. A separate enclosed motor, direct-connected to the hoisting drum, provides for operating the tiering hoist.

Crankpin Re-turning Tool: Sawyer-Weber Tool Mfg. Co., 350 S. Alameda St., Los Angeles, Cal. A tool for re-turning crankpins, which may be furnished with different forms of cutters to provide for finishing crankpins of various lengths. The tool is made in four sizes, for pins ranging from 1¼ to 3 inches in diameter by 1½ to 3 inches in length up to 3 to 6 inches in diameter by 3½ to 7 inches in length.

Profiling Machine: R. M. Clough, 327 Colony St., Meriden, Conn. A small profiling machine for use in cutting dies, stamps, etc. The machine is driven by a ⅛-horsepower motor and the spindle runs in ball bearings. A longitudinal movement of 12 inches and a cross movement of 5 inches are provided for the table, a micrometer dial being furnished on both screws, in addition to a micrometer table stop.

Milling Cutter and Counterbore: New Britain Tool & Mfg. Co., New Britain, Conn. The milling cutter has a body made of mild steel with high-speed steel blades inserted and locked in place by pins which have slightly tapered flat sides to engage the blades. The counterbore has a renewable high-speed steel cutter, while the shank of the tool is made of carbon steel and drives the cutter by the keyway across its end.

Tumbling Barrel: Ideal Concrete Machinery Co., Cincinnati, Ohio. A tumbling barrel which is equipped with an automatic loading device that takes parts from the ground level and discharges them directly into buckets or buggies, without stopping the rotation of the barrel. To prevent overtumbling or insufficient tumbling, the operator can reach in and take out a sample of the work at any time, without interrupting the process.

Self-gripping Mandrel: Efficiency Tool Products Co., Bridgeport, Conn. A self-gripping mandrel which has two sets of three-equidistant grooves that are inclined circumferentially. Carried in each groove there is a roller backed up by a flat steel spring. With a piece of work in place on the mandrel the pressure of the cut forces the rollers up the incline so that the mandrel's gripping power is proportional to the severity of service.

Machine Tool Center: Federal Steel Co., Detroit, Mich. A center adapted for use on lathes and milling, gear-cutting, and grinding machines, and which consists of a high-speed steel center or point carried by a hardened steel sleeve. The sleeve acts as a holder and is not subject to wear, being merely required to support the center in a tapered hole. The point can be entirely removed without requiring the sleeve to be taken out of the machine.

Lifting Magnet: Cutler-Hammer Mfg. Co., Milwaukee, Wis. A lifting magnet which is made rectangular in shape and is adapted for handling iron and steel products including bars, sheets, billets, ingots, pipes, etc. Advantages claimed for the rectangular magnet for this class of work are that the maximum lifting capacity can be obtained for a given weight of the magnet, and that it is possible to attain greater speed in handling the work.

Ellipsograph: Daniel C. Reid, 2717 N. Crosky St., Philadelphia, Pa. An instrument for drawing ellipses, which may be provided with either a pen or pencil which is carried at the end of a slotted bar. If so desired, this bar may be easily removed to allow the remainder of the instrument to be used as an ordinary pair of spring dividers. Ellipses with major axes ranging from 1½ to 12 inches can be drawn at a single operation, and circles up to 12 inches in diameters may also be drawn.

Universal Vise: New Britain Tool & Mfg. Co., New Britain, Conn. A tilting and swiveling vise which is adapted for use on milling and drilling machines, and for laying out work. The important feature of this tool is that it combines means of obtaining any desired angular setting. Any angle within a complete circle may be obtained in a horizontal plane; and from vertical to 10 degrees below the horizontal, in a vertical plane.

Portable Radial Drilling Machine: Multi-Angle Drill Corporation, 1 W. 34th St., New York City. A machine adapted for use in connection with any standard electric, pneumatic, or hydraulic drills, although such tools are not furnished as a regular part of the machine. The drill is carried by a radial arm supported by the column which also carries the usual form of round table. The whole machine is mounted on a truck for portable service.

Keyway Cutter: V. E. La Point Mfg. Co., Manchester, Conn. A series of keyway cutters which are intended for use on arbor presses or similar machines, although they could be driven through holes in the work with a soft hammer. One pass of the tool through the hole finishes the keyway. The body of the tool is of the diameter of the hole in which the keyway is to be provided, and the cutters are for keyways of standard size.

General-purpose and Welding Goggles: T. A. Willson & Co., Inc., Reading, Pa. Two types of shop goggles, one of which has aluminum cups fitting over the eyes, that can be furnished with either plain or colored glasses, and may be without ventilating perforations if it is desired for them to be dust-tight. The other goggles have lenses which are "dropeye" in shape and are made of colored glass to afford protection against rays from welding torches.

Drill-holder and Friction Chuck: Roberts Mfg. Co., 152 Brewery St., New Haven, Conn. This holder provides for driving drills with twisted or mutilated tangs by driving at the large end of the shank. The drill is secured in place in the holder by turning a knurled collar by hand. The friction chuck of this company's manufacture is of simple design and is said to be positive in operation. It is adapted for driving taps and can be quickly adjusted to slip when the tap bottoms in its hole.

Screwdriving Outfit: Hergi Mfg. Co., 75 Third St., Bridgeport, Conn. A power-driven equipment for driving and setting screws or nuts which enables work of this kind to be done with unusual rapidity. After the screw has been run down to the shoulder a ratchet movement can be applied to set the screw to any desired point. This device is automatic in operation, the screwdriving action commencing as soon as pressure is applied and, conversely, power is shut off when the pressure is released.

Thread Milling Machine: General Metals Co., Detroit, Mich. This machine was originally developed by the American Multigraph Co. for the performance of thread milling operations on primer bodies, which this firm was manufacturing for the British and Russian Governments. It proved so successful in this service that a decision was reached to redesign the machine to adapt it for handling general lines of work. This was undertaken by the General Metals Co., which has recently acquired the manufacturing rights.

Gear Generating Machine: Donaldson & Fisher Mfg. Co., Chicago, Ill. A gear-generating machine of exceptionally compact design, which is adapted for cutting spur and helical gears, worms, and worm-wheels, in addition to which it may be employed for generating splined shafts. The capacity is for work up to 14 inches in diameter by 14 inches face width, and cast-iron gears up to 3 diametral pitch may be cut, while the capacity for steel gears is up to 4 diametral pitch. Special provision may be made for handling work of wider face than has been mentioned.

Cross-feed Stops for Lathes: R. K. LeBlond Machine Tool Co., Cincinnati, Ohio. A series of cross-feed stops suitable for application on 15- and 21-inch lathes of this company's manufacture. From four to six hardened steel collars are fitted to a bushing on the cross-feed screw, and separated by spacing washers connected to the bushing. Each stop collar has a projection on its periphery which is engaged by the stop button in line with it. Engagement of one button by its collar pulls it out, leaving the cross-feed screw free to rotate until the next stop collar engages its button, and so on through the series.

Vertical Milling Machine: William K. Stamets, Pittsburg, Pa. A No. 44 heavy-duty vertical milling machine, the design of which differs considerably from established practice in the construction of machines of this type. It has the distinction of having a one-piece frame without an adjustable knee. The table is permanently located 32 inches from the floor, and the head bearing on the column is liberally proportioned. A counterweight inside the column balances the head, so that vertical adjustments may be easily made. Power quick return at 11 feet per minute is available for the cross, vertical and horizontal feed.

ADOPTED STANDARDS OF DESIGN FOR COMPOSITION GEARING

At the October meeting in Boston the American Gear Manufacturers' Association adopted standards of design for composition gearing. This gearing may be subdivided into four classes of gears or pinions, namely, rawhide, fabroil, bakelite, and fiber. The accompanying charts for rawhide pinions have been plotted for regular shop practice, and are self-explanatory, giving all the necessary detail. In regard to bakelite or fiber, the same assembling as used for rawhide applies when the gears are made up of several thicknesses or layers of either of these materials.

A few examples will show the application of the charts. Take for instance, a pinion of 3 diametral pitch. Referring to the left-hand section of the chart in Fig. 2, we find that the minimum allowance between the bottom of the teeth and the bore or dimension *S*, Fig. 1, is 1 inch. This dimension allows for standard rivets and standard keyseats with a maximum bore of approximately 3½ inches. The right-hand sec-

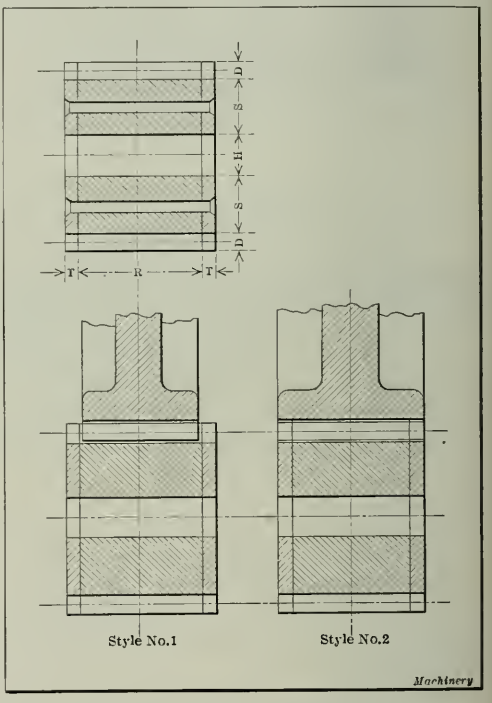


Fig. 1. Two Styles of Composition Gears

tion of the chart Fig. 2, shows the amount of extra face width which must be given to rawhide pinions when made according to style No. 1, illustrated in Fig. 1. For instance, it will be seen that for 3-pitch gears the face of the rawhide pinion should be ¼ inch greater than the mating metal gear. The chart Fig. 3 gives the thickness of brass retainers or flanges. In a note at the top of the chart reference is made to style No. 1 and style No. 2 gears which are shown in Fig. 1. As an example illustrating the use of this chart, take, for instance, a pinion having 18 teeth of 3 diametral pitch. For style No. 1 the thickness of retainers will be found to be 9/32 inch and for style No. 2, 11/32 inch. The left-hand section of the chart shown in Fig. 4, gives the diameter of rivets required. For 18 teeth, 3 diametral pitch, the diameter of rivet is ¼ inch. The right-hand section of the chart gives the number of rivets required. For instance, it will be seen that a pinion having 18 teeth of 3 diametral pitch requires five rivets.

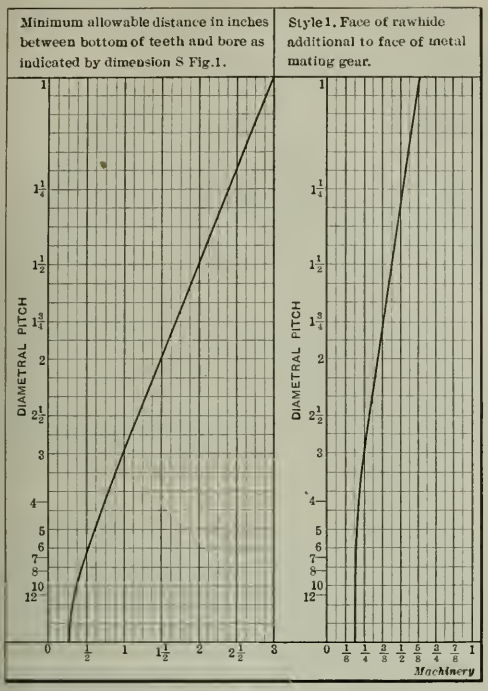


Fig. 2. Chart for proportioning Composition Gears according to Adopted Standards

For circular pitch gears, first determine the equivalent diametral pitch and then use the charts in the manner described. Pinions made with hubs, bushings built upon spiders, or with steel or cast-iron flanges are considered to be of special construction, and the charts given do not apply to their design. For strength and economical service, pinions should be made with not less than 15 teeth. To avoid charred condition of the rawhide caused by heat generated through friction when operated at excessive speeds, a maximum pitch line velocity of not over 2500 feet per minute is recommended.

Although in the case of bakelite or fabroil, definite methods of gear design have been developed by the manufacturers and recommendations may be procured from them, the recommendations here made apply equally well to these materials.

* * *

The International Railway Congress Association, the foundations for which were laid at the congress convoked at Brussels in 1885 by the Belgian government for the purpose of celebrating the fiftieth anniversary of its railways, has just been reconstituted under the title of International Railway Association. The association published, up to 1914, a monthly bulletin containing, besides original articles upon all questions relating particularly to the technique, working and organization of railways, reproductions of the most interesting articles appearing in the railway reviews of the world, and detailed reviews of works dealing with railway affairs. At the closing of the eighth session, held in Berne in 1910, it was decided that the ninth session should take place in Berlin in 1915, and the preparations for this session were far advanced in 1914 when Germany declared war and began the invasion of Belgium. Naturally the invasion of the country resulted in the paralysis of activity on the part of the association for nearly five years.

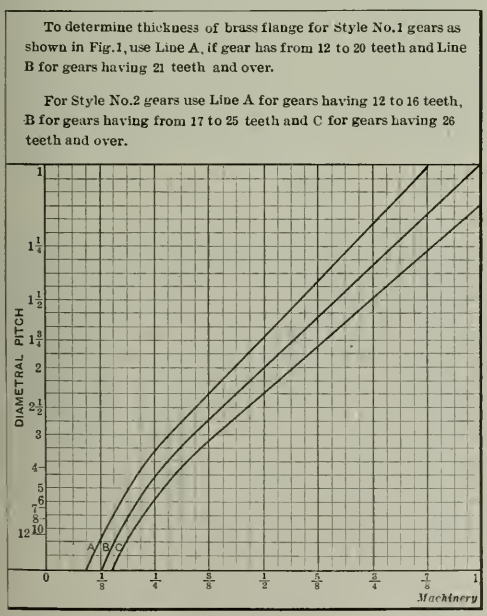


Fig. 3. Chart for determining Thickness of Brass Flanges for Composition Gears

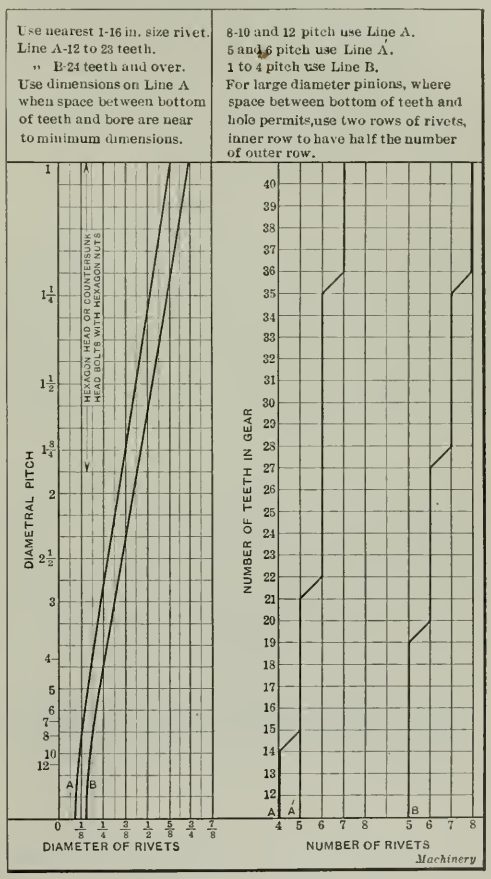


Fig. 4. Chart for determining Number and Size of Rivets required in assembling Composition Gear Blanks

Industrial Relations Report

A COMMITTEE appointed by the Merchants' Association of New York, upon which served, among others, John F. Galvin, president of the Metal Stamping Co., Long Island City, N. Y.; H. C. Seaman, secretary and treasurer of the E. W. Bliss Co., Brooklyn, N. Y., and Owen D. Young, vice-president of the General Electric Co., Schenectady, N. Y., has rendered a report on industrial relations which contains many valuable points, and which indicates the present trend of thought among employers.

The committee states at the outset that it is not attempting to offer a complete solution of the problem of industrial relations, but it is hoped that the report may be of value in stimulating employers to constant study and effort toward promoting in their individual plants measures based upon justice and conducive to prosperity; and in assisting in arriving at helpful decisions in bringing about harmonious relations with employes.

The change in fundamental industrial relations will be an evolution. With the proper thought and effort on the part of both employers and employes, improvement and advancement will be gradually made and progress will be successful in proportion to the interest and breadth of vision with which the problem is considered. Each advance will show a goal more desirable than that hitherto striven for. Care should be taken that each step is a real advance, not one which will have to be retracted. Employers must take the lead in the effort to apply sound principles to the improvement and advancement of industrial relations; much in the way of leadership is properly expected of them.

Retarding Influences

This evolution, says the report, is being retarded in part by three features of our industrial system which are not compatible with satisfactory industrial relations:

1. The short-sighted determination too often found on the part of employers and employes selfishly to get maximum results without consideration by either of the interests of the other, or of the public, as the controlling motive in industry. This selfish determination of employers and employes has hitherto been recognized by society as entirely proper, yet it is fallacious because it is destructive of maximum production.

2. Lack of understanding and mutual confidence of employers and employes. Suspicion and lack of complete understanding of each element in industry of the just aims, aspirations and problems of all other elements make constructive cooperation impossible.

3. The law of supply and demand as the determining factor in fixing wages and conditions of employment. Many of the results of this economic law are unfair and prejudicial to the interests of both employers and employes, and are socially undesirable.

The Rights of the Public and the Common Interests of Employer and Employe

In view of the detrimental influence of these three features of our industrial system, the committee recommends the recognition by both employers and employes that the determination to achieve national prosperity rather than to enforce maximum selfish returns should be the controlling motive in industry. The community, as such, has a right to insist that industry be carried on in the interest of all citizens rather than for the sole benefit of those engaged directly in it. The permanent welfare of all citizens depends on national prosperity, which is impossible unless there is maximum production at minimum "per unit" cost without impairment either of proper living standards of employes or the ability of the employers to earn a reasonable return on their investment. These requisites of national prosperity cannot be obtained unless employers and employes work together harmoniously with that end in view. Fundamental industrial problems of human relations can be solved upon the accepted basis that without national prosperity the permanent interests of parties to industry cannot be conserved; and that with such prosperity, relations between employers and employes can be worked out with justice to both.

In its broadest aspect, employers and employes unquestionably have a common interest, as it is only through the promotion of the interests of both that the country and the industrial communities in it can enjoy permanent prosperity. The actions and demands of employers and employes become unwarranted when they handicap the industries of the nation that are in competition with foreign industries.

Mutual Understanding Promoted by Conferences

The establishment of a recognized and permanent method of conference between the employer and his employes is recommended: Conferences, at which all subjects of mutual interest may be presented, are essential to the development of understanding and mutual confidence. The mere willingness of an employer to meet employes who have grievances is not sufficient. There should be a definite arrangement—satisfactory to both employers and employes—whereby employes can collectively take up disputes or matters of common interest with employers.

The committee offered no recommendations concerning the plan of conferences which should be established, except that such plans should be worked out jointly by employer and employes, and not prescribed by the employer. Conditions vary so much in different industries and plants that no one plan of conference can be adopted by all. The plan must be adapted to suit the conditions in each plant.

The functions of the conference and the determination of the proper subjects for consideration must be in each case a matter of gradual development. The committee suggests, however, that the following matters should be immediately recognized as included in those which should be discussed in conference: (a) Wages and working conditions, including steps to promote continuous and permanent employment, especially in the case of introduction of new machinery and new processes. (b) Plant conditions affecting health and general welfare of the workers.

General Labor Policies

The limitation of the economic law of supply and demand as a basis of labor policy by the utilization of a more human doctrine is also recommended by the committee. Like the solution of the entire problem of industrial relations, the development of any definite human doctrine which will modify and limit the economic law of supply and demand, will be a matter of evolution. Nevertheless, the committee recommends the immediate recognition of the following principles which will themselves modify the application of the law of supply and demand to a large degree, and are essential to the development of the human doctrine.

1. All wage earners, skilled and unskilled, in return for a fair day's work, have a right to a living wage sufficient to insure the workers and their families the opportunity to live in health and comfort in accord with the concepts and standards of American life.

2. Continuity of employment at normal wages should be maintained up to a point where permanent prosperity and stability of the business—rather than immediate profits—would be endangered thereby.

Profit-sharing not a Solution of Problems Involved

Recently much interest has been shown in plans of sharing in profits and participation in management. Many of these plans are undoubtedly valuable if properly developed and given their proper place. They deserve the careful attention of employers. However, the committee points out that they are merely aids, not remedies. Any plan, the introduction, continuation and final interpretation of which rests solely upon the volition of the employer, will not entirely eliminate dissatisfaction, because it lacks the elements of certainty and permanence, and there is no power of enforcement on the part of employe. Any plan of profit-sharing or participation in management to be of permanent value must receive the unqualified approval of both employer and employes.

The committee concludes by making a special appeal to employers generally to realize that the employment function in management is not second in importance to any other phase of business activity, and that intelligent study must be given to the problems of industrial relations and to the development of a proper labor policy. It is advised that the relations between employes and the management should be placed under the direct supervision of a separate department, and headed by a trained member of the firm.

* * *

ENGINEERS IN 1920 UNITED STATES CENSUS

As a result of the Engineering Council's request to the Director of the Census, the National Service Committee has been successful in effecting a reclassification of engineers so that all technical engineers will be listed as such, separately and distinctly from the non-technical engineers. Thus, the next census will bring an enumeration of all technical engineers together as one unit under the main headings of civil, mechanical, electrical, and mining. Architects will also be enumerated separately. This will enable the engineering profession, the Government, or any other interested organization or person to know exactly how many technical men there are in the United States and in each state. Under separate headings the enumeration will also include non-technical engineers (stationary engineers, locomotive drivers and other engine-men). There are, of course, many practitioners of engineering who do not ordinarily classify themselves under any one of the four headings given above, and there are others whose practice extends into more than one field. More numerous headings or more complex classification is impracticable in the work of the Census Bureau. With the general cooperation of all engineers along these lines a much better enumeration should result than in any preceding census.

* * *

THE NATIONAL EFFICIENCY SOCIETY

The National Efficiency Society at a meeting of its board of governors held on Tuesday, December 23, appointed H. F. J. Porter its executive secretary in place of Charles Dexter Allen, who had resigned on account of other duties which prevented his serving any longer in that position. Mr. Porter was the founder and the executive secretary of the Efficiency Society in 1912, and resigned in 1914 to return to his industrial engineering practice. In 1918, the National Institute of Efficiency and the Efficiency Society united under the name of the National Efficiency Society with headquarters at 119 W. 40th St., New York City. The society believes that the recent movement toward closer cooperation between the employer and the employe in industry through shop committees on which the employe is represented in the management, is the logical step toward higher productive efficiency in industry. Mr. Porter first introduced the shop committee in this country in 1913 and has been identified with the movement ever since. The National Efficiency Society will endeavor hereafter to be a clearing-house and a center of information on this important development in the industrial field.

PROFIT-SHARING INVESTIGATION

The National Civic Federation, under the direction of George W. Perkins, chairman of the Department of Profit Sharing, is making an investigation of profit-sharing methods, following the same lines as the investigation in 1916, the report on which contained an analysis of more than two hundred plans then in operation. There has been considerable demand for this report among manufacturers, and as it is now out of print, it is proposed to publish a new edition containing additional information. Circulars have therefore been addressed to manufacturers asking for the following information: Whether or not any form of profit-sharing is used, and, if so, the date of the installation of the plan, and if discontinued, the reason; average number of employes at the present time; average number of those participating in the plan; results obtained from the plan in regard to the creation of loyalty and the elimination of labor troubles; and any other information bearing upon the subject that would be of value in presenting a comprehensive review of the subject. Manufacturers who have not received the questionnaire may communicate with George W. Perkins, National Civic Federation, 1 Madison Ave., New York City.

* * *

GERMAN MACHINE TOOL SITUATION

Basing his observations upon recent developments in the machine tool situation in Germany, Wilbur J. Page, trade commissioner of the Department of Commerce, summarizes his general impressions of the machine tool situation in Germany as follows: Machine tools can in most cases, be delivered from stock, large machine tool building concerns having from twenty-five to forty machines of each type in stock, at prices that are approximately from 200 to 400 per cent above those previous to the war, as expressed in German marks. Of course, when sold abroad these prices are apparently very much lower, because of the low value of the German mark in foreign currency. In order to buy German machine tools, cash must be deposited in a German bank on receipt of advice that the machines are ready for shipment. A considerable amount of business has been transacted during the last six months with Holland, Sweden, Norway, Denmark, Spain, and South America. A large proportion of the machines made during the last six months have been for the export trade. The chief limiting factor in the output of the machine tool building plants is coal. There is a tendency to bring out new designs of a more specialized nature than those made in the past.

PERSONALS

JOHN CETRULE has been made assistant chief engineer of J. H. Wilhelm, Inc., consulting engineers, 225 Fifth Ave., New York City.

I. C. SCOVILL, previously sales manager of the Collis Co., Clinton, Iowa, has become sales manager of the Detroit Reamer & Tool Co., Detroit, Mich.

HUGO FRANKL is now in charge of the tool and die departments of the Steckert Electric Machine Co., Detroit, Mich., manufacturer of "Eureka" vacuum cleaners.

DAVID J. RICE, for the last three years manager of the Detroit office of the Illinois Tool Works, has become sales manager of the Michigan Tool Co., Detroit, Mich.

GUSTAVE BOTTIN, formerly salesman with the Allied Machinery Co. in Paris, is now connected in the same capacity with J. Horstmann, at 81 Rue Saint-Maur, Paris, France.

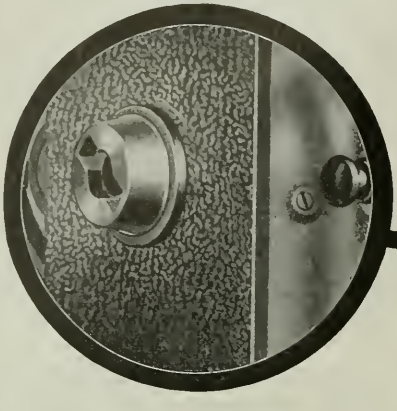
FREDERIC A. PARKHURST, organizing engineer, has opened an office at Room 2611, Grand Central Terminal Bldg., New York City, to consider organization, management, and production problems.

FRANKLIN SCHNEIDER was elected vice-president of the Van Dorn & Dutton Co., Cleveland, Ohio, at the last meeting of the Board of Directors. Mr. Schneider is also president of the Van Dorn Electric Tool Co.

F. G. ECHOLS, vice-president and general manager of the Greenfield Tap & Die Corporation, Greenfield, Mass., has been

The Taper Nose

Another Reason for Brown & Sharpe Milling Machines





Showing Relation of Slot in Cutter to Recess in Spindle



Showing How Cutter Driver is Inserted

THE simplicity and fewness of parts is particularly noteworthy. No plates, screws or loose parts are used and when arbor, collet or cutter is in place it is essentially as firm as though a part of the spindle itself.

Only a Drawing-in bolt and Cutter Driver Required to Hold and Drive Face Milling Cutters

The ease with which face milling cutters are attached to spindle is illustrated. Not only does this method make for greater convenience but it insures a positive drive.

Nose of Spindle Free From Projecting Parts

There are no threads to get bruised—no sharp corners to get broken—no such troublesome, time wasting conditions as "freezing" of cutter to spindle.

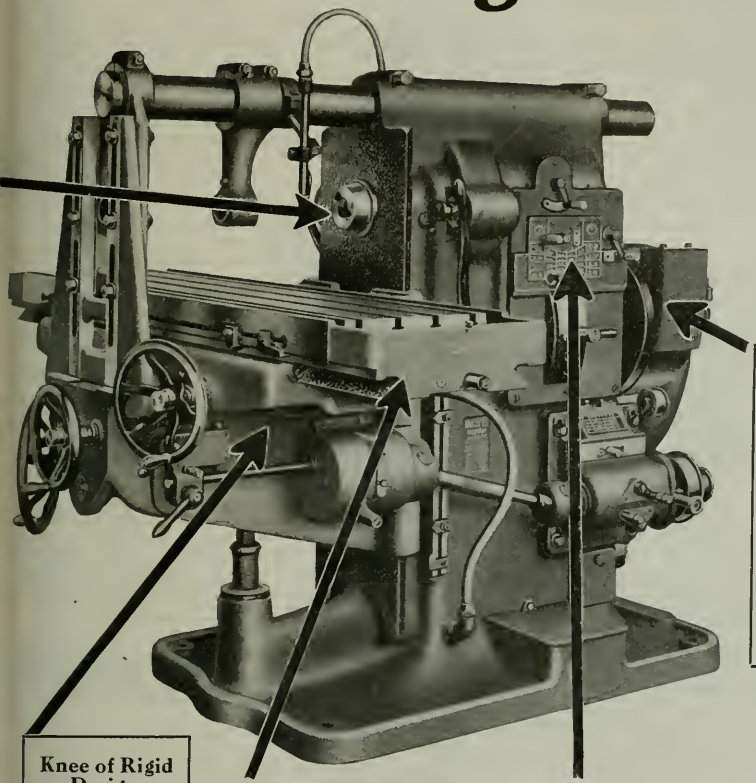
It is indeed an important reason for Brown & Sharpe Milling Machines but there are many more described in our Milling Machine book which we know will interest you.

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Brown & Sharpe Milling Machines



Large Proportioned Driving Pulley

The driving pulley is of large diameter and wide face. It is mounted on a shaft that is supported on both ends by ball bearings which take the pull of the belt.

In heavy service the value of this construction is well appreciated.

Knee of Rigid Design

The vertical depth, heavy sections, and interior transverse ribs, together with long and wide bearing surfaces for both column and saddle, overcome the tendency of the knee to vibrate or sag under the load of saddle and table during operation.

Reinforced Table Support

The wide bearings extend from the outside nearly to the center, because the severe stresses during operation are more successfully resisted when the table is well supported practically its full width. Strong, reinforcing ribs resist buckling tendencies.

Direct Reading Index Plate

All the available spindle speeds are given on a direct reading index plate fastened to the top of the speed case, and the exact position of the levers is clearly indicated. There are no combinations to figure out, as the proper positions for levers are pictorially shown and the operator grasps the idea at once.

elected a director of the corporation to fill the vacancy caused by the resignation of F. O. Wells.

ROBERT KIMBER, who formerly represented the Firth-Sterling Steel Co. in the Hudson River, Brooklyn, and Long Island territory, has been appointed eastern sales representative of the Le Moyne Steel Co., with offices at 30 Church St., New York City.

FREDERICK A. HARDIN has been appointed southern representative for the Victor Saw Works, Springfield, Mass., succeeding E. C. Paddock, who has been transferred to the Middle West. Mr. Hardin was previously connected with Oliver H. Van Horn, of New Orleans.

JOHN A. FOSTER, for the last two years superintendent of the High Speed Hammer Co.'s plant at Rochester, N. Y., and previous to that a department head with the General Railway Signal Co., is now associated with the Taylor-Shantz Co., Rochester, N. Y., in the capacity of factory manager.

F. W. SINRAM, president of the American Gear Manufacturers' Association, was elected president of the Van Dorn & Dutton Co., Cleveland, Ohio, at the last meeting of the Board of Directors of that company. Mr. Sinram has been general manager of the company for several years. He is also treasurer of the Van Dorn Electric Tool Co.

MYRON T. H. BLANCHARD, lately with the Hydraulic Pressed Steel Co., has recently been made a member of the Cleveland sales force of the Tacony Steel Co., Philadelphia, Pa. Mr. Blanchard has had considerable metallurgical experience, having been connected with the metallurgical departments of the Bethlehem Steel Co. and the Canton Spring & Axle Co. of Cleveland.

J. C. WARD, director of Edgar Allen Co., Ltd., Imperial Steel Works, Sheffield, England, is visiting this country in order to keep in close touch with trade conditions and further the cooperation between the Edgar Allen works in Sheffield and the agencies in the United States. Mr. Ward is making his headquarters at the Chicago office of the Edgar Allen Co. where G. R. Bennett is the general manager.

H. G. BAIN, until recently attached to the San Francisco sales office of the Midvale Steel and Ordnance Co., is now a member of the Tacony Steel Co.'s sales organization and will represent that company in the upper part of New York State. Mr. Bain, in addition to a long sales experience, has had considerable practical experience in the mills. He is thoroughly conversant with the tool steel, alloy steel, and forging branches of the steel business.

H. C. BARNES, for the last four years metallurgist and heat-treating engineer for the American Rolling Mills Co., at Middletown, Ohio, and for four years previous to that with the R. D. Nuttall Co., of Pittsburg, Pa. in the same capacity, has become associated with the Allegheny Gear Works, Chateau and Page Sts., Pittsburg, Pa., and will have charge of the metallurgical laboratory and heat-treating departments of the company's new plant.

FREDERICK H. KORFF has recently assumed his new duties as factory manager of C. E. Johansson, Inc., Poughkeepsie, N. Y. Mr. Korff has held the positions of factory manager with H. C. Hinchcliff, Inc.; production manager and mechanical engineer with the Frank S. Betz Co.; assistant general superintendent and production manager with the Stromberg Carburetor Co.; and assistant factory manager with the several plants of the Wright-Martin Aircraft Corporation, manufacturer of the Hispano-Suiza airplane motor.

KINGMAN BREWSTER, formerly vice-president and general sales manager of the Greenfield Tap & Die Corporation, Greenfield, Mass., is now president of the Millers Falls Co., Millers Falls, Mass. Mr. Brewster became associated with the Greenfield Tap & Die Corporation in 1918. Previous to that he practiced law in Springfield, Mass., having had charge of the legal work for a number of New England corporations. His work as counsel for these interests led to his being made vice-president of the Greenfield organization.

CLAYTON O. SMITH, until recently sales manager of the Norton Grinding Co., Worcester, Mass., is now general manager, secretary, and treasurer of the O. S. Walker Co., Worcester, which company has recently been sold by Oakley S. Walker to a group of men prominently connected with the machine tool and supply business. Mr. Smith is a graduate of the Worcester Polytechnic Institute and received his earlier practical engineering training with the Westinghouse Electric & Mfg. Co., East Pittsburg, Pa., the C. W. Hunt Co., Staten Island, N. Y., and the Norcross Bros. Co., Worcester, Mass.

RICHARD MARTENS, organizer and director-in-chief of R. Martens & Co., Ltd., London, England, and 6 Hanover St., New York City, has resigned his directorship of the firm and will hereafter devote his entire efforts to the development of direct trade between the United States and Russia. In cooperation with American manufacturers and bankers, plans are being considered for putting into Siberia and the southern part of Russia the necessary tools and machinery to restore agricultural industry as quickly as possible. Mr. Marten's address will remain at present in care of the firm at 6 Hanover St., New York City.

ARTHUR B. MEAD has been appointed district sales manager of Peter A. Frasse & Co., Inc., 417 Canal St., New York City, for the territory covering Philadelphia, middle Pennsylvania, southern New Jersey, Virginia, Delaware, and Maryland. Mr. Mead has been a member of the sales organization at the general offices of the company for several years. His headquarters will be at the Philadelphia office and warerooms, 625 Arch St., where larger stocks of the Frasse electric, tool, and alloy steels, open-hearth steels, Frasse polished drill rods, and Shelby seamless steel tubes, will be carried to meet the growing demand.

E. I. CHAPIN, for the last few years assistant factory manager for the Brown-Lipe-Chapin Co.'s plant in Syracuse, N. Y., has resigned his position to take active charge of the Chapin & Baker Mfg. Co., Syracuse, of which he is now manager. Previous to his connection with the Brown-Lipe-Chapin Co., Mr. Chapin was with the H. H. Franklin Mfg. Co., of Syracuse. The Chapin & Baker Mfg. Co., which was organized by Mr. Chapin and his associates some months ago, is manufacturing a line of special tools, including reamers, counterbores, tool-holders, etc., and is engaged in jig, fixture, and general contract work. Several new lines of tools are being developed, and the plant on Edison St. is being enlarged to meet the needs of this expansion.

FRANK O. WELLS, president of the Greenfield Tap & Die Corporation, Greenfield, Mass., has announced that he has sold out his holdings in this corporation to interests represented by Frederick H. Payne, vice-president of the concern. Mr. Wells will retire as president and from the board of directors, but will remain with the corporation in an advisory capacity. Mr. Wells has spent 45 years of his life in the industry, being the founder of Wells Bros. Co., which is now one of the larger units of the Greenfield Tap & Die Corporation. He began his career as a workman in the Wiley & Russell factory, but in 1874, he started, with his brother, Frederick E. Wells, manufacturing in his own interest. The new business grew so rapidly that it required a new factory, and one was built on Sanderson St., which was afterward greatly enlarged. Later came the merging of the Wiley & Russell company with the Wells Bros. Co. under the name of the Greenfield Tap & Die Corporation, and to this was added the F. E. Wells & Son Co., the Bickford Machine Co., and the Smart Manufacturing Co. During the war Mr. Wells was called into the counsels of the government and gave invaluable assistance in the direction of organizing industries for war production. He was made a member of the National Screw Thread Commission, and this summer went to Europe to consult with leading manufacturers on the question of the world standard screw thread.

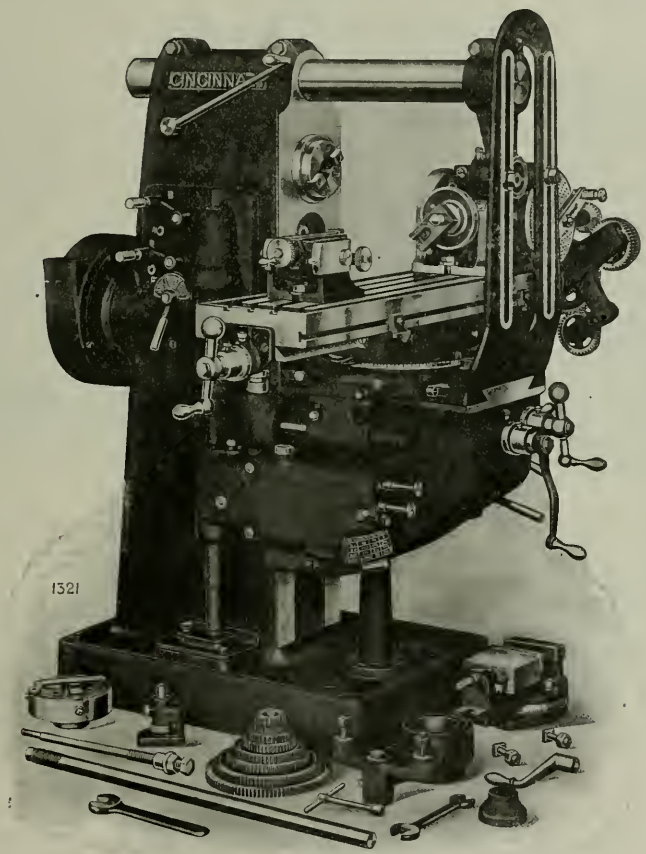
OBITUARIES

H. L. GANTT, one of the best known of the consulting engineers who have devoted themselves to the installation of methods for increasing industrial efficiency, died November 23. Mr. Gantt was born in 1861 and was educated at Johns Hopkins University and at the Stevens Institute of Technology. He was the author of several books on industrial efficiency, and had unusually clear and definite views on the relations between capital and labor and the best means for securing friendly relations between employer and employe. He had been a member of the American Society of Mechanical Engineers since 1888, having served the society as manager from 1908 to 1911 and as vice-president from 1913 to 1915.

CHARLES BURGESS, founder of the Cyclops Steel Works, died at his home in Titusville, Pa. on November 18. Mr. Burgess was born in Pelsall, England, in 1841, and in his early youth became interested in the manufacture of iron and steel products. In 1866, he came to this country and was first employed at Troy, N. Y. He later organized the Burgess, Aston Co., which operated a puddling plant near Pittsburg until 1870. Soon after disposing of his interests at Pittsburg, Mr. Burgess went to Portsmouth, Ohio, where, in 1871, he organized the Burgess Steel & Iron Works in which he retained a controlling interest until 1884, when he went to Titusville where he purchased the plant and business of the Eames Petroleum Iron Works, operating the plant under the name Cyclops Steel Works. In the early stages of the high-speed steel market, Mr. Burgess developed a secret process for the manufacture of high-speed steel. He was considered one of the leaders in tool steel manufacture and was one of the first men to puddle steel for agricultural implements in the puddling furnace.

Announcing a new line of

Small Constant Speed Drive Millers



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1 M and 2 M
Plain, Universal and Vertical

Ask us!

THE CINCINNATI MILLING MACHINE COMPANY

CINCINNATI OHIO, U.S.A.

COMING EVENTS

January 8-15—First aeronautical exposition in the Coliseum in Chicago, Ill., given by the Manufacturers' Aircraft Association, Inc., 501 Fifth Ave., New York City.

January 29—Monthly meeting of the Rochester Society of Technical Draftsmen, in Rooms 131-137 Sibley Block, 328 Main St., E., Rochester, N. Y. Secretary, O. L. Aagevine, Jr., 547 Arnett Blvd., Rochester, N. Y.

February 2-6—First annual mechanical inspection equipment exposition and convention of the American Society of Mechanical Inspectors at the Hotel Astor, New York City. Secretary, Henry F. Wister, 35 W. 39th St., New York City.

May 12-15—Seventh national foreign trade convention in San Francisco, Cal. Secretary of the National Foreign Trade Council, O. K. Davis, 1 Hanover Square, New York City.

SOCIETIES, SCHOOLS AND COLLEGES

Clarkson College of Technology, Potsdam, N. Y. Bulletin containing views of the college.

University of Utah, Salt Lake City, Utah. General catalogue of the university for 1919-1920.

Johns Hopkins University, Baltimore, Md. Catalogue of the Department of Engineering of the university.

University of Minnesota, Minneapolis, Minn. Bulletin of the College of Engineering and Architecture for 1919-1920, containing calendar, courses of study, and general information.

BOOKS AND PAMPHLETS

War-time Changes in Wages. Research Report No. 20. 128 pages, 6 by 9 inches. Published by the National Industrial Conference Board, 15 Beacon St., Boston, Mass.

Works Councils in the United States. Research Report No. 21. 135 pages, 6 by 9 inches. Published by the National Industrial Conference Board, 15 Beacon St., Boston, Mass.

Thirty-sixth Annual Report of the Department of Labor of the State of Michigan. 766 pages, 6 by 9 inches. Published by the Department of Labor of the state of Michigan, Lansing, Mich.

Some Tests of Light Aluminum Casting Alloys—the Effect of Heat-treatment. By P. D. Merica and C. P. Karr. 31 pages, 7 by 10 inches. Published by the Department of Commerce, Washington, D. C., as Technologic Paper No. 139 of the Bureau of Standards. Price, 10 cents.

Mechanical Properties and Resistance to Corrosion of Rolled Light Alloys of Aluminum and Magnesium with Copper, with Nickel, and with Manganese. By P. D. Merica, R. G. Waltenberg, and A. N. Finn. Published by the Department of Commerce, Washington, D. C. as Technologic paper No. 132 of the Bureau of Standards. Price, 5 cents.

Exercises in Lettering—Vertical Gothic. By George G. Greene. 31 pages, 2½ by 5 inches. Published by the Bruce Publishing Co., Milwaukee, Wis. Price, 10 cents.

This little book is one of a vest pocket series of exercises in lettering which has been brought out for the purpose of teaching the student to letter rapidly and neatly. It contains sixteen exercises, showing the correct form and proportions of vertical Gothic letters and numbers.

Millwrighting. By James F. Hobart. 454 pages, 6 by 9 inches. Illustrated. Published by the McGraw Hill Book Co., Inc., New York City. Price, $4.

In the second edition of this book, which has just been brought out, a chapter has been added dealing with the installation and control of electrical motors. The conditions under which the millwright works have changed greatly during the last few years, and an idea of how these changes affect millwright work is given in the new material. Several changes and corrections have been made in the original text to bring the book up to date.

Robison's Manual of Radio Telegraphy and Telephony. By Rear Admiral S. S. Robison, U. S. Navy. 307 pages, 6 by 9 inches. Published by the U. S. Naval Institute, Annapolis, Md. Price, $1.50.

This is the fifth revision of a radio manual for the use of student operators and others, presenting the elementary principles of the art of radio telegraphy and telephony and describing apparatus commonly used. The fourth and fifth editions have been brought up to date by Captain D. W. Todd, U. S. Navy, and Commander S. C. Hooper, U. S. Navy. The latest edition contains much material that was confidential during the war. This book is used as the standard for the Navy and Shipping Board.

Machine Tool Operation—the Lathe. By Henry D. Burghardt. 326 pages, 4¾ by 7½ inches. Illustrated. Published by the McGraw-Hill Book Co., Inc., New York City. Price, $2.

This book treats of the principles and elementary operations of machine shop work, referring particularly to lathe construction and operation. The book is divided into two main parts, the first treating of the lathe, and the second of bench work and work at the forge. An idea of the material covered will be gained from a list of the chapter heads: The Machinist's Trade; Lathe Construction and Manipulation; Cutting Tools and Cutting Speeds; Measuring Tools; Centering; Facing; Turning; Chucking Work; Tapers and Angles; Threads and Thread Cutting; Faceplate Work; Hammers, Screwdrivers, Wrenches, and Hacksaws; Laying Out; Chipping, Filing, and Scraping; and Work at the Forge.

NEW CATALOGUES AND CIRCULARS

Cregan Mfg. Co., Bangor, Me. Circular of steel measuring tapes.

Aluminum Castings Co., Cleveland, Ohio. Circular of Lynnx brass and bronze bushings and bearings.

Baldwin Locomotive Works, Philadelphia, Pa. Record No. 94, containing specifications of tank-frame locomotives.

General Electric Co., Schenectady, N. Y. Pamphlet B-3549, descriptive of the "Pyrotip" electric burner for lead burning.

Electric Controller & Mfg. Co., Cleveland, Ohio. Circular of Type ZB alternating-current starting switches for small induction motors.

S. P. Rockwell, 122 Dickerson St., Syracuse, N. Y. Circular descriptive of the Rockwell hardness tester for testing the hardness of metals.

Smith & Serrell, 144 Cedar St., New York City. Bulletin 103, describing the construction and use of "Pintite" rigid couplings for lineshafting.

Lewis-Shepard Co., 49 Binford St., Boston Mass. Circular illustrating the use of "Jacklifts" for moving loaded platforms in manufacturing plants.

Black & Decker Mfg. Co., Towson Heights, Baltimore, Md. Catalogue illustrating and describing Black & Decker electric air compressors, portable electric drills, and electric valve grinders.

Gisholt Machine Co., 9 S. Baldwin St., Madison, Wis. Circular treating of Gisholt turret lathes, horizontal boring and drilling machines, vertical boring mills, special lathes and universal tool grinders.

Federal Steel Co., Penobscot Bldg., Detroit, Mich. Bulletin 1, descriptive of the Federal center for lathes, milling machines, gear-cutters, and grinders, which is made with an inserted high-speed steel point.

Bucher-Smith Co., East Liverpool, Ohio. Catalogue of Bucher-Smith portable keyseaters, which are made in hand and electrically operated styles. Catalogue of ball-bearing jiggers and roller-bearing pull-downs.

Smalley-General Co., Inc., Bay City, Mich. Bulletin E containing charts giving the necessary data for milling work under any condition of feeds and speeds on the Smalley-General No. 1 thread milling machine.

Wodack Electric Tool Corporation, 23-27 S. Jefferson St., Chicago, Ill. Circular describing and giving specifications for Wodack portable electric drills made in four sizes—¼, ⅜, ½, and ⅝ inch respectively.

McLain-Carter Furnace Co., Goldsmith Bldg., Milwaukee, Wis. Catalogue describing McLain-Carter open-hearth furnaces for melting steel. The illustrations show installations of these furnaces in a number of plants.

Cleveland Punch & Shear Works Co., Cleveland, Ohio. Calendar for November, 1919, to May, 1920, Ohio. Calendar for November, 1919, to May, 1920, of the working days arranged by weeks, each sheet also illustrating the punches, dies, and other products made by the company.

Leeds & Northrup Co., 4901 Stenton Ave., Philadelphia, Pa. Catalogue 80B, describing the construction, use, and application of the Leeds & Northrup optical pyrometer, a portable instrument for making temperature measurements.

Werner G. Smith Co., Cleveland, Ohio. Booklet entitled "The Chemistry of a Core," treating of "Licoil"—a core oil for use in core sand. The booklet illustrates clearly by means of magnified photographs the function of oil in sand cores.

Bilton Machine Tool Co., Bridgeport, Conn. Catalogue of milling cutters, small tools, and machine tools, including automatic milling machines, gear milling machines, thread milling machines, plain milling machines, riveting machines, and drilling machines.

C. E. Johansson, Inc., Poughkeepsie, N. Y., is issuing a publication known as "The Johansson Journal," which contains information relative to the product of the company, the intention being to illustrate and describe in each number specific uses of Johansson gages and precision tools.

Westinghouse, Church, Kerr & Co., Inc., 37 Wall St., New York City. Circular illustrating a number of shops that have been constructed by this company. The W. C. K. method of construction comprises the laying out of the equipment and the construction of the building to suit the lay-out.

J. G. White Engineering Corporation, 43 Exchange place, New York City. Catalogue illustrating a nitrate plant designed and constructed by this company. The work of the company comprises engineering investigations and reports, designing and construction work, and the purchase of apparatus, materials, and supplies.

Davis-Bournonville Co., Jersey City, N. J. Circular describing briefly the Davis acetylene flare-light generator—a portable lighting apparatus—and suggesting some of its many possible uses. This equipment can also be used for lead burning, light welding, and other industrial purposes requiring a low acetylene pressure only.

Bacharach Industrial Instrument Co., 422 First Ave., Pittsburg, Pa. Pamphlet F, describing a new pressure-volume indicator for the control of air delivery to cupolas, suitable for either permanent installations or testing purposes. Pamphlet P, treating of pitot tubes and orifices for measuring the flow of gases in connection with hydro flow meters.

Franklin Mfg. Co., 738 Gifford St., Franklin, Pa. Catalogue FC 7-19, treating of Franklin heat insulating and fuel saving products. The bulletin contains engineering data that will enable fuel users to calculate the losses, determine the best material for each condition, and estimate the yearly saving effected through the installation of heat insulating products.

Chicago Flexible Shaft Co., 1154 S. Central Ave., Chicago, Ill. Catalogue 75, of Stewart gas and oil furnaces, which are made in three types, namely, the oven, crucible and forge types. In addition to illustrating and describing the furnaces and giving specifications of the various sizes and types, information is given on the hardening of high-speed tool steel and practical hints on hardening steel.

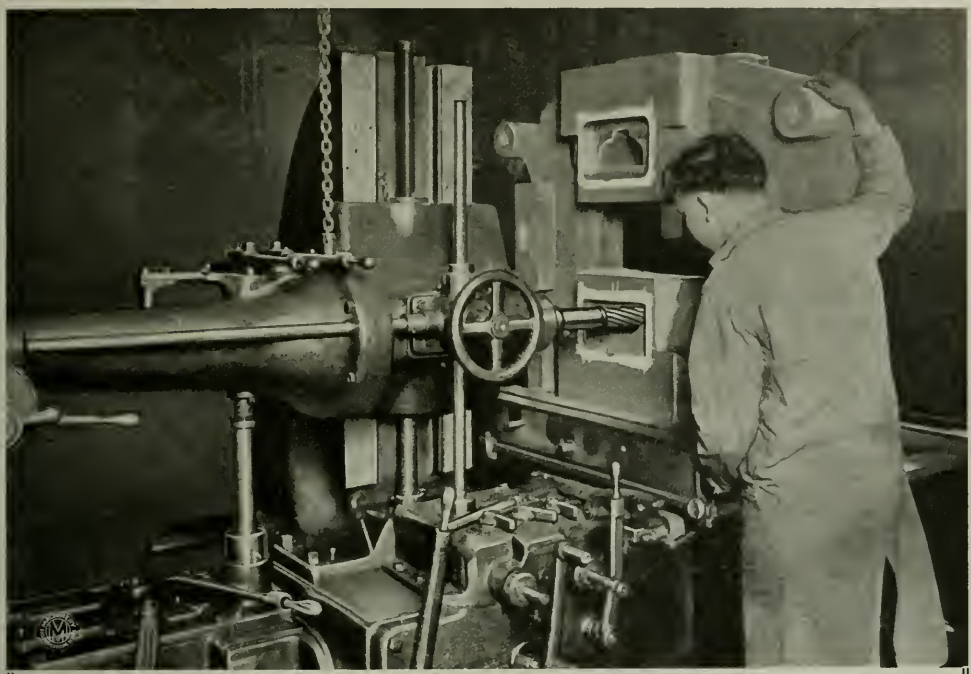
Clark Equipment Co., Buchanan, Mich. Catalogue 17, of "Celfor" high-speed twist drills, reamers, countersinks, flue cutters, lathe tools, and internal gear drive axles. Dimensions, prices, and other data covering these tools are given. The last section of the book, covering general information gives tables of proper feeds and speeds for "Celfor" drills, drill lists with taps for U. S. standard threads, machine screw taps, taps with V-threads, pipe taps, etc.

Sipp Machine Co., Keen and Warren Sts., Paterson, N. J. Bulletins 4 and 5, illustrating and describing the Sipp quick-change-speed sensitive drilling machines, which are made in three types, either single- or multiple-spindle styles with 6¼-, 8-, and 12-inch overhang, respectively. Circular descriptive of the automatic power feed for Sipp quick-change-speed sensitive drilling machines. Booklet entitled "Facts" containing excerpts from letters of recommendation written by users of the Sipp drilling machines.

Onondaga Steel Co., Syracuse, N. Y. Catalogue of Onondaga high-speed steel, giving dimensions, weight, prices, etc., of rounds and squares, flats, disks, and blocks. The catalogue contains information on selecting quenching oils; directions for heat-treatment, including a color chart that gives an idea of the various heats required; and suggestions for steel conservation, and the selection of high-speed steel scrap. A number of useful tables are included, among which are tables of sizes and weights of high-speed steel bars in metric and English measurements, the millimeters and kilograms being printed in red, and the inches and pounds in black.

Eastern Machine Screw Corporation, New Haven, Conn., maker of the H & G line of self-opening die-heads and collapsible taps, has just issued a new catalogue of 96 pages, containing considerable threading information and tables pertaining to thread cutting. The book is well illustrated and comprises practically a text-book on the subject. In addition to describing the H & G die-heads, collapsible taps, chasers for H & G die-heads, stock, system, and service, instructions are given for opening the die-heads, installing the chasers, closing the heads, adjusting for pitch diameter, and grinding the chasers. Information is given on cutting speeds, lubricants, and much other material relative to standard thread forms, decimal equivalents, weight per foot of screw stock, etc. A revised price list has also been issued.

Norton Co., Worcester, Mass., has issued the following publications: "Safety Bulletin," describing causes and remedies of troubles common among men doing shop work; "Health Bulletin," containing suggestions for preventing troubles common to shop men, and for encouraging the maintenance of sanitary conditions in the shop and in the home; "Principles of Cylindrical Grinding," treating of work-speed, depth of cut, grade of wheel, wheel-speed, finishing, etc.; "Storage, Handling, and Supervision of Grinding Wheels"; "Safety as Applied to Grinding Wheels," discussing preventive and protective safeguards applied to grinding wheels and machines; "Safety Code for the Use, Care, and Protection of Abrasive Wheels"; "Alundum Tile and Terrazzo Aggregates"; "Tests of Alundum Tile at Columbia University"; "Indian Hill—an Industrial Village," containing a description of homes constructed by the company for its employes.



"Satisfactory" comes the report on every test

One of the finest tool shops in the Middle West uses two Lucas Precision Boring Machines on large drill jigs, punches, dies and gages for manufacturing automobile parts. Tolerances are close, mostly plus or minus .0005", and during the war these machines were run continuously 24 hours a day.

LUCAS

"Precision" Boring Machines

respond 100 per cent to every kind of test. The one here shown is milling openings measuring 11" by 6½" by ¼" deep in a cast iron die shoe for a piercing die used in making front frame connections. The shoe itself measures 37" by 48" by 8" thick.

We'd like to tell you more—to explain in detail the distinctive advantages of this wide range precision tool. Write us.

LUCAS MACHINE TOOL CO. NOW AND ALWAYS OF **CLEVELAND, OHIO, U.S.A.**

FOREIGN AGENTS: Alfred Herbert, Ltd., Coventry. Societe Anonyme, Alfred Herbert, Paris. Societe Anonyme Belge, Alfred Herbert, Brussels. Allied Machinery Co., Turin, Barcelona, Zurich. Benson Bros., Sydney, Melbourne. V. Lowener, Copenhagen, Christiania, Stockholm. R. S. Stokvis & Zonen, Rotterdam. Andrews & George Co., Tokyo.

P. W. V. Automatic Machine Corporation, Fitchburg, Mass. Catalogue detailing the design, construction, and manufacture of "Radical" automatic screw machines. The plan of presentation is rather unusual, and is such as to give a very clear and comprehensive idea of the construction of these machines. The first pages show the assembled machine with symbol oumbers to designate the different parts, and the following pages show each part and give specifications and necessary data. The illustrations show the machioe in what may be termed the process of manufacture, the first view showing the pan, and the subsequent views showing the addition of each unit, in the correct order of assembly, until the machine is shown complete with all its parts assembled. Attention is called to the fact that the threading mechanism is an entirely separate unit, which can be easily removed if it is desired to use the position that it occupies for other tools.

TRADE NOTES

Hyatt Roller Bearing Co. has established an office at 309 Marshall Bldg., Cleveland, Ohio, to accommodate its customers in that territory.

V. Lowener, 114 Liberty St., New York City, desires to receive catalogues and price lists for all kinds of automobile accessories and supplies for export to Scandinavia.

Erie Crucible Steel Co., Erie, Pa., has recently received a contract from the United States Navy for a large quantity of Erie high-speed steel for the Naval Ordnance plant at Charleston, W. Va.

Van Dorn Electric Tool Co., Cleveland, Ohio, manufacturer of portable electric tools—drills, reamers, and grinders—has completed a new four-story building, giving the plant 30,000 square feet of additional floor space.

Hammacher, Schlemmer & Co., 4th Ave. and 13th St., New York City, announces the opening of a new department which will handle exclusively a large assortment of high-grade automobile supplies and accessories.

Willard Machine Tool Co., Cincinnati, Ohio, manufacturer of lathes, has erected a 100- by 65-foot addition to its plant. This addition will considerably increase the capacity of the firm to take care of its growing business.

Wilmarth & Morman Co., 1180 Monroe Ave., N. W. Grand Rapids, Mich., manufacturer of grinding machinery, has established an eastern branch office at 1 Madison Ave., New York City, with W. E. Heibel, eastern district manager, in charge.

Warner & Swasey Co., Cleveland, Ohio, announces that the following changes have been made in the sales department: A. C. Cook has been made general sales manager, L. K. Berry, domestic sales mansger, and Charles J. Stilwell, foreign sales manager.

Bridgeport Drafting & Engineering Co., Warner Bldg., Bridgeport, Conn., designer of special automatic machinery, jigs, fixtures, and tools, has installed a catalogue filing system, and would like to receive catalogues from concerns handling tool and shop equipment, structural steel, and sheet-metal work.

Smalley-General Co., Inc., Bay City, Mich., has increased its capitalization from $50,000 to $525,000. The management and officers of the company remain the same. The new capitalization will permit the company to increase its production of thread milling machines, and serve its customers more efficiently.

St. Louis Machine Tool Co. is building an addition to its plant at 932 Loughborough Ave., St. Louis, Mo., which will practically double the capacity, affording 13,000 square feet of additional floor space. This enlargement was made necessary by the increasing demand for the grinding, polishing and tapping machinery made by this company.

Compton & Knowles, Worcester, Mass., builders of textile machinery, are planning to increase their plant by an addition calling for an expenditure of approximately $300,000 for buildings, including an extension of the company's foundry in Providence. A building six stories in height will also be erected on the site of the present forge shop in Worcester.

Crescent Washing Machine Co., 840 Larrabee St., Chicago, Ill., announces that the Nivin metal parts washing machine will hereafter be known as the "Crescent" metal parts washing machine. The change of name is made merely for the purpose of identifying the product with the company, and no change will be made in the machine, factory, personnel, or policy.

Black & Decker Mfg. Co., Towson Heights, Baltimore, Md., has opened an office on the Pacific coast, at 201 Maynard Bldg., Seattle, Wash. The office is in charge of A. E. Nordwall, who will attend to the distribution of the Black & Decker products in the state of Washington, working under the direction of the main Pacific coast office at 918 Hearst Bldg., San Francisco, Cal.

Fairbanks, Morse & Co., Inc., 900 S. Wabash Ave., Chicago, Ill., announce that they will build a foundry in Beloit, Wis, that will cover 11 acres at a cost of $1,500,000. The structure, when completed, will be 900 feet long and 550 feet wide, which is said to equal any foundry in the world in size. It will have an ultimate capacity of from 350 to 400 tons of gray iron daily and will employ 1500 men.

Bound Brook Oil-less Bearing Co., Bound Brook, N. J., has completed another new addition to its plant, 100 by 180 feet. A new power plant has also been added as well as an office building, 100 by 40 feet, two stories high. The new building adjoins the foundry which was completed in 1917. These additions have been made necessary by the increasing demand for Bound Brook and Nigrim oil-less bushings.

Pneumatic Scale Co., Norfolk Downs, Boston, Mass., has recently placed a contract with the Aberthaw Construction Co. of Boston, for the immediate erection of a manufacturing and office building of reinforced concrete. The new building will be three stories high and will cover an area of 150 by 160 feet. Its completion will practically double the capacity of the plant. Work on the new building is already under way.

Doehler Die-casting Co., Brooklyn, N. Y., manufacturer of die-castings in white metal, aluminum, and brass alloys, and bronze-back and aluminum-back babbitt-lined bearings, has recently purchased a seven-acre tract in Chicago, Ill., on which a modern one-story concrete steel and brick structure will be erected for the manufacture of die-castings and bearings. The contract for the building has been let and operations have been started.

Firth-Sterling Steel Co., whose New England headquarters have been at 35 Oliver St., Boston, Mass., for a generation, will move during the month of January, the Oliver St. property having been purchased by the Federal Reserve Bank. After February 1 the Firth-Sterling Steel Co. will occupy its new warehouse at 85-91 W. First St., South Boston, where a complete stock of "Blue Chip," high-speed, and other Firth-Sterling tool and die steels will be carried.

Federal Bearinga Co., 42 William St., Poughkeepsie, N. Y., has started construction on an addition to its plant, which has become necessary in order to take care of its largely increased business. When this is completed in the early spring, the factory capacity and production will be more than doubled. An increase in capital stock from $1,000,000 to $2,000,000 has also been announced. A certain part of this new stock will be sold to finance the expansion.

American Machinery Syndicate, Inc., 35-37 W. 39th St., New York City, announces that a company has been formed in Madrid, Spain, with a capital of $100,000 to erect a factory for the manufacture of commercial gears, and that this factory will be equipped completely with American machine tools, the purchase of which has been entrusted to the American Machinery Syndicate, Inc. Henry S. Moos, president of the American Machinery Syndicate, Inc., is one of the directors of the Spanish company.

Mulliner Bros., 445 S. Warren St., Syracuse, N. Y., announces the opening of offices as manufacturing engineers. The engineering department of the company is prepared to develop commercial machine models, mechanical ideas or patents, and to design and supervise the building of special machinery and manufacturing equipment, as well as to assist in placing personally products on the market. The mechanical and technical advertising department will develop catalogues, booklets, and bulletins.

Black & Decker Mfg. Co., Towson Heights, Baltimore, Md., announces that it will exhibit the following products at the automobile show to be held in New York, in January: "Lectro-fluter" electric air compressors, portable electric drills, electric valve grinders, a 6-foot Black & Decker electric air compressor, and a portable tire inflation outfit. Models of electric air compressors, electric drills, and electric valve grinders will be operated under their own power at slow speeds to demonstrate the actual functioning of each part.

Wilkins, Champion & Wilkins, London, England, which firm is represented in the United States by Charles H. Champion, 347 Fifth Ave., New York City, in a purchasing capacity, desires to be placed in touch with manufacturers of mechanical and electrical labor-saving appliances with a view to their sale in the United Kingdom. The firm is especially interested in automobile accessories, tires and shoes, electrical fixtures and fittings, and domestic electrical apparatus, such as washing machines, vacuum cleaners, motor-driven sewing machines, electrical water heating apparatus, etc.

Greenfield Tap & Die Corporation, Greenfield, Mass., announces that Frank O. Wells, president of the corporation, has sold out his holdings to interests represented by Frederick H. Payne, vice-president of the concern. Mr. Wells will retire as president and from the Board of Directors, but will remain with the corporation in an advisory capacity. Mr. Payne, to whom Mr. Wells has sold, was prominent in the merging of the Wiley & Russell and Wells Bros. companies. During the war he accepted a commission as Major in the Ordnance Department and was stationed in Bridgeport, Conn.

Dittmer Gear & Mfg. Corporation is a new concern which has been organized at Lockport, N. Y., with a capitalization of $175,000, for the manufacture of automobile motor truck and tractor transmissions, gears and shafts. A lot, 264 by 272 feet, has been purchased on which a steel, brick and concrete plant will be constructed, having a floor apace of 22,000 square feet. The president of the company is A. H. Dittmer. Mr. Dittmer has had considerable experience in the production of automobile parts, having been associated for a number of years with several of the large automobile industries.

Norma Co. of America, manufacturer of Norma ball and roller bearings, has moved its factory from the Bronx, New York City, to Anable Ave., Long Island City, N. Y., where a modern four-story reinforced concrete building has been acquired. Under the new arrangement a largely increased factory space has been secured, making possible an increased output of Norma bearings to meet the growing demand. The new plant is being equipped with the special machines needed for precision manufacture and the full capacity will be available shortly. The executive offices at 1790 Broadway have been consolidated with the factory at the new address.

Link-Belt Co., 910 S. Michigan Ave., Chicago, Ill., has recently constructed an extension to its Belmont foundry at Indianapolis, Ind., which comprises two new furnace buildings; for the present only one furnace of 15-ton capacity will be installed. The company is also purchasing machinery such as rolling mills, sand-blast and other foundry equipment needed to take care of the additional capacity. The building will be 70 feet wide by 400 feet long. These additions are being made in order to give better service to the customers and to take care of the constantly increasing demand for Link-Belt malleable iron chains, and for elevating, conveying, and power transmission purposes.

A. H. & F. H. Lippincott, 24th and Locust Sts., Philadelphia, Pa., manufacturers of screw machine products, announce that they have purchased the assets of the Carlson-Wenstrom Co. and the Carwen Tool & Steel Co., Erie Ave. and Richmond St., Philadelphia, Pa., and will continue, under the direct supervision of A. H. & F. H. Lippincott, the manufacture of the Carwen dynamic balancing machine in conjunction with their screw machine product business, on a much larger scale. Joseph A. Ganster, will be associated with the corporation as director and works manager, and Jacob Lundgren, as engineer. The business will be conducted under the corporate name of Lippincott-Carwen Corporation.

Detroit Hexagon Drill Co. has been reorganized and is now located at its new plant at 27-29 Woodward Ave., Detroit, Mich. The company occupies four floors in the building, and expects to accelerate production immediately. The new officers are W. A. Smith, president and general manager; William S. Manning, vice-president; J. W. Donaldson, treasurer; and E. J. Jenks, secretary. Mr. Smith was formerly general manager of the Russell Motor Axle Co.; Mr. Manning was vice-president of the Manning-Blake Tool & Die Co.; Mr. Jenks was secretary of the Russell Wheel & Foundry Co.; and Mr. Donaldson has been connected with the Detroit Hexagon Drill Co. since it was started. This concern is now making a five-lipped drill.

Chicago Pneumatic Tool Co., 1060 Fisher Bldg., Chicago, Ill., reports that it has received orders during the month of October in excess of any previous month since the signing of the armistice. This is also true of its English and German subsidiaries. While the German subsidiary was seized by the German Government and has been run under compulsory administration since the United States' participation in the war, the compulsory administration has now been abolished and the management has been transferred back to the Chicago Pneumatic Tool Co. Reports show that the German company was well managed during the war and is now operating on a satisfactory basis. Arrangements have been made to materially increase production.

Hooven, Owens, Rentschler Co., Hamilton, Ohio, has opened a new office in Philadelphia Pa., at 2129 Land Title Bldg. C. M. Decker, formerly with the R. D. Wood Co., has been made manager. The company has also opened a new office at Richmond, Va., with E. H. Fairchild, formerly of the C. & G. Cooper Co., in charge. The following additions to the force of the Hooven, Owens, Rentschler Co. are announced: E. S. Cooley, who was previously associated with the Fall River Ship Building Co., is now connected with the New York office; Henry E. Balaley, formerly with the American Bridge Co., has been made manager of the Chicago office; and R. C. Holman, who was previously in the centrifugal department of the General Electric Co., is in charge of all blowing engines.

O. S. Walker Co., Worcester, Mass., manufacturer of grinding machines and magnetic chucks, has been sold by Oakley S. Walker to a group of men prominently connected with the machine tool and supply business, and the reorganization of the corporation has been completed, the new management having assumed control. The name of the company will remain unchanged. The sale includes the company's plant on Rockdale St., Greendale. The officers of the company now are: President, W. B. McSkimmon, Boston; vice-president, J. H. Drury, Athol; and general manager, secretary, and treasurer, Clayton O. Smith, who was until recently sales manager of the Norton Grinding Co. Isaac F. Williame, who was manager of the business before its reorganization, will remain with the company. William F. McCarthy, of Boston, is also a director.

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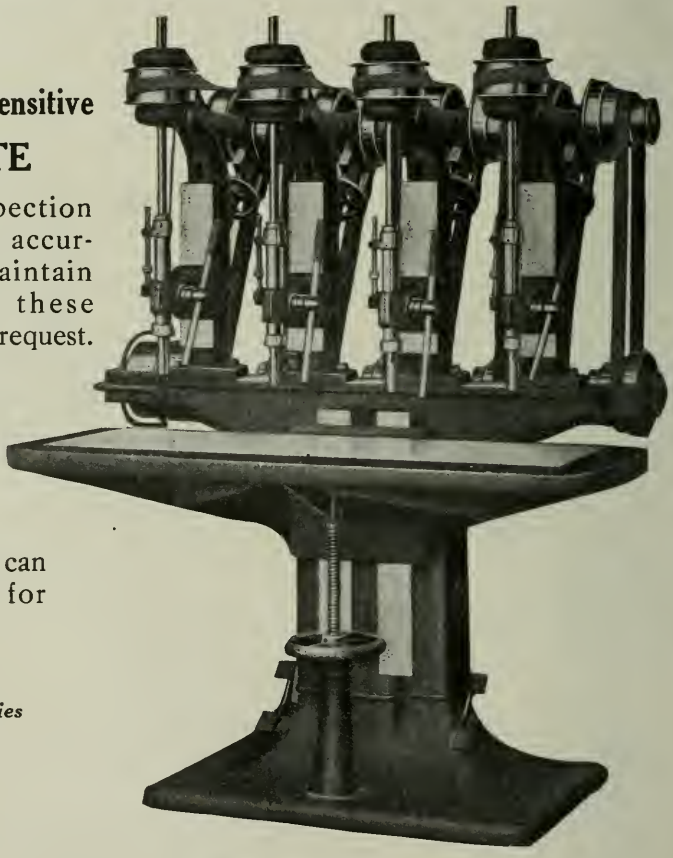
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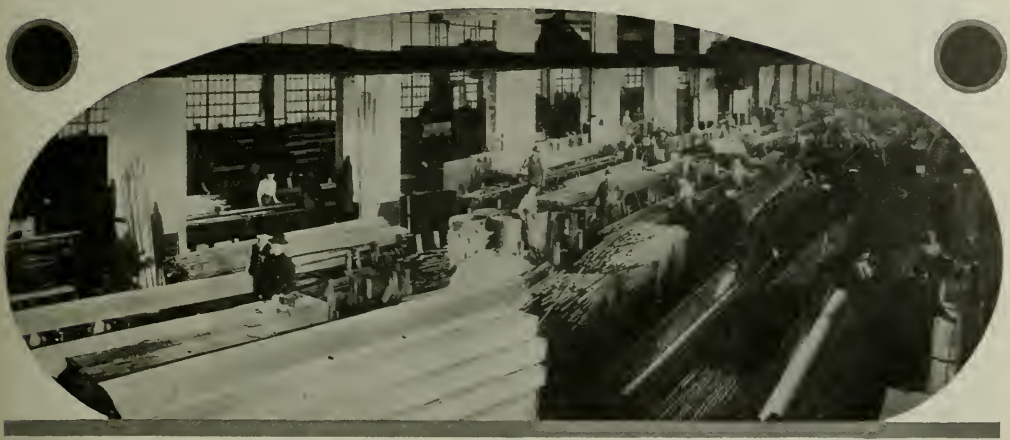
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Making Seamless Copper and Brass Tubing

A Detailed Description of the Methods Employed and the Equipment Required in the Production of Seamless Copper and Brass Tubes

By EDWARD K. HAMMOND

SEAMLESS copper and brass tubing is used in the construction of various types of surface condensers as well as for a great many other purposes. While the war demand for manufactured products was at it height, the Wheeler Condenser & Engineering Co., of Carteret, N. J., experienced trouble in obtaining prompt deliveries on tubing required for use in the construction of condensers. This difficulty finally became so acute that a decision was reached to install a casting shop and tube mill at the company's plant, so that tubing could be made at the factory instead of depending upon an outside source of supply. This department of the business was placed in operation a little over three years ago and proved successful from its very beginning. At present all of the tubing used in building Wheeler condensers is made at the plant, and in addition the mill is turning out a substantial surplus which is being sold for general consumption under the trade name of "Crescent" brand.

Materials Used in Making Seamless Tubing

There are a number of different metal mixtures used by the Wheeler Condenser & Engineering Co. for making seamless copper and brass tubing, among which three typical formulas are as follows: (1) Pure copper. (2) Copper, 60 per cent; and zinc, 40 per cent. This mixture produces an alloy known as "Muntz" metal. (3) Copper, 70 per cent; zinc, 29 per cent; and tin, 1 per cent. This produces a brass known as "admiralty" mixture.

The method of procedure in making seamless tubing varies according to the metal of which the tubing is made, but in any case the process is started in the brass foundry, where the required constituents of the various alloys are mixed together. The metal is then melted and cast into billets ready for delivery to the tube mill. At the Wheeler plant two types of melting furnaces are used, one of which is the familiar pit type of crucible furnace equipped with natural draft and using coal for fuel. The other is an oscillating type of electric furnace built by the Detroit Electric Furnace Co. of Detroit, Mich. Installation of the electric furnace is a recent development at this factory, but the prediction is made by those responsible for the work of the casting shop that eventually all of the metal will be melted by heat generated by electric current. In making up a charge of metal ready to be melted and cast into billets for the tube mill, there is just as definite a relationship between the percentage of copper, zinc, tin, and other constituents, as that which exists in a doctor's prescription as it is made up by a druggist. Where the metal is to be melted in a crucible furnace, a separate charge is made up for each furnace and placed in a tote box in which it is delivered to the furnace.

Solid Billets and Cast Shells

There is a difference of practice in casting the metal from which seamless tubes are to be made, according to its composition. Some billets are cast solid, with a small socket at one end, while others are cast with a cored axial hole extending all of the way through the billet. All alloys crystallizing in a form known as the alpha (α) structure are worked with the metal cold, whereas Muntz metal containing 60 per cent copper and 40 per cent zinc is first cast in billets and then heated before being pierced, because it is composed of a mixture of alpha (α) and beta (β) crystals. The beta crystals give to an alloy in which they occur the property of being ductile at a higher temperature. It is necessary, however, to form these billets with a shallow recess or socket at one end, so that this socket may be made the starting point in piercing the billet.

Construction and Use of the Billet Mold

Regardless of whether the billets are cast solid or in the form of cylindrical shells, the molds used for this purpose are of essentially the same form. These molds are made of a grade of gray cast iron which is high in graphitic carbon.

Each mold is supported by two trunnion bearings, with a latch at the lower end of the mold, to hold it in a vertical position until the metal has been given time to solidify. The mold is then swung into a horizontal position to enable the billet or shell to be removed. It might appear that the cast-iron molds used for this purpose would not be particularly durable, but this is not actually the case. In a shop where forty or fifty heats are poured every day, these cast-iron molds can frequently be used for as long a period of time as nine months before it is necessary for them to be replaced.



Fig. 1. Tube Mill of Wheeler Condenser & Engineering Co.

After the metal has been cast and given time to solidify, the latch at the bottom of each mold is released and the mold is tilted into a horizontal position. Then a pin, which projects crosswise through the bottom of the mold, is withdrawn so that an iron plug which closes the bottom of the mold is no longer held in place by this cross-pin. The workmen now are able to take iron bars and push the billets out of the molds, as shown in Fig. 2, after which the molds are thoroughly cleaned with a wire brush and swabbed with a mixture of oil and graphite before they are ready for subsequent use. The plug which enters the bottom of each billet mold has a pilot on its upper end, which forms a socket in the end of the billet.

After the billets have been removed from the molds, the molds are cleaned by first using a wire brush to remove all oxide scale and other foreign matter; and then the inside of each mold is swabbed with a cotton waste swab saturated with a mixture of oil and powdered graphite. The purpose of this treatment is to cover the inside iron surface of the mold with a film of graphite which serves the double purpose of making the billet exceptionally smooth on the outside, and of protecting the inside iron mold from damage by the molten brass or copper.

For use in casting metal from the electric furnace, a special track has been constructed for passing the billet molds under the furnace. This track carries trucks on which the billet molds are supported, and a chain conveyor traverses the trucks and molds under the furnace. Adjacent to a controller which governs the tilting of the electric furnace to pour the molten metal, there is a controller that governs the movement of the molds under the furnace. This makes an ideal manufacturing equipment, as practically no manual labor is required in casting the metal, while with the old crucible type of furnace, the removal of the crucibles and pouring of the metal is an exceedingly laborious job even under the most favorable conditions.

Recovery of Scrap Brass and Copper

With copper selling at approximately twenty cents a pound, and other constituents of the alloys used in making seamless tubing commanding proportionately high figures, it is of unusual importance for the greatest care to be taken in recovering as much scrap metal as possible. In the tube mill, there are a number of obvious sources from which scrap metal can be collected. For instance, many tubes are sold



Fig. 2. Molds for Solid Billets in the Brass Foundry



Fig. 3. Making Cores for casting Hollow Brass Shells



Fig. 4. Oscillating Table over which Foundry Refuse is passed to recover Particles of Brass and Copper

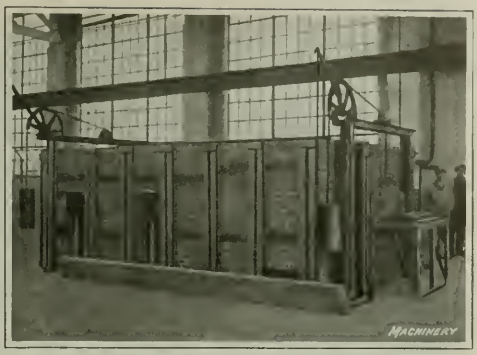


Fig. 5. Rockwell Furnace in which Copper and Brass Billets are heated preparatory to piercing the Hole

on orders calling for specified lengths; and after being drawn, such tubes are cut to length, with the result that pieces known as "crop ends" are left, which are too short to be used. Such pieces of tubing are collected and sent back to the casting shop in order that they may be remelted. Another obvious source of scrap metal is created by the necessity of pointing the end of a pierced billet in order that it may be passed through the drawing die and grasped by the tongs on the draw-head. After the tube has been drawn down to the required size, this pointed end that has been grasped by the tongs must be cut off, and the scrap metal produced in this way is returned to the casting shop.

Examples of the collection of scrap metal which were mentioned in the preceding paragraph represent fairly self-evident methods of saving material; but there is another saving of a less obvious and far more interesting character. This is the recovery of all scrap metal from the furnace ashes in the casting shop. In lifting the crucibles of molten metal out of the furnace, it is inevitable that a certain amount of their contents will be spilled, both in the furnace and on the floor adjacent to the top of the pits. To prevent a serious item of loss resulting from this cause, a point is made of collecting both the furnace ashes and the dust which is swept up from the floor around the furnace. All of this material is first passed through a No. 3 Marcy mill. The barrel of this mill is filled with steel balls and water, and the barrel rotates continuously, so that the balls crush the larger pieces of ash and enable a separation of the metal and ash to be made during a subsequent step of the process. A stream of water is continually flowing through the Marcy mill, and as the contents of the barrel are crushed, the water washes the small pieces out through the openings to an oscillating separating table of the type shown in Fig. 4. The surface of this table is inclined in two directions so that the corner on which the contents of the mill are discharged is at the highest elevation.

Along the left-hand side of the table, as shown in the illustration, a continuous stream of water flows over the table while it is continually oscillating. The combined effect of the water and oscillation of the table is to effect a complete separation of all particles of metal from lighter materials such as coal, ash, etc., the lighter substances moving across to the right-hand side of the table, while the heavier metal moves lengthwise along the table and is collected in the trough at the front end. The illustration shows what appears to be a diagonal line of demarcation extending across the table from corner to corner. This represents metal particles at the left-hand side and coal and ash particles at the right. After passing over the oscillating table, the metal which is collected in the trough must be subjected to a further process of purification. This is made necessary by the fact that certain iron particles are present, which would impair the quality of the metal for use in making seamless non-ferrous tubing. To remove the particles of iron and steel which are present, the scrap metal is passed through a magnetic separator made by the Magnetic Separator Mfg. Co., of Milwaukee, Wis., and after being purified in this way, the metal is ready to be remelted and cast into billets for delivery to the tube mill.

Making Cores for Casting Hollow Shells

Mention has already been made of the fact that the hollow cylindrical shells, which represent the starting point of certain classes of brass tubing, are cast in the same form of molds that are used for producing solid billets. It will be evident, however, that a core must be provided in order to make the axial hole in the shell. The cores used for this purpose are made of sand, but in order to give them the necessary strength, the sand is molded on an iron pipe in which holes are pierced so that gas from the molten metal may pass through the core and readily escape from the mold.

In making the cores that are used for casting these shells, the method of procedure is as follows: A layer of hay is first wrapped around the iron pipe and the sand is then molded on top of this hay. For use in making cores of this type the sand is carefully ground to a uniform fineness on the grinding machine built by the International Clay

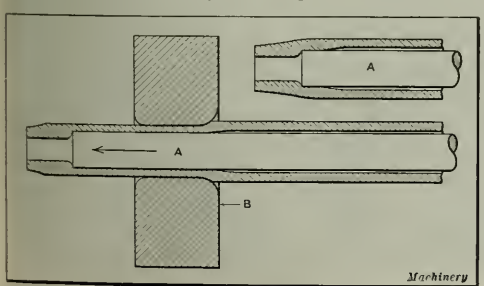


Fig. 6. Diagram illustrating Principle governing Operation of Extrusion Press shown in Fig. 8

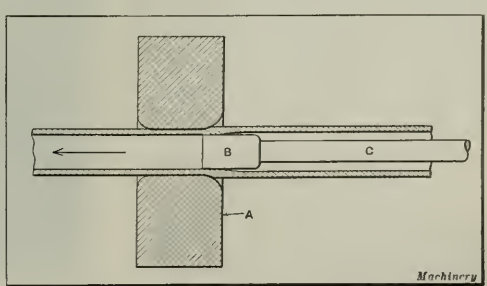


Fig. 7. Diagram illustrating Principle governing Operation of Equipment for drawing Seamless Tubing

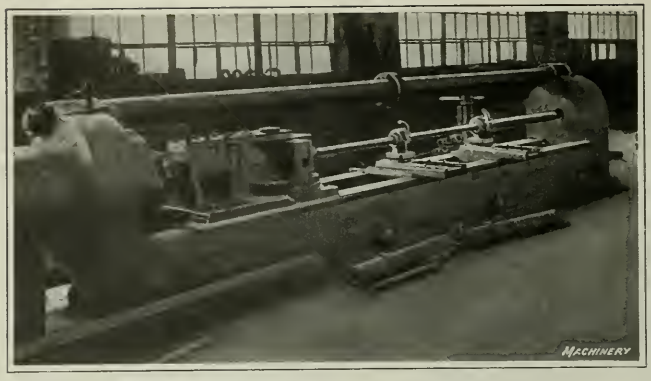


Fig. 8. Special Hydraulic Extrusion Press on which Large Billets are reduced to a Point where they can be handled on the Tube Drawing Benches

Machinery Co. of Dayton, Ohio. This sand is mixed with water to give it about the consistency of a batter, so that it may be readily spread over the hay-covered pipe by hand. The iron pipe is then placed on two special roller bearings as shown in Fig. 3, so that it may be rotated in contact with a straightedge, and in this way the surface of the sand is worked down to make the core perfectly straight. After it has been trued up in this way, the core is placed on a rack in a steam-heated oven, which thoroughly dries the sand. The final step in core-making is then to remove the cores from the oven and cover their surface with whiting which serves about the same purpose as the graphite which is applied to a sand mold in the foundry, namely, to give the cores a smooth surface so that they will produce shells with a uniformly smooth bore. It is absolutely important for the cores to be kept perfectly dry until they are used. Even the small amount of moisture which the core might absorb from the atmosphere would be detrimental. For that reason, the cores are stored in a room heated by braziers of burning charcoal.

Removing the Cores from Cast Shells

After the cast shells have been removed from the molds, it is necessary to get the cores out of the shells. A special horizontal hydraulic press is then used for this purpose, that has a cradle in which the shell is placed so that its end rests against a shoulder on the cradle. When the ram comes forward and strikes one end of the core, it is able to push the iron pipe out, because under pressure the core sand between the iron pipe and the shell is readily broken up. The shells are now thoroughly cleaned on the inside to remove all traces of core sand and other foreign matter. They then go to a special lathe, equipped with a rotary cutter-head, on which an operation known as "scalping" is performed. This consists of turning the outside of the shell in order to remove all scale and other foreign matter which might cause trouble in two ways, namely, through damaging the tube-drawing die or by causing seams or other surface defects to appear on the finished brass tubes. It is not necessary to perform such a scalping operation on the copper billets; but all brass shells and solid brass billets must be turned to remove the outer scale, before the tube-drawing operation is started.

Preparing Billets and Shells for Drawing them into Seamless Tubing

After certain preliminary operations have been performed, the method of drawing all classes of seamless copper and brass tubing is the same, except for the number of annealing treatments which the work receives and the amount of reduction in size which is possible for each passage of the work through the drawing dies. But there is a distinct difference in practice in so far as the preliminary operations on solid billets and hollow shells are concerned. Alloys which are cast in shells are made up of metal that forms alpha crystals at normal temperatures, and they become brittle when heated; whereas, the solid billets are composed of a metal mixture which contains both the alpha and beta crystallization forms, and they are ductile when heated and can, therefore, be worked hot. Alloys having the alpha crystallization, after being strained or worked and then annealed, will show on examination with a microscope that the crystals are polyhedral in form and entwined. In a worked brass alloy containing both the alpha and beta crystals, the alpha will show twining, whereas the beta will not show that characteristic.

Having made this preliminary explanatory statement of the reasons governing the variations of practice in handling different classes of work, we are ready to proceed with a detailed description of how the operations are performed. The cast cylindrical shell of the admiralty alloy must first be annealed in order to remove the copper-tin eutectic, known as the delta crystallization, which is deleterious to the working properties of metal. The annealing is done in an oil furnace built by the W. S. Rockwell Co., 50 Church St., New York City. The time required for annealing depends upon the alloy and the thickness of the metal. After they have been annealed, the shells go to a pointing machine which slightly reduces the diameter of one end, so that the point will enter the die on a hydraulic extrusion press, shown in Fig. 8, by means of which the shell is forced through the die that reduces its outside diameter and holds the inside diameter constant, so that the shell is gradually worked out into the form of a tube. As the shells are made of alpha metal, it will be evident that the extrusion operation is done cold.

The way in which this extrusion press operates is the exact reverse of the action of a draw-bench, and this will be best understood by referring to the diagram Fig. 6, which shows the arrangement of the different parts of the apparatus. Here it will be seen that plunger *A* is made of the same diameter as that to which the inside of the tube must be reduced by the extrusion operation. Plunger *A* is pushed through the inside of the shell until it abuts against the shoulder formed by the inside of the pointed end of the work, which has already been passed through the die *B*. Application of hydraulic pressure causes the plunger *A* to move in the direction of the arrow, and the result is that

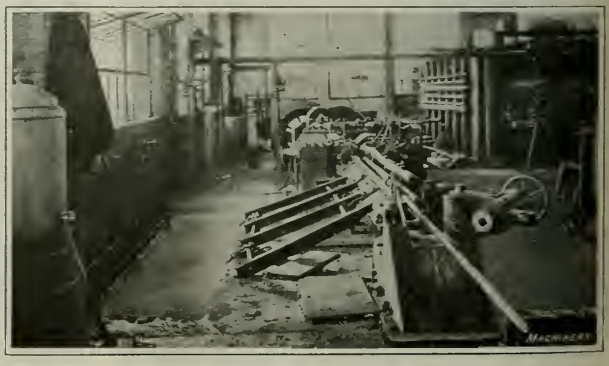


Fig. 9. Special Rotary Piercing Machine on which the Billets are pierced preparatory to the Tube Drawing Operations

it draws the shell through the die. Plunger *A* determines the inside diameter of the work, and die *B* determines the outside diameter, the tendency being for the metal to flow backward around the lip of the die to reduce the outside diameter and make a corresponding increase in the length of the work. It is considered necessary to perform three or four operations on the extrusion bench before starting to draw the work through dies mounted on the chain draw-benches. The work is annealed between each pass through the die.

Piercing Solid Billets

In the case of copper and brass billets which are cast solid, a piercing operation is performed which represents the counterpart of the extrusion operation on hollow shells. There is, however, an important distinction; namely, that the solid billets are made from beta metal, so they can be pierced while at a cherry red heat. As they come from the casting shop, the billets are placed in a W. S. Rockwell oil-heated furnace, shown in Fig. 5, to have their temperature raised to the required degree, after which they go to a special rotary piercing machine shown in Fig. 9, which is equipped with two feed-rolls that force the work over a piercing mandrel. It will be recalled that an iron plug is placed in the bottom of each mold used in the casting shop for making solid billets, to form a cavity or socket approximately 2 inches deep in the bottom of the billet. This socket forms the starting point of the piercing operation, enabling the mandrel to center itself on the work. The two feed-rolls on the piercing machine have their axes inclined at a slight angle to each other. When the billet is placed between these rolls, which rotate in opposite directions the angularity of the rolls tends to impart a longitudinal movement to the work between them. In this way, the heated billet is fed against the end of the mandrel with sufficient force to cause it to pierce a hole right through the billet. The piercing mandrel is made of tool steel mounted on a machine-steel shank, and after the work has been pushed over the mandrel, a hydraulic cylinder connected to the rear end of the shank pulls the mandrel out of the work. The general arrangement of this equipment is in accordance with the Mannesman principle which was illustrated and described on page 326 of the December, 1918, number of MACHINERY, in connection with an article entitled "Making Electric Steel for Roller Bearings," dealing with the manufacture of seamless steel tubing.



Fig. 10. Rotary Type of Pointing Machine on which One End of the Pierced Billet is reduced to a Diameter Small Enough to enable it to pass through the Tube Drawing Die

Pointing Pierced Billets and Extruded Shells

An explanation has just been given of the way in which billets which are cast solid are pierced preparatory to performing subsequent operations on the draw-bench; and it will be recalled that in the case of cylindrical shells which are cast over a core, the preliminary steps in converting the shell into a drawn tube are performed on a hydraulic extrusion press. Regardless of whether the preliminary operations were performed on a piercing or an extruding machine, it is necessary to point the end of each piece of work before it is sent to the draw-bench. This pointing operation may be performed in either of two ways: On the larger sized billets and shells, it is found convenient to use a special form of power press which is equipped with an upper and lower die member in each of which several semi-cylindrical openings are cut. When the two halves of the die are together, each of the cylindrical openings so formed is slightly smaller than the next opening to the right of it. In pointing the tube, the operator first inserts it in the opening at the right-hand end of the die, and allows the press to reciprocate the top die member up and down while the tube is turned in the die. After getting a preliminary point in this manner, the operator moves the tube into a die-opening further to the left, and repeats the performance. By following this method, the tubes may be pointed with very little loss of time, and the surface of the reduced diameter is sufficiently smooth and uniform so that it will always pass through the die without giving any serious trouble.

For pointing smaller sizes of work, it is found advantageous to make use of a rotary swaging machine, Fig. 10, in place of the reciprocating pointer which has just been described. These rotary machines are of essentially standard design, being equipped with a swaging head which rotates at high speed and imparts a rapid succession of blows upon the end of the tubing that is introduced into the die, thus reducing the diameter.

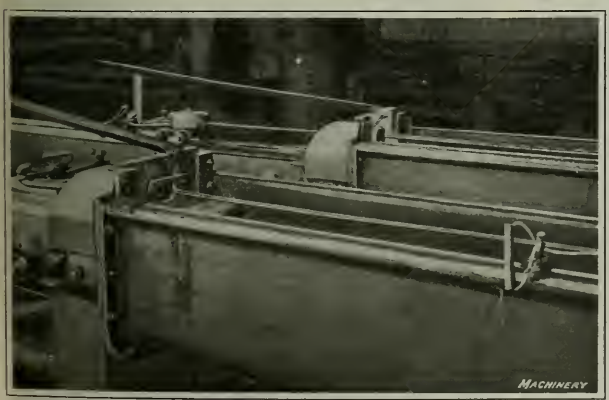


Fig. 11. Close-up View of Dies on Two of the Draw-benches. The Die governs the Outside Diameter of the Tube; and the Inside Diameter is held Constant by a Sizing Mandrel

Drawing the Tubes

Regardless of whether the metal is of the alpha structure which was cast in the form of a hollow shell or of the beta structure, cast as a solid billet, the practice in drawing tubing is the same. After the work leaves the extrusion press or the piercing machine, it is pointed and then subjected to successive cold-drawing operations on draw-bench equipments of the form shown in Fig. 11.

There is nothing special about the design of draw-benches used for producing seamless tubing, the construction being identical with

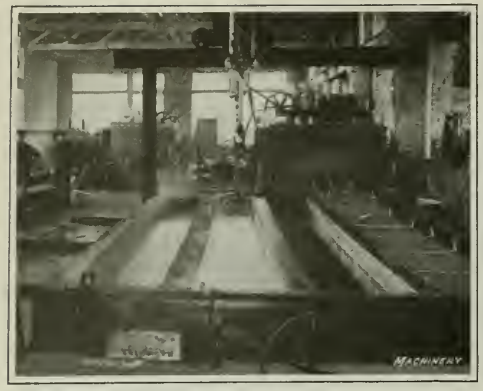


Fig. 12. Annealing Furnace and Pickling Baths. After annealing, the Hot Tubing is sprayed with Water and then dipped in the Pickling Baths to remove Scale



Fig. 13. Close-up View of One of the Straightening Machines through which the Tubing is passed to remove Irregularities in Shape after it has been drawn

that of equipments used for the production of cold-drawn shafting, etc. Such draw-benches have been fully illustrated and described in previous articles published in MACHINERY. The drawing die is also of standard design, but it is necessary to provide a mandrel for governing the inside diameter of the tube. By referring to the diagram shown in Fig. 7, the reader will obtain a good idea of the way in which the die *A* and mandrel *B* function in reducing the outside and inside diameters, respectively. In drawing a tube through the die, the action is exactly the same as if a solid bar were being reduced to a specified diameter; but the tool-steel mandrel is secured to the end of a machine-steel rod *C* anchored to the draw-bench in such a position that the mandrel is held immediately in front of the die, as shown in Fig. 7. This leaves an annular space between the die opening and the mandrel through which the tube passes, and in so doing the outside and inside diameters are reduced to the required sizes.

Annealing

The effect of the drawing operation upon the metal is similar to that which takes place in drawing steel or other products—namely, to impart a high finish to both the inside and outside surfaces of the tube, and to compress the metal, thus increasing its density. There is a tendency for copper and brass to become harder as a result of mechanical working, and to overcome this tendency, recourse is had to an annealing operation which is performed between each draw or each second or third draw, according to the nature of the metal and the tendency it shows to become hard and strained when passed through the die. Oil furnaces built by the W. S. Rockwell Co. are used for this purpose. A track runs right through each of the annealing furnaces, and trucks are provided that run on this track. A number of these trucks are loaded with tubing to be annealed, and coupled together so that they may be drawn through the furnace in a continuous train. Each truck remains in the furnace just long enough to anneal the tubing carried on it. Fig. 12 illustrates the general arrangement of the equipment used for this purpose.



Fig. 14. General View in the Tinning Department where a Protective Coating of Tin is applied to the Inside and Outside of Copper or Brass Tubing

Pickling

After annealing, the tubes are cooled by spraying water on them with a hose. They are then dipped into a pickling tank containing a solution of "Edis" compound which is an acid sodium sulphate that is a by-product in the manufacture of nitric acid. The pickling bath is of such strength that it has a specific gravity of 30 degrees Baumé. When it has been pickled, the work is washed by dipping it into a tank of clear water, after which it is allowed to dry and is then ready to receive the next draw. The amount of reduction which can be made in the thickness of the wall of the tubing for each pass through the die varies according to the nature of the metal and the size of the tubing.

Straightening

While being annealed, the tube shows a tendency to become quite badly distorted, and after each annealing process, it must be passed through a straightening machine before the next drawing operation is performed. The need of this straightening will be evident when it is recollected that the sizing mandrel must be pushed through the work, as a great deal of time would be lost in attempting to push the mandrel through a distorted tube. One of the straightening machines used to bring the tubes back into condition for the next operation is shown in operation in Fig. 13, from which it will be seen that the design is the same as the familiar form of staggered roll straightener that is used in wire mills, except that it is of much larger size. The straightened tubes are then thoroughly cleaned, cut up into specified lengths, and subjected to a water pressure test to make sure that there are no leaks in the tubes or flaws which are likely to develop into leaks. Every tube then receives a thorough visual inspection, as shown in Fig. 15, and samples are subjected to bending and flattening tests. The tubing which successfully passes all of these inspections and tests is packed in wooden boxes for shipment to the user.

Making Tinned Seamless Tubing

For certain classes of work, some engineers specify seamless copper or brass tubing which has been



Fig. 15. General View of the Inspection Department where all Defective Tubing is rejected before the Product goes to the Shipping Department

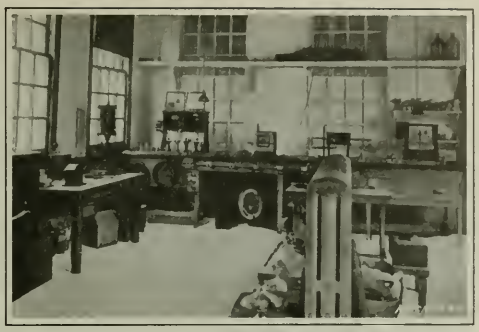


Fig. 16. A Corner of the Chemical and Metallurgical Laboratory where the Quality of Raw Materials and Finished Product is definitely ascertained

tinned to protect it from corrosion. The making of such tubing is done in exactly the same way as the process already described, except that the finished tubing is sent to the tinning department where it is first immersed in a bath of muriatic acid, which serves as a flux to cut any oxide scale or grease off the work, after which the tubes are immersed in a bath of molten solder which tins both the inside and outside of the tube. A view of the tinning department is shown in Fig. 14. In order to obtain a job of good appearance, it is necessary for the excess tin to be removed, and this is done in the following way: While the tube is still hot and the tin in a molten condition, the outside of the tube is wiped with a bundle of jute; and after this has been done, a cork of suitable size is pushed through the inside of the tube to provide for removing the excess tin from this surface.

Engineering and Chemical Laboratory Service

A large part of the tubing made at the Wheeler plant is for use in the construction of condensers, and in this service trouble is sometimes experienced through the corrosive action of certain waters on the condenser tubes. This is a matter that is entirely apart from all considerations of workmanship in making tubing. It is simply a result of the fact that chemical constituents in the water show a tendency to corrode a given kind of tube. To overcome trouble of this kind, the Wheeler Condenser & Engineering Co. maintains a laboratory and is prepared to make technical investigations of all cases of trouble and recommend special metal mixtures for tubing that will be able to overcome existing local conditions. A general laboratory view is shown in Fig. 16.

Two photomicrographs are presented in Figs. 17 and 18 which show the structure of an admiralty brass tube before and after being subjected to the annealing treatment. Every mechanic knows that annealing is resorted to in cases where it is required to remove strains from the metal, and these illustrations show to very good advantage the result of annealing. In Fig. 17 it will be noticed that there are a number of fine lines running across the photograph; these lines are the result of strains which have been introduced in the metal by the mechanical treatment to which it has been subjected. After annealing, no such lines are visible, and this shows that all of the strains have been removed from the metal. The taking of photomicrographs to ascertain if the annealing process has been conducted in a way that assures the removal of all strains from the metal, is only one of the applications of this method.

Photomicrographs are extensively used to determine the homogeneity of alloys from which tubing is made. Sometimes there is a tendency for an alloy to partially separate. This tendency toward separation produces what is known as a "eutectic" in the alloy, and is extremely objectionable from a practical viewpoint, because the eutectic does not bond firmly to the metal adjacent to it, and so produces a weak point at which the tube is likely to break. When tubes break during the drawing process, etc., samples are sent to the laboratory, where the photomicrographs will often show eutectic characteristics; and steps are then taken to correct the process of manufacture.



Fig. 17. Photomicrograph of Structure of 70 Per Cent Copper Alloy before working, or as received from Casting Shop



Fig. 18. Photomicrograph of 70 Per Cent Copper Alloy after being annealed and having previously been worked

DESIGNING A LOCKING DEVICE

By VICTOR M. SUMMA
Engineering Examiner, American Brake Co., St. Louis, Mo.

While the simple locking device shown in the accompanyillustration has been used for many years, the calculations required in designing such a device to meet any given requirements of service have been given but slight attention. The following formulas were evolved as a result of experiments and investigations conducted for the purpose of determining why a device similar to the one shown failed to function properly. The formulas are based on a careful analysis of the forces which act on the different members of the device when it is in operation. They enable the locking power of a device of this kind to be determined quite accurately and should therefore prove of value to the designer who is confronted with the problem of designing a device of this type which may be depended upon to develop a given locking power under known working conditions.

Let P equal the force acting on the washer B at the point S, and f and f_1 the frictional resistances between the surfaces of contact N and M of washer B and rod A. It is obvious that there will be no motion of rod A in the direction P (namely, the device will automatically lock itself)

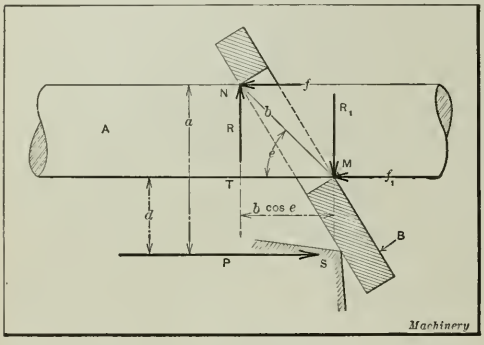


Diagram showing how Forces act on Different Members of the Locking Device

if the developed friction is greater than the actuating force P. In other words there must exist the following relation if the device is to be self-locking:

$$P \text{ is less than } f + f_1 \qquad (1)$$

Also, calling R and R_1 the reactions of P at the points N and M, and noting that they act normal to the surfaces of contact, it is evident that

$$f = kR \qquad f_1 = kR_1 \qquad (2)$$

in which k is the coefficient of friction of the contact surfaces. It is necessary now to ascertain the values of the reactions R and R_1. For equilibrium of rotation the algebraic sum of the moments of the forces P, R and R_1 must be equal to zero. That is, taking moments about points N and M successively, and since by trigonometry $TM = b \cos e$ (where $b = NM$) we have:

$$P \times a = R_1 b \cos e$$

Therefore

$$R_1 = \frac{P \times a}{b \cos e}$$

and

$$P \times d = Rb \cos e$$

Therefore

$$R = \frac{P \times d}{b \cos e}$$

Substituting these values of R and R_1 in Equations (2)

$$f = k\frac{P \times d}{b \cos e} \qquad f_1 = k\frac{P \times a}{b \cos e}$$

and by again substituting these results in Equation (1)

$$P \text{ is less than } k\frac{P(d + a)}{b \cos e}$$

or still better, by solving for k,

$$k \text{ is greater than } \frac{b \cos e}{a + d}$$

Hence, the device will only be able to lock itself if the arithmetical value of the expression $\frac{b \cos e}{a + d}$ (3) is *smaller* than the least possible value of the coefficient of friction k of the material. By choosing a point S so located that the cosine of angle e may be a minimum and $(a + d)$ may be a maximum, it should always be possible to obtain the required condition.

If the force P is relatively great it would be advisable to use a square bar instead of the round rod A, so that the reactions R and R_1 may have a larger bearing surface than that given by the tangential points N and M, and in order to prevent the washer from cutting into the rod.

Example 1—Assuming that the angle e is equal to 50 degrees and that $a = 31/32$ inch, $b = 13/16$ inch, $d = 1/4$ inch, it is required to ascertain whether the device will be self-locking, taking $k = 0.25$ as the coefficient of static friction of steel over steel.

By substitution in Formula (3) we have:

$$\frac{0.8125 \times 0.6428}{1.218} = 0.43$$

a value considerably greater than k, indicating that the mechanism will not work.

Example 2—Find the advantage, if any, when the device is modified so that angle $e = 68$ degrees, $a = 1\frac{1}{4}$ inches, $b = 13/16$ inch, and $d = \frac{1}{2}$ inch.

Here we have:

$$\frac{0.8125 \times 0.3746}{1.75} = 0.174$$

a value sufficiently smaller than the assumed minimum value of the coefficient of friction as to give reasonable assurance that the device will have a self-locking action.

If the shaft is lubricated, the value of k probably would not be more than 0.12 or 0.14, in which case the angle e should be as near 90 degrees as possible and a and d increased until the fraction $\frac{b \cos e}{a + d}$ is below the minimum coefficient 0.12.

* * *

CAUSES OF PRESENT HIGH OCEAN FREIGHT RATES

The present high ocean freight rates to a large extent hamper the early resumption of foreign trade along the same lines as before the war. Business men engaged in international trade are continually asking: "When will ocean freight rates be lower?" The answer is that it will be a considerable period of time before this will happen, and freight rates will never be as low as they were before the war. The main reasons are as follows: There is a shortage of tonnage, because the losses sustained during the war have not yet been replaced by the building of new tonnage; a large number of vessels are under repairs after the stress and strain of the war service; the various governments engaged in the war still require a large tonnage for transport service; strikes and labor difficulties have prevented the using of existing tonnage to its full capacity during the past year; increased wages have greatly added to the cost of new ships; higher insurance rates must be paid on the increased valuation of ships; in addition, higher costs of repairs and maintenance, increased wages for both officers and crew, heavier bills for their maintenance and other ships' stores, increased dock dues, and much higher prices for coal produce high operating costs. All these factors make it necessary to charge much higher freight rates, and exporters should not anticipate any material change in ocean rates for some time to come. The adverse influence upon international trade that is caused by these high ocean freight rates will doubtless tend to reduce foreign trade, and increased efforts must be exerted to extend trade connections to offset that influence.

Dies for Automobile Oil Filler Cup

By J. BINGHAM
President, The B. J. Stamping Co., Toledo, Ohio



THE dies used in the manufacture of an oil filler cup or breathing tube for an automobile engine, are shown in the illustrations accompanying this article. Each of the dies is illustrated in the order in which it is used, and a detail of the shell is shown as it appears after each operation. The shell is made from cold-rolled strip steel 0.065 inch thick, the blank being cut to a diameter of 6¾ inches.

The blank is cut and the first drawing operation performed by the die illustrated in Fig. 1. This die is of a standard type and is used in connection with the usual rubber buffer attachment. The sheet metal is laid upon the cutting ring *A*, and the blank is cut to the required size as the lower edge of the punch face ring *B* passes the upper edge of ring *A* on the downward stroke of the press ram. The shell is drawn on the forming die *C* as the punch *D* concludes its descent.

The die shown in Fig. 2 is employed to make the three reductions in the diameter of the shell as shown beneath the die. The die as illustrated will produce the shape *A*. In order to reduce the shell to shape *B* after a quantity have been formed as shown at *A*, it is necessary to replace the die ring *D* and punch *E* for those of suitable dimensions. The punch and die ring are again changed in order to produce the shell as shown at *C*. The upper surface of the die ring *D* is hollowed out to the external diameter of the shell to be operated upon, in order to locate it properly for the operation. This die is equipped with an automatic stripping device for forcing the shell from punch *E* upon the return stroke of the press. It consists mainly of the stripper *F* and spring *G*. As the shell is forced through the die on the downward stroke of the press ram the stripper is pushed in an outward direction. When the shell reaches the position shown, the stripper is actuated by the spring and forced toward the center of the die so that when the punch makes the return stroke, the end of the stripper keeps the shell from adhering to the punch, and when the punch has been completely withdrawn the shell drops through the die. The knock-out pad *H* is provided for use in case stripper *F* does not function properly.

Three dies of the type shown in Fig. 3 are used to draw the shell to the shapes *A*, *B*, and *C*. Knock-out devices *D* and *E* are provided in each case for forcing the shell from the punch and die. These dies complete the drawing operations on the shell. The die illustrated at *A* in Fig. 4 trims the edge of the shell at the large end. The shell is placed on the device as shown, the screw *C* acting as a gage to give the shell the proper length. The end of the shell is trimmed as the cutting tool *D* descends into slot *E*, the shell being turned by hand after each stroke of the cutting tool until the entire end has been trimmed. The punch and die shown at *B* in the same illustration cuts a hole in the small end of the shell. There is sufficient clearance between the ring *F* and the die-shoe *G* to permit the cutting ring *H* to be reground a number of times. The punch *J* is equipped with a novel stripping device consisting of stripper *K*, which is held in position on punch *J* by means of screws *M*, and springs *L*. The stripper is forced downward on the return stroke of the press ram by the expansion of the springs, thus forcing the shell off the punch.

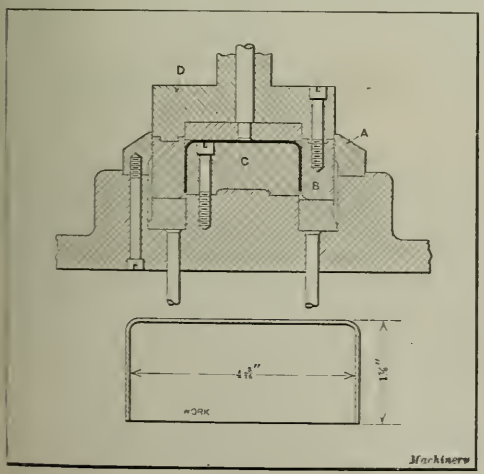


Fig. 1. Blanking and Forming Die which performs First Operation

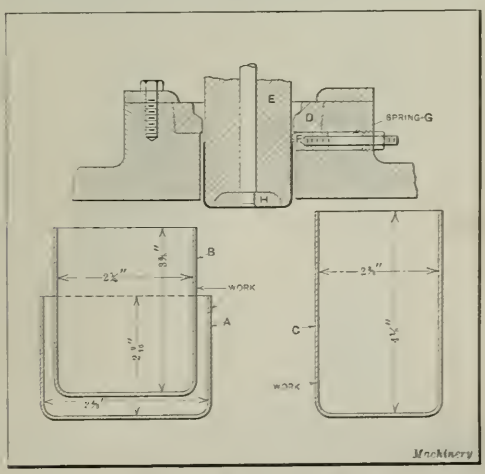


Fig. 2. Die used for making Three Reductions in Shell Diameter

Fig. 5 shows the die that stamps the bead on the large end of the shell. The method of doing this is very similar to the trimming operation performed by the die shown at *A* in Fig. 4; that is, the shell is placed in the die with the large end against the surface *A*, while the beading tool *B* reciprocates and forms the bead on the shell. The shell is also turned by hand in order to allow it to be beaded around the entire circumference. A die of similar design is employed to produce a bead on the small end of the shell.

The die illustrated in Fig. 6 produces the foot-plate which may be seen attached to the detail of the shell in Fig. 7. This part is made from strip metal which is fed through the die opening *C* in the direction indicated by the arrow in the

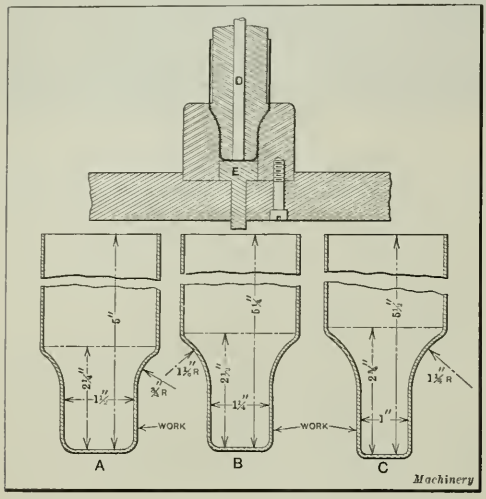


Fig. 3. Type of Die employed to draw the Shell to the Shapes shown

plan view. Two strokes are required to complete one piece, the three holes being punched through on the first stroke, while the blank is cut by the second stroke. It is obvious that after the first operation, a completed piece will be produced with each stroke of the press ram. The construction of the punching tools which pierce the holes in the plate may be clearly seen in the section shown at *A*, while the enlarged sectional view at *B* shows the tool which cuts the blank. The pilots *D* enter the holes cut in the plate by the first operation to locate the plate for the second operation.

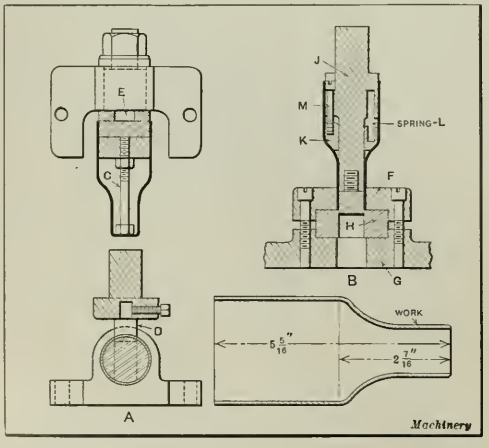


Fig. 4. (A) Die for trimming Large End of Shell. (B) Die for punching Hole in Small End

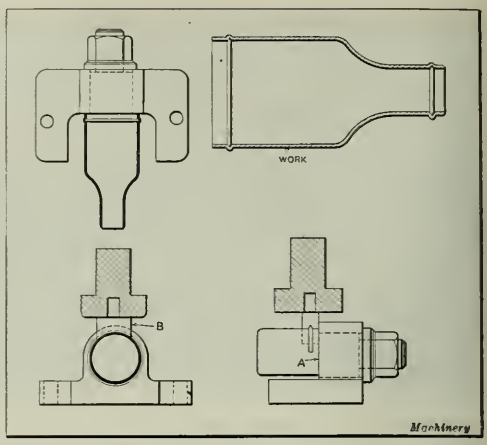


Fig. 5. Type of Die employed for forming the Beads on the Ends of the Shell

The final operation consists of closing the foot-plate on the small end of the shell, which is performed by the die illustrated in Fig. 7. Prior to this operation, the large hole in the foot-plate is reamed to the flared shape which may be clearly seen in the illustration. In this operation, the punch *A* expands the metal to fit the hole in the foot-plate

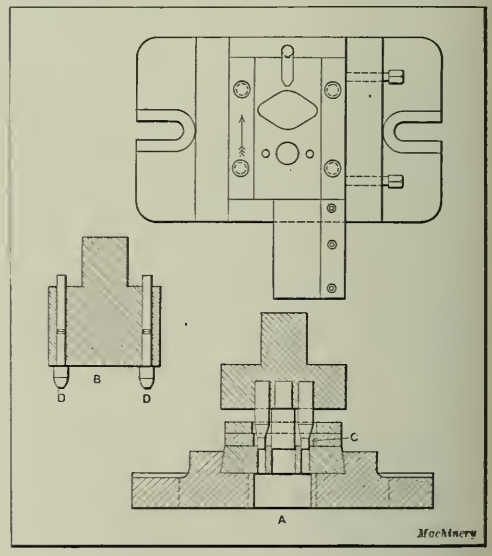


Fig. 6. Combination Piercing and Blanking Die for producing Foot-plate

and at the same time draws the beaded surface up against the other side of the foot-plate, thus holding it securely in place. The construction of the die is as follows: The jaws *B* are hinged on pin *C* and are swung open to permit the insertion of the shell. After the shell has been placed in position, the jaws are locked together by means of handle *D* and pin *E*. This device holds the shell firmly during the operation. The head and body of screw *F* fit in recesses in both jaws and hold the jaws down during the return stroke of the press ram. If this feature were not provided there would be a tendency for the jaws to lift and bend pin *C* and the forming end of punch *A*, resulting in ruining the die. The dies described were made while the writer was superintendent at the Acklin Stamping Co., Toledo, Ohio.

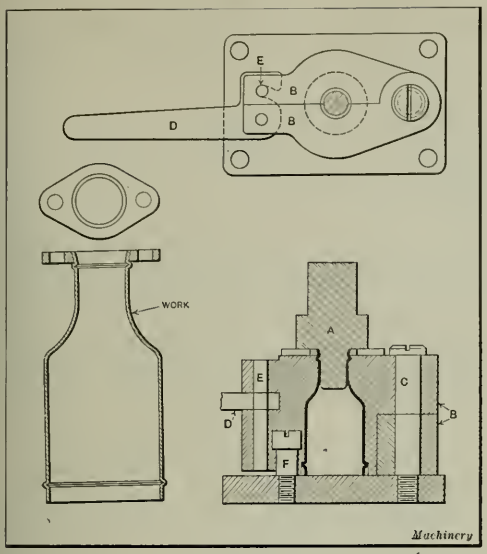


Fig. 7. Device used for holding the Shell during the Final Operation

WAGES AND PROFIT-SHARING

In an address by Charles Piez, president of the Link-Belt Co., Chicago, Ill., before the Illinois Manufacturers' Association, emphasis was placed upon the point that greater production, greater thrift, and frugality are the most effective factors in reducing prices, but increased production cannot be achieved unless wages be based on output instead of on hours worked. Wages based on output, under safeguards that will correct and prevent abuses, should be accepted by organized labor in industries where this practice has been discarded.

Interest in the ownership of a business, according to Mr. Piez, has a steadying, stabilizing effect, but it must be earned through thrift and sacrifice, and not demanded as a right. A real pecuniary interest by the employes is a good thing provided it is paid for. Partnership must carry with it a sense of responsibility in the pecuniary success of the venture, and cannot be helpful or effective if it represents an association in which one partner is purely interested in securing all he can for himself, without thought of the continued strength and success of the venture. The opening up of the opportunity for acquiring a stock interest in an industry should be favored, and that chance given to every workman whose length and character of service justifies it, and who is willing to assume the responsibility to pay for that interest in cash.

* * *

A remarkable record in regard to freedom from accidents is that of the crucible melting department of the Halcomb Steel Co., Syracuse, N. Y. In October, 1918, there were four accidents in this department serious enough so that they resulted in lost time for the workmen. Both the workmen and the man responsible for safety in the plant started the next month with the determination of making a record—no accidents at all. They succeeded in this and succeeded in repeating the same performance from month to month so that from the end of October, 1918, to the beginning of October, 1919, there was not a single lost-time accident in the department. This result is ascribed solely to the exercising of constant vigilance, in the taking care of little things such as prompt attention to minor scratches, the keeping of all tools and appliances in their proper place and in first-class condition, and the elimination of all fooling and horse play in the plant.

PROBLEM IN MENSURATION

By ELMER LATSHAW

The following is another solution of the problem which was solved on page 170 of the October number of MACHINERY. This solution, though very similar to the one that appeared in the May, 1917 number, is much simpler in form and therefore is of more practical value to the toolmaker. Although in the derivation of the formula the solution of a quadratic equation is required, this formula, when once derived, is so simple that anyone who is capable of extracting a square root will have no difficulty in using it. The formula is not only easily applied, but does not involve the use of trigonometry, and is in such simple form that for small and simple numbers the radius R can often be determined by inspection. However, a table of squares for extracting the square root of the number under the radical sign, will greatly facilitate the use of the formula where the numbers involved are large or complex. In the solution of quadratic equations, as is well known, two valves which will satisfy the equation are always obtained. The accompanying diagram illustrates the application of each of these two values.

Case 1—$AB = a$; $BC = b$; R = required radius. Draw AE parallel to BC. Then

$$(AE)^2 + (EO)^2 = R^2$$

But $$AE = (b - R)$$

and $$EO = (R - a)$$

Therefore, after substituting and squaring the binomials and simplifying, the equation becomes

$$R^2 - (2a + 2b)\,R + a^2 + b^2 = 0$$

Solving the above quadratic equation

$$R = (a + b) \pm \sqrt{2ab}$$

By referring to the diagram for Case 1, it will be apparent that the equation $R = (a + b) - \sqrt{2ab}$, is the one to use in this case, since R is less than $a + b$.

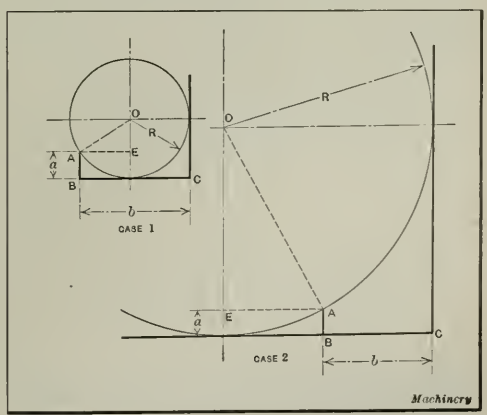
Case 2—It will be seen by following the derivation of the formula used in Case 1 that the formula $R = (a + b) + \sqrt{2ab}$ applies where R is greater than $a + b$, as shown in the diagram for Case 2.

The quadratic equation is generally evaded wherever possible in practical problems, but a careful investigation of the foregoing solution will illustrate the practical value of both roots of a quadratic equation. Applying the formula for Case 1 to the conditions of the problem under discussion, where $a = \frac{1}{4}$ inch and $b = 1$ inch,

$$R = (\tfrac{1}{4} + 1) - \sqrt{2 \times \tfrac{1}{4} \times 1}$$
$$= 1.25 - \sqrt{0.5}$$
$$= 1.25 - 0.70711 = 0.54289 \text{ inch.}$$

For the adaptation of the formula to the conditions illustrated in Case 2,

$$R = 1.25 + 0.70711 = 1.95711 \text{ inches}$$



Diagrams used in deriving the Formulas for the Mensuration Problem

Railway Car Axle Design

By A. L. NICHOLS
Assistant Chief Engineer, St. Louis Car Co., St. Louis, Mo.

IT is not the object of this article to enter deeply into the technical side of the design of axles, but to present some everyday problems of the car designer with their solutions. It is the belief of the writer that the results obtained are sufficiently accurate for all practical purposes. The American Electric Railway Association and the Master Car Builders Association have established standards for steam and electric railway axles, and the tables covering them are presented herewith. For further information and specifications the proceedings of the associations may be referred to. A standard axle may be selected from these tables for most cases; there are sometimes, however, special conditions which make this impractical, and it is with these special cases that this article deals.

In the design of axles we must first determine the stresses to which the axle will be subjected. This can best be explained by considering a practical problem. Let it be required to design an axle for a double-truck, motor-driven car, weighing complete with load (less wheels and axles) 80,000 pounds. As there are four axles, there will be a total load on each axle of 20,000 pounds. The greatest stress will occur when the car is on a curve; therefore we will make our calculations for that condition. There are four component forces which act on the axle of a motor-driven car; the first is that due to the static load of the car and its contents; the second, that caused by the centrifugal force of the car on a curve; the third, that due to the torque of the motor; and the fourth that due to the torque of the wheels when the car is on a curve.

Analysis of the Forces Acting on the Axle

Referring to Fig. 1, it will be seen that the distance from the journal to the center of the rail is 10 inches and that the load on each end of the axle is 10,000 pounds; therefore the bending moment is $10{,}000 \times 10$ or 100,000 inch-pounds. It will also be noticed by referring to the diagram in the lower part of this illustration that the diameter of the wheel is assumed to be 26 inches; therefore the distance from the rail to the center of the axle is 13 inches, and if the centrifugal force is taken at 0.4 of the load on the axle, the bending moment due to the centrifugal force will be 20,000 $\times$ 0.4 or $8000 \times 13 = 104{,}000$ inch-pounds. The centrifugal force is calculated from the formula

$$F = \frac{Wv^2}{gR}$$ (MACHINERY'S HANDBOOK, page 286)

in which

F = centrifugal force;
W = weight on one axle;
v = velocity in feet per second;
g = acceleration due to gravity;
R = radius of curve in feet.

It is interesting to note that when the value F exceeds one-half the downward load, the car will overturn. In practice, the value of F is never taken at more than 0.4, and the center of gravity should never be more than 72 inches above the rail. The formula given for finding the centrifugal force was used to plot the chart shown in Fig. 2, on the left side of which the velocity in miles per hour and in feet per second is given, while across the bottom of the chart is indicated the radius of the curve in feet and the equivalent number of degrees of curvature of the rails. From this chart the centrifugal force on any curve up to 400 feet radius and with any speed up to 75 miles per hour can readily be found. Curves having a radius of 35 feet are common in street car work, and the rails are grooved to prevent the car from running off the track. On steam railway and interurban roads it is the general practice to elevate the outer rail in order to overcome, to some extent, the centrifugal force. The chart is not to be used for determining the speed at which a car can travel around a curve, as there are many other conditions entering into this, such as friction between the wheel flange and the tendency of the wheel to mount the rail.

The motor in this particular example has been assumed to have a torque of 175 foot-pounds; the pinion, a pitch radius of 1.86 inches; and the axle gear a pitch radius of 8.45 inches.

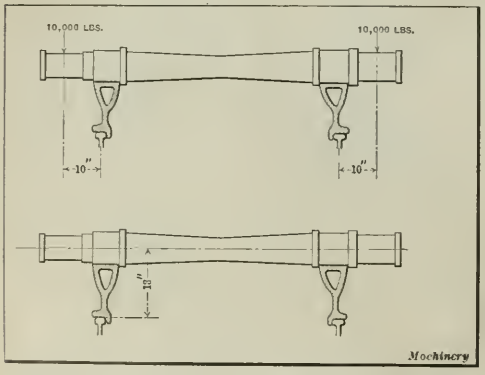


Fig. 1. Illustrating Application of Stresses exerted on Car Axles due to Static Load and to Centrifugal Force on Curves

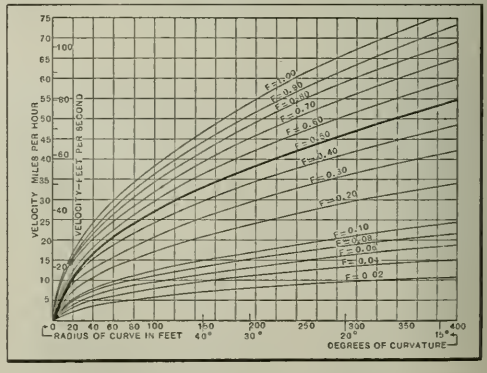


Fig. 2. Chart for Use in determining the Centrifugal Force exerted on Car Axles when turning a Curve

Then $175 \times 12 \div 1.86 = 1129$ pounds, and $1129 \times 8.45 = 9540$ inch-pounds torsion in the axle. As the outer rail of a curve is longer than the inner rail and as the wheels are fixed to the axle, one of the wheels must slip, producing a torsion in the axle which is equal to the load of one end of the axle multiplied by the coefficient of friction multiplied by the radius of the wheel. The coefficient of friction is the ratio of the maximum tractive effort to the load on the wheel, and on a dry rail, well sanded, may equal 30 per cent of the load. Then, $10{,}000 \times 0.30 = 3000$ pounds, and $3000 \times 13 = 39{,}000$ inch-pounds torsion in the axle. The torque of the wheels in steam railway practice is not so pronounced as in street railways, as the curves are not nearly so sharp on the steam roads. It is the usual practice to make car wheels with a taper of one inch in twenty-five on the tread, which gives a smaller diameter on the outside of the wheel. The rails are laid to a wider gage on the curve and the centrifugal force will carry the car to the outside rail and thereby change, to some extent, the diameters of the wheel. This does not occur, however, after the wheels have become worn down.

Calculating the Size of the Axle

Having determined the stresses in the axle, and the forces which cause them, we will now calculate the size of the axle required. This may be done by the use of the formula for combined bending and torsion moment:

$$SZ = \sqrt{M^2 + N^2}$$

in which

S = safe fiber stress per square inch;
Z = section modulus for bending;
M = bending moment in inch-pounds;
N = torsional moment in inch-pounds.

The total bending moment, in the example being considered, is 100,000 inch-pounds (static load) plus 104,000 pounds (centrifugal force), or $M = 204{,}000$ inch-pounds. The total torsional moment is 9540 inch-pounds plus 39,000 inch-pounds, or $N = 48{,}540$ inch-pounds. Extracting the square root of the sum of the squares of these two values and dividing the result by the safe fiber stress S for axles, that is, by 18,000 pounds,

$$Z = \frac{\sqrt{43{,}972{,}131{,}600}}{18{,}000} = \frac{209{,}695}{18{,}000} = 11.1$$

To find the section modulus of round bars use the formula given on page 311 of MACHINERY'S HANDBOOK,

$$Z = \frac{\pi d^3}{32} = 0.098\, d^3$$

in which 0.098 is a constant and d the diameter of the bar. Referring to Table 1 of motor axles, we find that the 4¼- by 8-inch axle of 22,000 pounds capacity has a diameter of 5½ inches and hence a section modulus of 16.3, which is the correct axle to use. The section modulus 11.1 is for the axle when it has become worn to the removing point, and provision must be made in the new axle for wear; therefore, the axle selected is slightly larger than would be required if this allowance were not made. The pressure on the journal should never exceed 325 pounds per square inch of projected area and should be kept as much below this as possible. The ratio of the length of the journal to its diameter should be about 1.8.

Bending Moment Diagram for Non-Motor Car Axles

A. Stucki, formerly chief engineer of a large car company and inventor of the Stucki frictionless side bearing, has published a bending moment diagram, Fig. 3, by means of which the required strength of axles for non-motor cars or trailers may be graphically determined when laying out the design. Referring to the diagram, Q represents the load on one axle, and the horizontal force due to the centrifugal force and the swaying of the cars on curves is taken as $0.4Q$; this includes the benefit derived by raising the outer rail, and is the result of experiments made under ordinary track conditions at the highest safe speeds. The point o is the center of gravity of the car and its load, and the line oE is the resultant of the horizontal force $0.4Q$ and the vertical force Q. From the head of the right-hand rail draw T_1O at right angles to the coning of the wheel tread intersecting the center line of the axle at Q_2; similarly, draw TO from the other rail head intersecting the axle center line at Q_1. Extend oE to point O in one direction, and to the center line of the axle in the opposite direction intersecting it at E_1. From these three points E_1, Q_1, and Q_2, drop perpendiculars as shown in the diagram.

Lay off on the auxiliary diagram shown in the upper left-hand corner of the illustration, a vertical line AC to any convenient scale (preferably 1 inch = 2000 pounds) so that its length represents to scale the vertical load Q. Locate the point v horizontally 10 inches to the right of the line AC and vertically one-third or one-fourth of its height from the bottom, and connect A and v. Then, in the large diagram drop perpendiculars from P and P_1—the centers of the journals—to points p and p_1. Draw a line from p parallel to Av until it intersects the perpendicular drawn from E_1 at point c. Connect C with v and draw cp_1 parallel to Cv. Connect p and p_1 and draw vB in the auxiliary diagram, parallel to it. Line AB represents to scale the load at P and line BC represents the load at P_1.

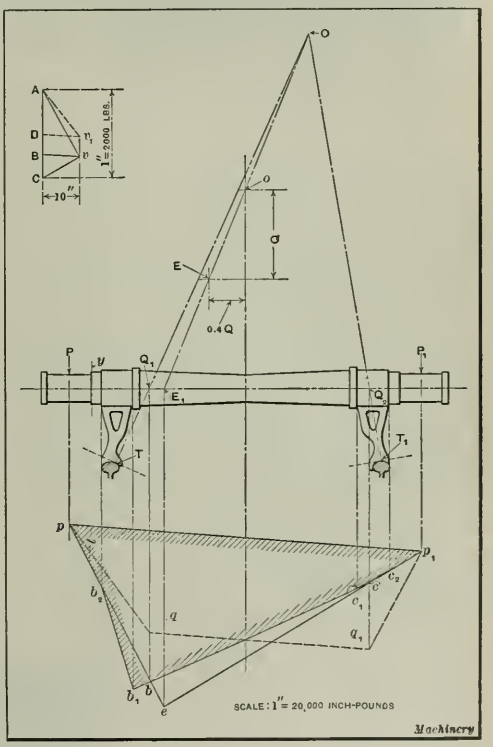
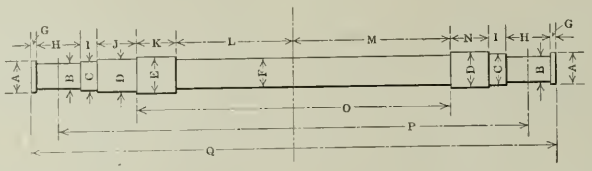


Fig. 3. Bending Moment Diagram for Non-Motor Car Axles

Drop perpendiculars from the hub faces of the wheels terminating at points b_1, b_2, c_1, and c_2. Draw cb and extend it to b_1 and connect b_1 with b_2 and also c_1 which is located on line cb, with c_2. The link polygon pb_2, b_1, c_1, c_2, p_1 is the moment diagram for the assumed load and is drawn to a scale of 20,000 inch-pounds to the inch, since the scale of load was assumed to be 2000 pounds = 1 inch with the length of the lever-arm Bb equal to 10 inches. The length of any perpendicular drawn from line pp_1 included in the shaded portion of the diagram, corresponds to the moment in inch-pounds of the corresponding section of the axle. For ex-

TABLE 1. PROPORTIONS OF MOTOR CAR AXLES
(ADOPTED BY A. E. R. A.)



Size of Journal	Load Capacity, Pounds	Dimensions, Inches																
		A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
3¼ by 6	9,000	3 7/8	3½	3¾	3 15/16	4	3½	½	6	2½	10 5/16	6⅛	12 11/16	17 5/16	11 13/16	36⅛	69½	76½
3¼ by 6	13,000	3 7/8	3½	3¾	4 1/16	4½	4	½	6	2½	10 5/16	6⅛	12 11/16	17 5/16	11 13/16	36⅛	69½	76½
3¾ by 7	15,000	4⅜	3¾	4⅜	4 1/16	5	4⅜	⅝	7	2⅝	6	6⅜	17⅞	24	6	48	72	80½
3¾ by 7	16,000	4⅜	3¾	4⅜	4 1/16	5	4½	⅝	7	2½	4⅝	6⅜	17⅞	24	4⅝	48	69½	77½
3¾ by 7	12,000	4⅜	3¾	4⅜	4 1/16	5	4	⅝	7	2½	4⅝	6⅜	17⅞	24	4⅝	48	69½	77½
3¾ by 7	14,000	4⅜	3¾	4⅜	4 1/16	5	4½	⅝	7	2½	7½	6⅜	17⅞	24	7½	48	75	83½
4¼ by 8	18,000	5⅛	4¼	5⅛	5 1/16	6	5	⅝	8	2	7½	6⅜	17⅞	24	7½	48	75	84¼
4¼ by 8	22,000	5⅛	4¼	5⅛	5 1/16	6	5½	⅝	8	2	7½	6⅜	17⅞	24	7½	48	75	84¼
5 by 9	27,000	6⅛	5	6⅛	6 1/16	7	6	¾	9	2	6½	6⅜	18⅞	25	6½	50	76	86½
5 by 9	31,000	6⅛	5	6⅛	6 1/16	7	6½	¾	9	2	6½	6⅜	18⅞	25	6½	50	76	86½
5½ by 10	38,000	6⅝	5½	6⅝	7 1/16	8	7	¾	10	2	6½	6⅜	18⅞	25	6½	50	77	88½

Machinery

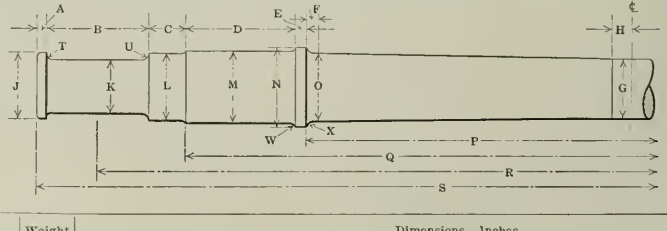
ample, the line t actually measures, by the scale used in diagram ACv, 7.75 inches, which multiplied by the load, 20,000 pounds, gives 155,000 inch-pounds as the moment of the section at y. In order to find the bending moments in the axle, if the centrifugal forces are disregarded, move point v vertically upward so that a line drawn from D which is half way between A and C and parallel to Bv, will pass through the point v_1. Connect A with v_1 and draw a line parallel to it from p (in the moment diagram) until it intersects the perpendicular dropped from Q_1 at point q. From q draw a line parallel to Dv_1 until it intersects the perpendicular dropped from Q_2 at point q_1. The vertical distance between the lines pp_1 and qq_1 represents the moments for the shank of the axle.

Having graphically determined the bending moments M, throughout the length of the axle, next calculate the sectional modulus Z at various points, using the familiar formula for bending, $M = SZ$, or $Z = \frac{M}{S}$, S being the safe fiber stress of the material. Transposing the formula $Z = \frac{\pi d^3}{32}$, $d = \sqrt[3]{\frac{32Z}{\pi}}$, from which the diameters may be readily found. After a sufficient number of diameters have been obtained at different points, the theoretical shape of the axle can be sketched in. To allow for wear and for imperfections in the material, the diameter of the journals is usually made ½ inch larger than the theoretical diameter; the dustguard seat is made ¼ inch larger; the wheel seat is made ¼ inch larger; and the center of the axle ⅛ inch larger. The axle should never be allowed to wear below the theoretical size determined. To compensate for lateral wear on the axles and brasses, the loads P and P_1 should be assumed as being applied ½ inch outward from the center of the journals.

* * *

The American Woolen Co. has formed a corporation for the purpose of constructing houses to be sold at cost to its employes. An initial payment of only 5 per cent of the construction cost will be required, the remainder forming a mortgage held by the company. The plans of the houses will be standardized, but each will have an original architectural treatment. This is an effort to solve the labor problem in the right way. By helping the employes to become property owners, the company will do a great deal more to prevent future labor troubles than by any other welfare work.

TABLE 2. PROPORTIONS OF TENDER AND CAR AXLES
(ADOPTED BY M. C. B. AND M. M. A.)



Size of Journal	Load Capacity	Weight	Dimensions, Inches																				
	Pounds		A	B	C	D	E	F	G	H	J	K	L	M	N	O	P	Q	R	S	T	U	W	X
3¾ by 7	15,000	420	⅝	7	2½	7 1/16	1⅜	23/32	4¼	1½	4¾	3¾	4¾	5⅛	5½	4⅞	46	63	75	83¼	¼	⅛	¾	1
4¼ by 8	22,000	520	⅝	8	2	7 1/16	1⅜	23/32	4¾	1½	5¼	4⅓	5¼	5¾	6⅛	5 7/16	46	63	75	84¼	¼	⅛	¾	1
5 by 9	31,000	680	¾	9	2	7 1/16	1⅜	23/32	5⅜	1½	6⅜	5	6⅛	6½	6⅞	6 5/16	46	63	76	86½	⅛	¼	¾	1
5½ by 10	38,000	830	¾	10	2	7 1/16	1⅜	23/32	5⅝	3	6⅝	5½	6⅝	7	7⅜	6⅝	46	63	77	88½	⅛	¼	¾	1
6 by 11	50,000	1000	⅞	11	2¼	8¼	1¾	¾	6 7/16	3	7¼	6	7¼	7⅞	8	7 5/16	42½	62½	78	90¾	⅛	¼	¾	1

Machinery

Cadillac Stock-room Methods

The Manner in which the Cadillac Motor Car Co. Has Solved Some Difficult Stock-keeping Problems



FLUCTUATIONS in the price of tools and other supplies that are used in the manufacturing departments of industrial plants often make it a difficult matter to accurately distribute the cost of such items among the various departments to which they are finally delivered. Where different kinds of tools and supplies are constantly being bought, each shipment is delivered with an invoice, but it rarely happens that the supply on hand has been completely exhausted at the time a new shipment is received. Obviously, such a condition would frequently result in a shortage of tools that would retard production; hence, the trouble in adjusting accounts. If the price has either increased or decreased, it will be apparent that some special precaution must be taken to enable items which have been bought at two different prices to be distributed among manufacturing departments, with a correct charge made against each department.

Either of three different methods of procedure may be adopted in order to accurately adjust accounts to compensate for price fluctuations. The first and most obvious method of procedure is to keep separate accounts for different lots of a given item, which have been purchased at different prices, so that each department may be charged according to the original purchase price. This plan is feasible in the case of small or medium-sized plants, where the volume of tools and supplies to be handled is not very great. The second method of procedure is to make a practice of charging the various items to the different manufacturing departments in which they are used, at the price at which the last lot was bought. This method simplifies the work of accounting, but it is almost sure to cause serious discrepancies in balancing up accounts at the end of the year.

It will be of interest to note how this method has worked out in the large manufacturing plants of this country within the last few years. In 1915, the abnormal demand from Europe was responsible for a rapid rise in the cost of all kinds of manufacturing equipment. Each time a new shipment of tools would be received, all tools of that type still on hand in the stock-room would be immediately appraised at the price appearing on the last invoice, and as prices were constantly rising, such a practice would mean giving the firm a fictitious profit on those tools which remained on hand at the time the next shipment was received. This would result at the end of the fiscal year in a large balance showing on the credit side.

While visiting the Cadillac Motor Car Co.'s plant, the writer discovered that these problems of stock-keeping have been solved by the third system of cost accounting mentioned at the beginning of this article. This system consists of figuring the average price of all tools of a given type, which are on hand in the stock-room at the time each new shipment of tools of that type is received. As a simple example, suppose there are twelve twist drills on hand which cost $1 each, when a new shipment of four dozen drills is received, which were bought at $1.10 each. The average price of twelve drills at $1 each and forty-eight drills at $1.10 each will be $1.08; and all departments calling for drills from the stock-room will now be charged at this price. Where such a practice is followed, there is no error in cost accounting, and as a result, the accounts should balance exactly.



Fig. 1. Drawers for the Folios on which Stock-room Records are maintained

While working out the details of applying this system in the Cadillac plant, the general stores department adopted the use of Burroughs calculating machines to facilitate the work of arriving at average prices of the great variety of different items that are always on hand in the stock-room. A further improvement was made by installing special Burroughs bookkeeping machines to maintain a record of the quantity of each item which is on hand after making a delivery to some department of the plant, and the cash values of both the items delivered to that department and those which remain in the stock-room. It will be apparent from Fig. 2, which shows one of the

loose-leaf folios on which these records are kept, that the system has been worked out in such a way that both the quantity of tools on hand and the cash value must balance; otherwise, an investigation will be immediately instituted to discover the cause of error and make the necessary correction.

The Burroughs bookkeeping machines used for this purpose are of standard design, except that they are furnished with a special keyboard and characters to meet the special requirements of the Cadillac Motor Car Co.'s cost accounting system for the stock-room. Fig. 1 shows a number of

work of balancing up the folios has been completed, the file is turned over to an order clerk, who makes out a requisition calling upon the purchasing agent to issue orders for the various tools and supplies that are required. It will be of interest to note that the markers are of such a shape and size that it is impossible to drop them into the file in such a position that they will be concealed by the folios, thus preventing the issuance of a purchase order for the tools or supplies that are required. For a complete description of the stock-room system used at the plant of the Cadillac Motor Car Co., the reader is directed to two articles entitled

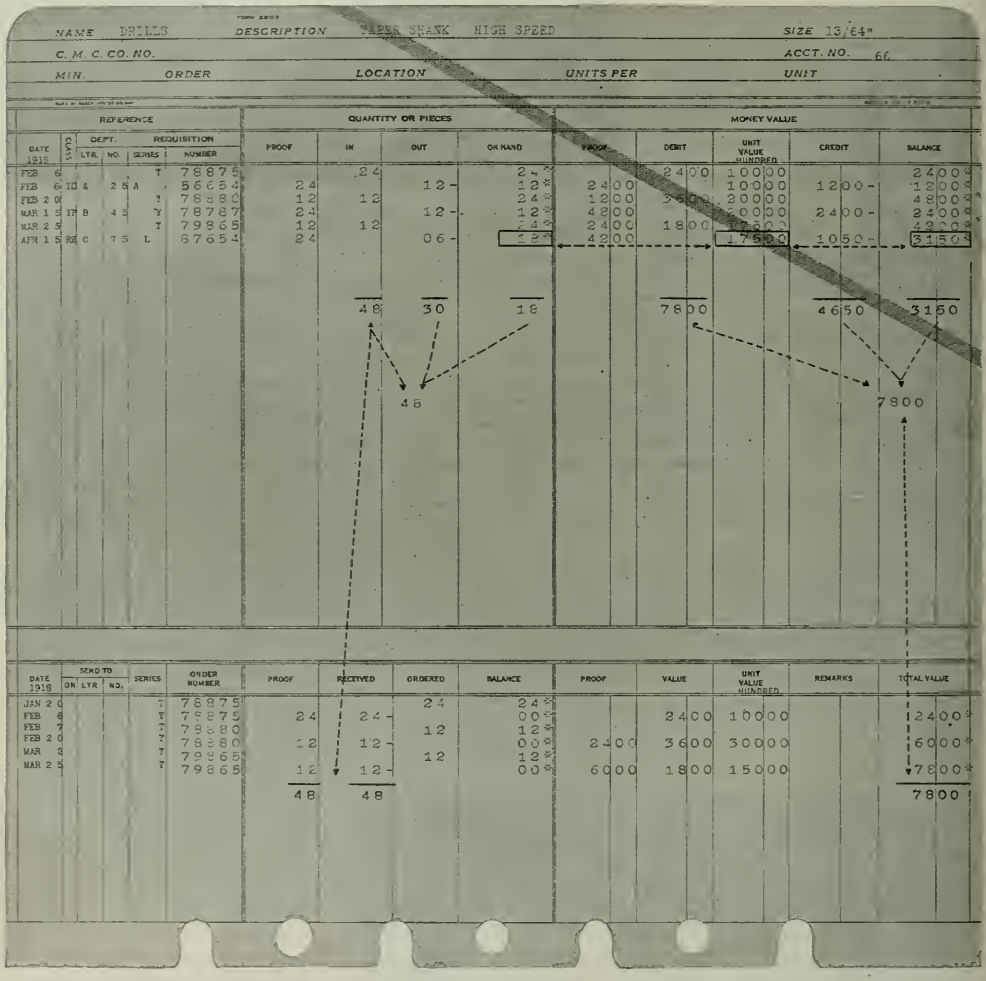


Fig. 2. One of the Cadillac Stock-room Records made up on the Burroughs Bookkeeping Machine

the files in which the folios are kept, and it may be of interest to know that when the stock of any tool, which is on hand in the store-room, has been reduced to a specified minimum, which varies according to the nature of the item, an order is at once issued to purchase a specified number of the tools, which also varies in different cases.

When the operator of the bookkeeping machine balances a folio and finds that the minimum number has been reached, a marker is at once dropped into the folio at this place. It will be apparent from Fig. 1 that the drawers are of greater width than the folios, the reason being to provide a clearance space into which the markers can project. Then when the

"Tool System of the Cadillac Motor Car Co." published in the June and October, 1916, numbers of MACHINERY.

* * *

A movement has been started by James A. Farrell, chairman of the National Foreign Trade Council, and president of the United States Steel Corporation, to endow a school of foreign commerce and service on a large scale at Georgetown University, Washington, D. C. It is intended that the school shall work along broad business-like policies. In the curriculum, special attention will be paid to the teaching of foreign languages in a manner that will make these studies of commercial rather than of literary value.

The Machine Tool Industry

THE domestic market is still capable of absorbing practically the entire output of the machine tool builders, and in many lines deliveries are quoted far ahead. The foreign trade situation is somewhat upset by the conditions of the foreign exchange rates, a subject which is dealt with in greater detail in the article "American Machine Tool Trade Abroad" beginning on page 509. Every indication points to continued prosperity in the industry, and as the general business conditions in the United States appear to be as favorable as the conditions in the machine tool industry, there is every reason to believe that the present prosperity is built on a firm basis. There is a lack of goods in practically every line of manufacture, the demand exceeding the supply; and in many industries the production capacity appears to be as yet much less than present consumption. There has been a considerable expansion of the textile industries, and yet there appears to be a scarcity in the products of this industry. In New England the expansion of the textile mills has reacted favorably on the machine tool industry, as regards the demand for machine tools; but on the other hand, the textile mills have absorbed labor that otherwise would have been available in other industries. In the Middle West, the automobile industry, which has been responsible for a greater demand for machine tools than any other line of manufacture, has also taken a large part of the labor supply, thereby somewhat restricting the maximum output of the machine tool builders.

The automobile industry is preparing for another busy year, and it is estimated that the planned production for 1920 is at least 20 per cent greater than the output in 1919. Possibly, however, the situation in the steel market will make it necessary to somewhat curtail this estimated production, as some of the classes of steel used in automobile building, especially sheet steel, are difficult to obtain excepting on very long deliveries.

Prices in some lines of machine tools like sensitive drilling machines, some kinds of grinding machines, and some sizes of turret lathes, have, according to reports, been increased, to take care of the constantly growing expenses for materials and labor. As indicated by the comparative price increases for different classes of machine tools published in MACHINERY last August, all of these lines of machines had increased much less in price than the average increase for the whole machine tool trade, so that the present increases may be considered merely an effort to equalize the selling price and the cost of production.

Predicted Scarcity of Steel

Even previous to the strike in the steel industry, there was danger of shortage of steel of certain kinds, because the demands of some of the manufacturing industries exceeded the capacity of the steel mills. The strike naturally tended to augment this difficulty, and there is now a decided shortage in certain kinds of steel, particularly sheet steel. The United States Steel Corporation, according to a statement made by Judge Gary, has announced that the present policy of the corporation is to adhere to the selling prices agreed upon by the Industrial Board at Washington on March 21, 1919. The Steel Corporation therefore will not raise prices at the present time, although the demand for its products is such that prospective purchasers would be willing to pay materially larger prices to obtain immediate deliveries. It is stated, however, that some of the independent mills have, in effect increased their prices, if not in theory, at least in practice. While they will adhere to present prices on orders for long deliveries, premiums are charged for deliveries within a specified time, these premiums varying from one-half cent a pound to one cent a pound on certain grades of steel and for deliveries within from three to six months. Makers of automobile pressed parts have, in some instances, refused orders from their customers, because of their inability to obtain sheet steel for early deliveries.

In the machine tool industry it does not appear that the steel situation will have any adverse influence, as most of the machine tool manufacturers had large quantities of both steel and pig iron on hand at the signing of the armistice; in fact, some report that they have supplies sufficient not only to tide them over the present alleged shortage, but that they are also able to sell some of their surplus stock; hence, they will be independent of the jobbers in steel, who are said to have bought up much of the available supply in sight at the beginning of the steel strike, and who are now quoting prices considered rather high for immediate deliveries.

The Labor Situation

While the labor situation now appears to be satisfactory in so far as comparative absence of disturbances in the form of strikes is concerned, there is a marked shortage of both skilled and unskilled labor in most localities where machine tool plants are located. Throughout New England, complaints are made that it is difficult to obtain toolmakers and skilled machinists, and that it is not a question of wages, because there are not enough men of this type to fill the demands of the industry. Unskilled labor is also scarce because there has been no immigration to supply the cheaper grades of labor and also because some of the industries, particularly the textile industry, have drawn heavily upon the present available supply. Some plants are not able to make use of their full machine capacity because of their inability to obtain a sufficient number of skilled men. The wage situation seems to have gradually reached a level at which wages, the cost of living, and the prices at which the manufactured products are sold, seem to bear approximately the same relation to each other as they did previous to the war.

Need for Apprenticeships

The scarcity of skilled mechanics brings up the question of apprenticeship. Many manufacturers realize the absolute necessity of some steps being taken to revive the old-fashioned apprenticeship on modern lines. Just how this can be done in the case of the small shop is open to discussion, and a satisfactory solution has not as yet been presented. In the case of large plants, of course, apprentice schools are maintained and these are made attractive to the boys taking the courses because of the theoretical as well as practical training that is given. At the present time, however, when a boy can get a comparatively high wage at once by operating a machine tool on repetition work, it is difficult to persuade him to accept a lower rate of pay for a period of four years in order that he may learn a trade first and after that time become capable of earning a higher wage. A concerted effort on the part of manufacturers, however, doubtless would bring results. Some firms well known in the machine tool fields, have for years maintained very successful apprentice schools, and in a few instances, smaller firms who could not each individually maintain such a school, have cooperated in establishing a school where the theoretical instruction was given, while the practical instruction would be taken care of in each individual plant. Present conditions have forced the problem definitely to the front, and when the importance of the problem is thoroughly recognized, doubtless a satisfactory solution can be found.

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ECONOMICAL SHOP PRACTICE

Sometimes advertisements of milling machines and planers call attention to the large volume or weight of metal that can be removed per minute by the machine. The capacity of a machine expressed in this manner indicates to a man familiar with shop practice the character of the design and workmanship of the machine, and is an important factor to be considered in buying such equipment. But the claims made, while unquestionably accurate, often far exceed any practical conditions of operation that should be required of a milling or planing machine. If the castings or forgings have so much metal left on them to be removed, it is not a superior type of machine that is required, but an investigation into the responsibility for a wasteful practice; because there must be something radically wrong in the work of either the pattern shop or the tool-room, if the patterns from which the castings are molded or the dies used for the drop-forgings leave so much metal for machining.

To prevent waste in the manufacturing processes, it would be good practice for the production manager of the plant to check up the dimensions of patterns and dies used in the making of castings and forgings. If too much metal is left to be removed by machining, it is evident that the production obtained in the machine shop will be reduced, because as the depth of cut increases it is necessary to slow down the rate of feed, and consequently the number of pieces machined per day is reduced. Generally speaking, for castings, it will be found that in all ordinary cases a maximum allowance of ⅛ inch for machining is adequate; and on drop-forgings the excess metal need never exceed 1/16 inch in depth, except in very unusual and special cases; infact, it is frequently possible to work to even closer limits than 1/16 inch.

* * *

PRACTICAL RESULTS FROM ENGINEERING COOPERATION

The work of the convention of the Society of Automotive Engineers held during the past month in New York City shows what can be accomplished when manufacturers and engineers actively cooperate for the purpose of improving their product and reducing its cost. No commercial or engineering organization has done more toward product standardization than this society, its main efforts having been concentrated on that work. Great economies and a speeding up in the production of automobiles and motor trucks of all kinds have resulted from this broad and intelligent procedure.

C. F. Clarkson, the general manager, calls attention to some noteworthy results of the society's work—including specifications for automobile materials which are now used in other engineering fields; the elimination of minor differences in specifications, effecting a reduction in the selling prices of materials and enabling manufacturers to obtain them from stocks at the warehouses; the standardization of spark plugs, screws, bolts and nuts, many ignition appliances and electrical apparatus, pistons, piston-rings, carburetors, lock-washers, etc., making it possible to obtain repair parts quickly and to use them interchangeably on different makes of cars and trucks.

The society has actually established nearly 300 different mechanical and material standards, and has accomplished this result by methods which have in no way impeded the improvements in automobile construction. On the contrary, by simplifying the routine work of draftsmen and engineers, a considerable part of their time has been available for working out improved construction and the introduction of new features such as make the designers' work really worth while. The continuous decrease in the cost of automobiles previous to the war, and the fact that their prices have not been increased in anything like the same ratio as those of other mechanical products, show the importance of the results achieved by the automobile engineers and manufacturers through their standardization work.

At present the society has at work hundreds of representative engineers throughout the country endeavoring to determine new standards that will be generally acceptable. Nearly one hundred additional standards are established yearly, many of which benefit all the mechanical industries, and all the data thus acquired are generally accessible in handbooks published by the society, which contain records of the standardization and recommended practices that have been adopted.

* * *

PUBLICITY WILL HELP

It has been frequently stated that a considerable part of the industrial unrest of the day is due to exaggerated ideas of profits that labor agitators have systematically implanted in the minds of workers. During the Seattle strike, for example, agitators stated in open meetings that the largest shipyard in Seattle was earning $60 per day per man, out of which the worker himself received only $6. This statement was widely accepted as true by the men, and many newspapers, eager for sensational news, helped to spread it broadcast. Yet the facts were that the total output of the yard per man per day amounted to only $15, and out of the $15 not only the man's wages of $6 had to be paid, but the cost of all the material he used, his proportion of the cost of the buildings and special equipment required, the taxes and insurance, interest on borrowed money, the salaries of foremen and executives, the coal used in producing power, the indemnities payable in cases of accident, and the many other costs that must be met in such an industrial enterprise. The stockholders received their share only after all these different items had been paid.

When employers generally will combine to furnish their employes with accurate and enlightening information on the costs of their business and the items of expense involved, the effect of such false statements can be counteracted; but so long as employers virtually confirm their truth by silence, the employes will continue to be influenced by false or exaggerated statements about profits—and to act on them.



The Work of the Bureau of Standards

DURING the last few years the functions of the Bureau of Standards have been greatly increased, its activities during the war, particularly, tending to prove its importance in the industrial and engineering fields. A number of new buildings have recently been added, especially with a view to furnishing ample and well-equipped laboratories for industrial testing and research. It is evident that the maintenance of correct standards, not only of measurements and weights, but also of quality and of performance—as in the case of engines, boilers, pumps, electrical machinery, etc.—calls for continuous and scientific investigations of the highest order, and involves competent expert services and the best scientific equipment. When this is accomplished, there still remains the serious problem of making the results available and useful in the industries.

One of the functions of the Bureau of Standards is to compare with its own standard of measurements, the measuring instruments used by states, cities, scientific laboratories, educational institutions, and commercial corporations. The Bureau also gives advice concerning these standards and their use, and many questions of disagreement either between corporations, or between the public and a corporation, involving the use of standards, are referred to the Bureau for advice or adjustment. The Bureau also certifies the accuracy of standards of measurement, such as gages, and in addition publishes a great deal of information relating to measurements and standards of all kinds, in the form of small booklets, each dealing with one definite subject. Numerous tests and investigations are carried on in this connection.

The materials of construction are also dealt with by the Bureau. In the mechanical engineering trades, the materials of the greatest interest are steel, brass, and bronze, the characteristics and properties of which are investigated in the metallurgical laboratory. In this laboratory part of the gage work is also done.

Relation of the Bureau of Standards' Work to the Industries

The activities of the Bureau of Standards are fundamentally concerned, either directly or indirectly, with the improvement of methods of production or the quality of the output of the industries. The Bureau occupies somewhat the same position with regard to the manufacturing plants of the country that the Department of Agriculture does to agricultural interests. Many industries are just beginning to realize the importance of precise methods of measurement and scientific investigation, which in practically every case involves some kind of measurement.

As pointed out in the annual report of the director of the Bureau of Standards, it is upon quality as well as upon price that competition must finally depend, whether in domestic or foreign commerce. The use of exact methods and scientific results is the greatest factor in the improvement of quality, or in the development of new industries. The educational value of the Bureau's work in this respect seems to be very little understood by manufacturers, although recently the Bureau has received hundreds of letters, as well as many personal visits from manufacturers, seeking information as to standards of measurement, how to use them, how to measure the properties of materials, or as to the fundamental physical and chemical principles involved; also, what is of even greater importance, how to initiate and carry out scientific investigations and tests on their own account in their particular fields of work.

Institutions Abroad Similar to the Bureau of Standards

The importance of maintaining scientific institutions having to do with standardization and the application of precise measurements to the industries has been recognized by all the leading countries of the world. Great Britain maintains the Standards Department of the Board of Trade; also the National Physical Laboratory, whose functions include matters pertaining to scientific and technical standards, physical constants, and to some extent the properties of materials. The Laboratoire d'Essais of France, while not as extensive as the English institution, is charged with similar duties. Germany maintains three such institutions—the Normal-Eichungs Kommission, equipped with the buildings, personnel, and apparatus necessary in standardizing and controlling the weights and measures of trade; the Physikalisch-Technische Reichsanstalt, covering testing and investigations in connection with scientific and technical standards other than weights and measures; and the Prussian Government maintains the Materialprüfungsamt, a large institution devoted to the investigating and testing of structural, engineering, and

other materials. It is generally recognized that these institutions have been exceedingly important factors in the industrial progress of these countries.

Cooperation between Bureau of Standards and the Industries

While the greater part of the Bureau's efforts were given up during the war to work in connection with the military departments of the Government, it was never before called upon to such an extent for advice and scientific data by the industries. Most of these questions arose out of the manufacture of war material. A great many of these requests came directly from the manufacturers, others through the War Industries' Board, and still others from various commissions having to do with the war material production.

Every section of the Bureau cooperated to a greater or lesser extent with the manufacturers of the country, and, as a result, closer relations have been established between the industrial plants and the Bureau. It is evident that this relationship will continue and become of great economic value; but, if the Bureau is to retain its high position in the various industrial fields and meet the rapidly increasing demands for its services, the greatest amount of support possible must, of course, be given to it by the industries.



Fig. 1. Metallurgical Laboratory of the Bureau of Standards in which Part of the Gage Testing is being done

Training of Experts in Various Industrial Fields

Through the increased activities of nearly all the industries of the country and the demand for trained investigators, the Bureau's scientific staff has been largely depleted, and it will be a matter of some time before it can be brought back to the plane of high efficiency which it has previously maintained. It is assumed that the compensation paid scientific and technical men in the Government service will be adjusted to a scale more commensurate with that paid by scientific institutions and industrial laboratories, but even then the industries should cooperate in every way possible to maintain the Bureau's staff intact. Many instances could be given where the industries have taken experts with little warning and with no apparent consideration as to the consequences. The training of men for research is one of the most important ways in which the Bureau can aid the industries; but to do this it must keep its own staff in the highest degree of efficiency.

Organization of the Bureau of Standards

The organization of the scientific and technical staff is based on the nature of the expert service involved rather than on the classes of standards. For example, the division of weights and measures has to do with all matters pertaining to standards of length, weight, time, density, and similar questions, whether they arise in connection with the precision standards used in scientific investigation, the master standards of manufacturers, or the ordinary weights and measures of trade. A standard of quality or performance where any of the above measurements form the fundamental and most important factor would be referred to this division.

The division of heat and thermometry has to do with heat standards, the testing of heat-measuring apparatus, the determination of heat constants, of which there are many, and all investigations pertaining to quality or performance where heat measurement is the essential and predominating factor.

The electrical division is concerned with all the electrical problems that may be taken up at the Bureau, whether in connection with the various electrical standards of measurement, electrical constants, the electrical properties of materials, or the performance of electrical equipment.

Questions in optics enter into standards of all kinds to a greater extent than has been supposed; hence, there is an optical division with experts in spectroscopy, polarimetry, color measurement, the principles of optical instruments, and the measurement of the optical properties of materials.

Practically all investigations concerning the various classes of standards involve chemistry in one form or another. There are also many chemical standards and questions which arise in connection with chemical work generally, especially in the industries; hence, there is a chemical division, cooperating with every other division of the Bureau, as well as taking care of the questions of a purely chemical nature that fall within its regular functions.

The work of the structural engineering and miscellaneous materials division includes investigating, testing, and preparing specifications for these materials, such as the metals and their alloys, stone, cement, concrete, lime, the clay products, paints, oils, paper, textiles, rubber, and miscellaneous classes of materials.

The division of engineering research makes investigations and tests regarding the performance and efficiency of such instruments, devices, or machinery as the Bureau may take up that do not fall directly under one of the scientific divisions. The questions pertaining to the manufacture, specifications, testing, and use of the metals and their alloys is so important that a division known as the metallurgical division was formed of the experts engaged in these problems.

Gage-testing Section

One of the most important sections of the work of the Bureau of Standards, as far as the mechanical industries are concerned, is the gage department. The gage section was organized as a part of the division of weights and measures at the beginning of the war, to provide facilities on a larger scale to inspect and certify limit gages and precision length standards, and to assist in the solution of problems in connection with gage work. The staff of the section numbered about 140 on July 1, 1918, and had further increased to 225 in November of the same year. By July 1, 1919, the number had been gradually reduced to 55 members.

Scope of Work in Gage-testing Section

Besides the routine testing of gages at the Bureau in Washington, the section during the past year conducted three branch laboratories; developed and manufactured Hoke precision gages; improved, designed, and constructed gage-testing apparatus; salvaged and manufactured limit gages; stored, shipped, and conducted a clearing house for master gages; conducted instruction courses for government gage inspectors; studied gage and tolerance problems for the

National Screw Thread Commission; and prepared and distributed communications and reports regarding such parts of the work as are of general interest.

From July, 1918, to June, 1919, altogether 40,630 gages were tested. Of these 45 per cent were screw thread gages, 45 per cent were plain gages, and 10 per cent were profile and miscellaneous type gages. During the war this testing work was handled in such a way that the average time between the date of arrival and the completion of the tests and shipment back to the owner, was from three to four days.

Branch Gage-testing Laboratories

The three branch gage-testing laboratories maintained during the war were located in New York City; Cleveland, Ohio; and Bridgeport, Conn. Each was equipped with facilities duplicating on a small scale the Washington laboratory. These branches served a large number of manufacturers in the industrial centers in which they were located and aided gage production materially by making it possible for manufacturers to send sample gages and work by messenger for immediate inspection. All of the branch gage laboratories thus established have been discontinued on account of lack of funds.

Development and Manufacture of Precision End Standards

In July, 1918, experimental work was begun to demonstrate the feasibility of mechanical production of precision end gages under the direction of the inventor, W. E. Hoke, and in cooperation with the Bureau's experts in optical methods of measurement, which are essential. An early set of samples of equal length within 0.000002 inch, flat within 0.000004 inch, and within 0.000008 inch of the desired size has proved the practicability of the method. Upon receipt of this report the Ordnance Department made an allotment to cover manufacturing cost and commissioned the inventor. Machinery and special apparatus purchased under the allotment was installed and manufacture begun. By the close of the year more than 3500 gages had been manufactured, accurate within 0.000005 inch, and assembled in sets, the total value of which, compared with the price of the formerly imported gages, exceeded the amount of the allotment. The cost of experimental work and all machinery purchased was virtually saved in the first year's production.



Fig. 2. New Industrial Research Laboratory of the Bureau of Standards at Washington

Gage Salvage and Manufacture

During the year, 487 new master and inspection gages were manufactured, and 962 additional obsolete gages were salvaged for the Ordnance Department to conform to revisions in design. This was done as exigency work in the gage shop only when serious delay would result from the regular method of procuring gages from outside manufacturers, or when a small amount of work would salvage obsolete gages and save the expense of contracting for entirely new gages. Five additional lead testers were manufactured for the Ordnance Department during the past year, so that one machine has now been supplied for each of the principal arsenals.

Design and Construction of Gage-testing Apparatus

The following new designs of gage-testing apparatus have been made to embody the results of experimental work: Simplified projection lantern of short range with horizontal projection, ground-glass screen, and equipped with incandescent arc illumination; an improved and simplified balanced micrometer to be used for pitch-diameter measurements of thread gages by the three-wire method; a mechanical indicator to replace the optical lever system on the Bureau's lead-testing machines; apparatus for the measurement of periodic lead errors in plug thread gages; and a device for standardization of wire measurements. Apparatus and instruments are under construction at the present time for all of these designs. In addition to this work, the shop has built during the past year practically all of the special apparatus that was required for use in the Washington laboratory and in the branches.

Research Work Carried on by the Bureau

Research work has been carried out largely in connection with problems of the National Screw Thread Commission. Experiments have been made to determine suitable tolerances, allowances, and interference values for various classes of fits. Study has been made of methods of manufacturing taps and screw thread gages, together with the effect of errors in taps on the size and character of tapped holes. Proposed tolerance systems have been worked out, tabulated, and charted. Questionnaires have been prepared and issued, through which information has been secured from manufacturers and users of screw thread products relating to current practices. The replies that have been received have been studied, classified, and tabulated.

A large amount of valuable data have been collected relating to all phases of gage work. From this recorded experience it has been possible to advise manufacturers on a great many subjects relating to the proper design, inspection, and use of limit gages. This work is being continued and will be supplemented by literature prepared and distributed in such a manner as to reach and benefit the largest number of manufacturers. Standardization, research, routine testing of commercial gages and standards, and development of measuring apparatus will form important parts of the future work of the gage section.

Other Interesting Tests of Value in the Mechanical Industries

A carefully planned series of tests intended to demonstrate the economy and efficiency of oxy-acetylene welding and cutting apparatus is being made at the present time. Apparatus from the leading manufacturers in this line have been received for test. These tests are planned to show the conditions under which back-firing occurs, the characteristics of regulators under varying tank pressures, the economy of the apparatus in welding and cutting operations on material of various thickness, and the durability of the apparatus and the ease with which repairs can be made in service. Tests on electric welds have also been made in connection with the work of the Welding Research Committee of the Emergency Fleet Corporation.

An interesting investigation has been made on the strength of wire rope, the results of which have been published in

the Bureau's Technologic Paper No. 121. On the subject of hardness testing some investigations have been made, and a Brinell hardness numeral table, correct to the second decimal place, has been compiled. This table gives the Brinell hardness numeral for each one-hundredth of a millimeter of diameter of indentation from 2 millimeters to 6.94 millimeters both for 500 and 3000 kilograms pressure. Copies of this table are obtainable from the Bureau upon application.

The metallurgical section has carried on an extensive research work. During the past year the experimental heat-treating plant has been enlarged, new furnaces having been installed and the pyrometer equipment for individual units changed to a central station control. A new method of making thermal analysis has been developed and various tests have been made upon the mechanical properties of heat-treated structural alloys and steel.

High-speed Steel Investigations

A study of high-speed steels is being made (1) to throw further light on their constitution and properties; (2) to develop a simpler method than now in use for determining the relative value of two steels as cutting media. The methods now in use include thermal analysis, whereby heating curves are taken on previously quenched samples, and hardness tests made after hardening and tempering at various temperatures. Cooperation from the steel makers is expected in this work.

The Bureau has had the opportunity of carrying out tests on several types of product, including cast high-speed cutting tools which in test have shown cutting properties equal to the best forged tools of similar composition. The extension on a large scale of the use of cast tools will result in great labor and material saving and in lowering the cost of working metals. Besides these performance tests an investigation has been in progress on the general problem of the constitution and theory of the much-discussed high-speed steel and its "red" hardness. Data on several of the physical properties and microstructure of this steel, as affected by various heat-treatments, have been collected, and seem to answer many of the questions involved.

Investigations of Gage Steels

An investigation of the most suitable steels and treatments for the manufacture of precision gages, resulting from work originally carried on for the War Department, is now in progress. The work includes determination and comparison of resistance to wear, permanence, resistance to corrosion, soundness, expansibility, and economy under varying thermal treatments. It is expected that this investigation will be completed during the present year.

Valuable experiments have also been made upon operating methods, acid-resisting alloys, corrosion of brass, and the strength of solder and soldered joints, as well as upon the treatment of pure nickel, and of light aluminum alloys.

Scope and Resources of the Bureau of Standards

During the fiscal year ending June 30, 1919, the total expenditures of the Bureau of Standards amounted to approximately $2,674,000. The staff of the Bureau comprised about 1150 employes, of which 201 held scientific positions, 52 were office assistants, 55 engaged in the operation of the plant and 33 in the construction, in addition to 800 employes engaged in research and investigations, specially authorized by Congress. At the present the personnel consists of over 1000 regularly appointed employes as compared with approximately 500 prior to the war.

During the fiscal year ending June 30, 1919, the Bureau carried out 124,668 tests, of which 110,468 were for the Government and 14,200 for individuals. Of these tests nearly 10,000 were length measures, over 22,500 were physical and mechanical tests, and nearly 20,000 were temperature tests, while the remainder were distributed between engineering materials, structural materials, paper and textile industrial tests, metallurgical tests, aeronautical instruments, electrical, hydrometry, and optical tests, etc. Not less than 53 publications were issued by the Bureau, of which 36 were new and 15 were revised editions.

The laboratories of the Bureau of Standards are located in the northwest section of Washington on Pierce Mill Road, near Connecticut Avenue, and are reached by the Chevy Chase car line. They were located outside of the business center of Washington in order to insure freedom from mechanical, electrical, and other disturbances common to the business and more thickly populated sections of the city. Furthermore, the amount of ground necessary precluded a site near the city. It has been found by experience that the efficiency of the employes, especially those engaged in testing and scientific investigation, has been greatly increased by the location of the laboratories in a section free from the ordinary disturbances of city life.

* * *

TECHNICAL SCHOOLS MAY NOW BUY GOVERNMENT MACHINE TOOLS

The director of sales of the War Department announces that acting under the provisions of the Act passed by Congress known as the Caldwell Bill, plans have been completed for the sale of machine tools to educational institutions of recognized standing, at a price equivalent to 15 per cent of the original cost to the Government. School authorities who wish to purchase equipment under this act, will be requested to fill out a questionnaire from which will be determined the eligibility of the institution which they represent. This questionnaire must be submitted to the director of sales, War Department, Washington, D. C.

The director of sales will then pass upon the eligibility of the institution, and such institutions as are found eligible to make purchases will be supplied with purchasing coupons for the number of machines allotted to them, each coupon being good for the purchase of one machine. The various bureaus of the War Department having surplus machine tools for sale will also be directed to place the name of the educational institution on the mailing list for such machine tool bulletins as are issued from time to time. From these bulletins the educational authorities will be able to select machines to meet their requirements and can then negotiate directly with the office publishing the bulletin from which the machine is obtainable.

Under this plan, no preference will be given to either commercial organizations or educational institutions, and orders from either source will be considered on the same footing. Owing to the limited number of machine tools suitable for the purposes of educational institutions, however, all offices will be instructed to grant to educational institutions an option of ten days, from date of receipt of request to purchase a specific tool, in which to complete the details of inspection and purchase. Upon receipt of notice that the selected machine tools are available for sale, school authorities will forward shipping instructions, certified check for the amount of the purchase price, and one coupon for each machine bought. Freight charges will be paid by the purchasing institutions. School authorities desiring information relative to terms of sale under the "Caldwell Bill" should first write to the Director of Sales, Munitions Building, Washington, D. C. for questionnaire blanks. It has been announced that educational institutions in Ohio and Michigan lead among those who have filed questionnaires with the War Department as a first step toward securing surplus machine tools for their institutions.

* * *

Announcement has been made of the intention of the Australian Government to create an industrial court for the Australian Commonwealth, which will deal with labor disputes exclusively. The court will have power to legalize industrial agreements, and will be the final industrial court of appeal.

American Machine Tool Trade Abroad

THE exports of metal-working machinery from the United States during the month of November, figures covering which have just been made public by the Department of Commerce, show a slight decrease as compared with the exports during October. The total of the October exports amounted to over $5,000,000, while the total of the November exports amounted to slightly over $4,500,000. There is no perceptible decline in the exports of machine tools, however, the main decline being in metal-working machinery other than machine tools; but there is a very marked change in the destination of the machine tool exports. While, in October, France was the leader in imports of machine tools from the United States, taking a total of $570,000, the November imports amounted only to about $390,000. The exports to England, which were not quite $500,000 in October, rose to nearly $700,000 in November. Belgian imports of machine tools amounted to nearly $150,000, while Canada imported machine tools to a value of over $350,000, representing next to England and France, our largest customer.

EXPORTS OF METAL-WORKING MACHINERY FROM THE UNITED STATES, NOVEMBER, 1919

Countries	Lathes, Dollars	Sharpening and Grinding Machines, Dollars	Other Machine Tools, Dollars	All Other Metal-Working Machinery, Dollars
Belgium	129,837	6,924	8,305	69,351
Denmark	7,033	1,064	9,080	28,632
Finland	.....	.....	.....	14,955
France	136,830	112,555	143,968	1,021,842
Gibraltar	.....	.....	.....	4,000
Greece	.....	.....	1,073	72
Italy	945	17,500	53,772	42,096
Netherlands	13,862	.....	11,808	20,639
Norway	717	1,846	1,062	5,502
Portugal	.....	.....	.....	2,555
Spain	38,056	3,548	11,131	11,995
Sweden	19,421	9,974	2,212	24,827
Switzerland	125	706	324	2,450
Turkey in Europe	441	.....	.....	.....
England	112,499	163,396	414,043	550,841
Scotland	.....	.....	403	2,815
Ireland	.....	.....	1,336	.....
Canada	61,118	88,125	196,592	210,240
Costa Rica	1,665	.....	.....	70
Guatemala	.....	138	56	569
Honduras	.....	.....	.....	88
Nicaragua	.....	.....	450	183
Panama	.....	.....	335	.....
Salvador	.....	.....	74	.....
Mexico	4,666	419	8,716	22,066
Newfoundland and Labrador	.....	.....	221	.....
Jamaica	1,581	.....	138	625
Trinidad and Tobago	48	6	291	.....
Other British West Indies	903	.....	.....	.....
Cuba	16,276	400	49,274	24,567
Danish West Indies	.....	.....	64	.....
French West Indies	1,164	.....	42	.....
Haiti	.....	100	.....	37
Dominican Republic	842	.....	57	486
Argentina	5,504	5,857	11,685	18,711
Bolivia	.....	.....	22	.....
Brazil	4,808	1,234	7,583	4,381
Chili	700	583	2,790	75,206
Colombia	.....	295	833	576
Ecuador	.....	.....	148	.....
British Guiana	242	.....	.....	.....
Dutch Guiana	.....	58	.....	.....
French Guiana	.....	180	30	.....
Peru	2,754	18	2,393	11,009
Uruguay	3,175	.....	1,199	657
Venezuela	6,900	142	.....	300
China	3,585	520	2,081	11,592
British India	3,443	255	5,121	8,223
Straits Settlements	.....	.....	4,319	.....
Dutch East Indies	16,804	2,125	1,311	12,740
Hongkong	.....	.....	40	3,890
Japan	21,404	12,182	31,075	190,342
Russia in Asia	.....	.....	586	4,456
Australia	1,776	2,326	9,146	9,457
New Zealand	8,683	504	1,960	2,776
French Oceania	.....	.....	.....	17
Philippine Islands	10,616	764	8,106	16,027
Belgian Kongo	.....	.....	.....	1,382
British West Africa	960	.....	.....	.....
British South Africa	8,418	5,235	1,289	16,453
French Africa	.....	.....	.....	1,669
Portuguese Africa	.....	.....	.....	1,354
Total	647,801	438,979	1,006,544	2,452,721

Machinery

Present State of the Foreign Machine Tool Trade

Interviews with a number of machine tool builders and manufacturers of small tools on the present conditions in the foreign trade, have made it possible for MACHINERY to present a general review of the problems that now face the American machine tool industry. Reports from machine tool builders indicate that while during the last few months they have made deliveries on orders entered at an earlier date, and therefore shipped an appreciable amount of machine tools abroad, new orders are not coming in to the same extent as had been expected, due, mainly, if not entirely, to the abnormal foreign exchange rates. Some manufacturers have been able to sell to Belgium in spite of the low value of Belgian money, because Belgium must have machine tools irrespective of cost; the trade with France has been appreciably curtailed, while the trade with Great Britain has suffered less, due, of course, to the fact that the exchange rates are not as abnormal in the case of the United Kingdom as they are in the case of France or Belgium. The Italian lira is now worth less than the franc, and hence trade with Italy is still more difficult.

In the case of precision instruments, for example, where formerly some manufacturers sent nearly half of their output abroad, their foreign trade has been cut to from ten to fifteen per cent; and similar reports are given by manufacturers of certain lines of machine tools where the domestic European competition comes into play and is enabled to exclude the American tools. Trade in small tools, such as taps and drills, etc., has remained fairly normal until recently, but even in these lines there has been an appreciable decline.

On the other hand, there are certain lines of American machine tools which can always be sold in Europe, no matter what the exchange rates, because these lines are not made abroad and manufacturers there must buy them at any price. These machines include especially the more highly developed and special machinery in the grinding, milling, and automatic machine lines.

Proposals Made for Stimulating Foreign Trade

It is futile to expect that the exchange rates can be brought back to normal by artificial means. Loans extended by the United States will remedy the conditions only temporarily, and in the end, the condition which it was intended to remedy will only be aggravated, unless the European countries begin to produce on a large scale so that they can export goods to the United States and thereby build up a balance that will tend to equalize the exchange. Even the bankers, who ought to be best informed on a subject of this kind, state that it is impossible to foretell when the European exchange rates will return to normal, and they also state that it is likely that the exchange rates with some of the European countries will fall still more before they will again begin to rise. Some American manufacturers have allowed some of their foreign customers a special discount, aimed to partially or wholly make up for the difference in exchange. Others have made arrangements to allow longer credits than usual, and still others have agreed with their customers to have the purchase price deposited in foreign money, based on nearly normal exchange rates, in the banks of the country where the sale is made, the money remaining at this bank at a nominal percentage of interest until such time as exchange rates will again become more nearly normal, so that it will be advisable to have the money transferred to the United States.

In discussing these various plans with one of the firms that has always been one of the leaders in the foreign trade

of machine tools, it was pointed out that while discounts doubtless would tend to stimulate the trade, it would be necessary for the American manufacturer to carefully consider the effect of any policies now adopted upon their future dealings abroad. Trade customs are often inaugurated by making some special allowance intended to be in effect only temporarily, and every machine tool builder should carefully consider what effect any steps taken today will have upon his trade and business dealings abroad three or five years from now. Furthermore, it is highly important to ascertain if any discounts thus made will benefit the ultimate buyer or consumer of the machinery or tools, and not merely the dealer. Unless the discount allowed actually benefits the ultimate costumer, nothing has really been gained by allowing such a discount.

When considering the question of extending longer credits, it should be remembered that on account of the higher prices of materials and labor at the present time, the capital required to keep a manufacturing establishment going with the same amount of production as formerly is much greater than in the past; hence, the American manufacturer needs all the capital that he can obtain in his own business. He is, therefore, not in a position to extend long credits, permitting his customers to make use of the money which he himself requires for the conduct of his own business. At best, the extension of credit would mean only a few months more than ordinarily, and with the uncertainty as to when exchange rates will come back to normal, it is doubtful if a few months' extension of credit would be of any practical value. Instead, it has been pointed out that the use of trade acceptances by foreign buyers, especially dealers, drawn upon their financial representatives in the United States, would be one of the best solutions, and would be helpful to seller and buyer alike.

As already mentioned, some foreign dealers have requested American manufacturers to grant them the privilege of depositing the purchase money, based on nearly normal exchange rate, in a bank in their own country, with the idea that the money could be held there at a low percentage of interest until the exchange rates become normal. In one instance, the account thus created in favor of the American manufacturer carries four per cent interest. It is evident that in cases of this kind the American manufacturer takes all the risk. He is deprived of the use of his money for a long period, gets but a small percentage of interest on it, and has no assurance that the exchange rates will return to normal soon enough to make it worth while for him to keep his money abroad, awaiting a rise in exchange.

Foreign Loans Placed in the United States

The Belgian loan for $25,000,000 which was placed in the United States during the past month, will, of course, tend to aid in increasing the trade with that country. The United States Treasury Department has also just authorized the flotation in this country of an issue of $25,000,000 in Italian bonds, which is the first installment of a complete issue of a $100,000,000 loan, which is underwritten by a group of leading Italian bankers. These bonds are issued at par at an interest rate of 6½ per cent. Loans of this kind will, of course, temporarily, facilitate trade.

Opinions of Manufacturers

It is the opinion of those who have been long engaged in foreign trade and who have given the present situation very careful study, that of the various means proposed for stimulating the foreign trade, the special discount is the most feasible, providing the American manufacturer can definitely ascertain that the discount will accrue to the benefit of the ultimate consumer. It is pointed out, however, that every foreign country must be considered separately. In the first place, the difference in exchange rates in different countries is so marked that where a certain policy might be practicable and would stimulate trade in one country, it might be entirely impracticable in another. The problem is so involved that it is not possible to give any general rule as to the best way in which to handle it or to present any general solution of the problem. The American manufacturers, however, should be careful not to neglect their foreign trade connections at this time, even though sales may not be as large as usual. It is true that the domestic trade just now will absorb the output of most American machine tool builders, even if there were no foreign trade at all, but there has been no greater harm done to our foreign trade in the past than the policy of neglecting it whenever the domestic trade was booming. At the present time, on account of the difficult conditions in the foreign trade, there is a still greater temptation to neglect it. That tendency should be counteracted as far as possible, because the time will come when the foreign trade will provide a necessary outlet again for American machine tools, and whatever can be done at this difficult period to stimulate and foster that trade and to maintain the friendly relations with foreign customers, the more successful will that trade be in the future.

Summary of Important Points

The three cardinal points laid down by a machine tool manufacturer unusually well acquainted with the foreign trade, and which have been emphasized above, are as follows:

1. Any trade policies or practices adopted at the present time should be considered not only in the light of present conditions, but with a view to the future so that whatever practices or methods that are inaugurated today will not react unfavorably a few years hence.

2. American manufacturers must ascertain that any concessions or discounts which they may make in order to obtain foreign trade will benefit the ultimate user or buyer abroad.

3. While the conditions of foreign trade are unfavorable and those of domestic trade at the present time unusually promising, American manufacturers should not permit themselves to neglect their foreign trade connections, but should maintain their relations abroad to the fullest extent of their ability. Ultimately there will be a big opportunity for foreign trade, and the foundation for that trade will be laid at the present time in the face of unusual difficulties.

* * *

GOVERNMENT MACHINE TOOL SALES

In view of the criticism relating to the handling of the sales of government machine tools published last month in MACHINERY, it is of interest to note the following expressions of appreciation of the manner in which other offices have handled their sales, authority for publication of which has been given by the War Department through the office of the Director of Sales. In a letter by D. C. Selheimer, factory manager of the LaFayette Motors Co., Indianapolis, Ind., the statement is made that in addition to machines recently acquired, "all previous machines purchased from the Government have been received in good condition. We wish to take this opportunity to thank you for all past favors to us in the matter of securing machinery and to assure you that we fully appreciate your efforts." The machines referred to were secured from the Ordnance Salvage Board through the district office at Cleveland. The previous machine tools referred to consisted of 41 machines, the total value of the machines bought by the LaFayette Motors Co. being nearly $42,000.

W. G. Morse, factory manager for the Austin Mfg. Co., also speaks of the satisfactory service rendered by the Government in a letter to the office of the Director of Sales. He says: "I am pleased to advise that in all cases all of the machinery purchased was received here in first-class condition, properly packed and properly slushed, and I wish to thank you and the other men whom I met in connection with this proposition, for their interest and courtesy which they displayed in all of our dealings."

Special Types of Drilling Machines

By F. E. JOHNSON

A PREDETERMINED fixed rate of feed for a drill is a factor that will often assist in obtaining the maximum output of work and in reducing costs for broken drills. Piece-work operators are likely to force the drills in order to make as much money as possible if the feed and the tool are not automatically controlled. A fixed automatic quick-approach and feed combined with an automatic quick-return for the drill spindle or spindle head, after the hole has been completed, is a feature which, if applied to the operating principle of the machine, will greatly reduce the non-productive time per machine, particularly if the operator handles more than one machine or a single machine of the multiple-spindle type.

This operating principle as applied to a certain standard type of machine is illustrated in Fig. 1. The illustration shows only those particular features that are to be discussed here. The machine is of the semi-automatic horizontal multiple-spindle type, and is especially designed for drilling several pieces of work in which but one hole is required. Five duplicate holding jigs provided with the necessary means for guiding the drill are bolted to the seats *A* in alignment with the drill spindles. The feed for the spindles is obtained through the cams *B*, one cam being provided for each spindle. The tail end of each spindle is secured to a slide which is provided with a projecting lug carrying a roller that bears against the periphery of the cam. During the period that the drill is feeding into the work, the spring *C* (contained in the slide) is compressed through the action of the cam against plunger *D*. At the completion of the drilling operation, the high point on the periphery of the cam is in contact with the roller. As the cam continues to revolve this spring is released, resulting in the drill being quickly withdrawn from the work. The design of the cam is such as to allow the spindle to remain at rest long enough for the operator to unload and load the jig. The cams are so timed in relation to each other that they operate the spindle feeds in rotative order. The camshaft *E* is driven by a worm and worm-wheel, the details of which are not shown in the illustration. The rotation of the drill spindles is obtained by means of spiral gearing. The driving gear-shaft *F*, as well as the camshaft, is continuously in motion during the operation of the machine. The advantage obtained by the arrangement described is that the operator's time is entirely consumed in loading and unloading the jigs.

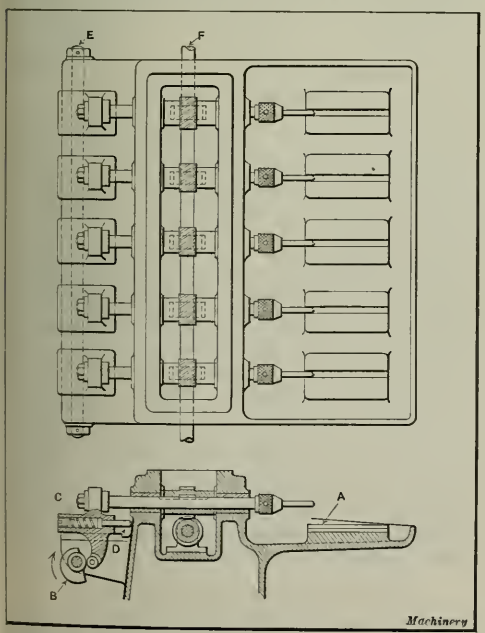


Fig. 1. Multiple-spindle Horizontal Drilling Machine with Cam-controlled Quick-return Feed

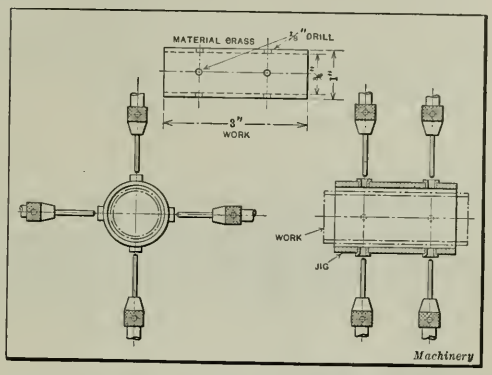


Fig. 2. Spindle Arrangement for Hand-feed Machine designed for simultaneously drilling Eight Holes in a Brass Sleeve

Hand-feed Drilling Machines for Production Work

For certain classes of work, a machine of the hand-feed type may be less expensive to design and build than one of the semi-automatic or automatic type and the results obtained may be wholly satisfactory. This fact can be best illustrated by referring to Fig. 2 in which are shown a brass sleeve with eight ⅛-inch holes drilled in it, and a special spindle arrangement by means of which the holes are drilled simultaneously. The feed required for the drill is 3/16 inch, which allows 1/16 inch for the drill point. The thickness of the bushing wall is ⅛ inch, and the time required to drill through the wall, at a spindle speed of 2600 revolutions per minute and a feed of 0.002 inch per revolution, is approximately 2¼ seconds.

A semi-automatic machine, or one equipped with an automatic feed in combination with a hand-operated jig, would not be of advantage for producing this class of work, because so little time is consumed in the actual performance of the operation. The time required to perform an operation, in conjunction with the quantity of work required, is a factor which must be given consideration in designing a machine. If a large output of sleeves is required, a full automatic machine equipped with a magazine feed and with provision for automatically clamping, drilling, and ejecting the work can be employed to advantage. One operator is able to handle a number of machines of this type, as his duties consist principally in keeping the magazines supplied. It is obvious that the full automatic drilling machine can generally be employed only for producing small light parts.

Advantages of the Semi-automatic Machine for Special Work

The time required for a semi-automatic machine to perform the work required of it will in many cases allow the

operator to handle conveniently more than one machine at a time. Fig. 3 illustrates a common type of special semi-automatic multiple-spindle machine of the horizontal type used on quantity production work for small- and medium-sized cast-iron and brass parts. The work to be drilled is shown at *B* in the upper right-hand corner of the illustration. The frame of the machine supports the camshaft upon which two cams *C* and *D* are mounted. The paths on these cams are designed to produce right- and left-hand traverse of the opposed spindle slides. The camshaft is driven by a worm and worm-wheel as shown. The jig for holding the work is attached centrally between the two spindle slides. The drill spindles are driven by the shaft *A* which carries two wide-faced gears for driving the spindles in each head.

The quick-return or back-throw function is accomplished by the 45-degree path shown in the cam development diagram. The sides *E* and *F* of the respective cams *C* and *D* force the roller studs attached to the slides quickly to the right or left, as the case may be, when the rotation of the cams brings the rollers in contact at points *a*. Cam angles greater than 45 degrees would not be practicable in this instance. The automatic quick-return could be accomplished in one second if the drill slides were operated against spring pressure. The weight of a body that is to be moved is a factor that must be considered when employing springs for functions that are similar to those required in the case under consideration.

In certain instances where this type of cam is used, it

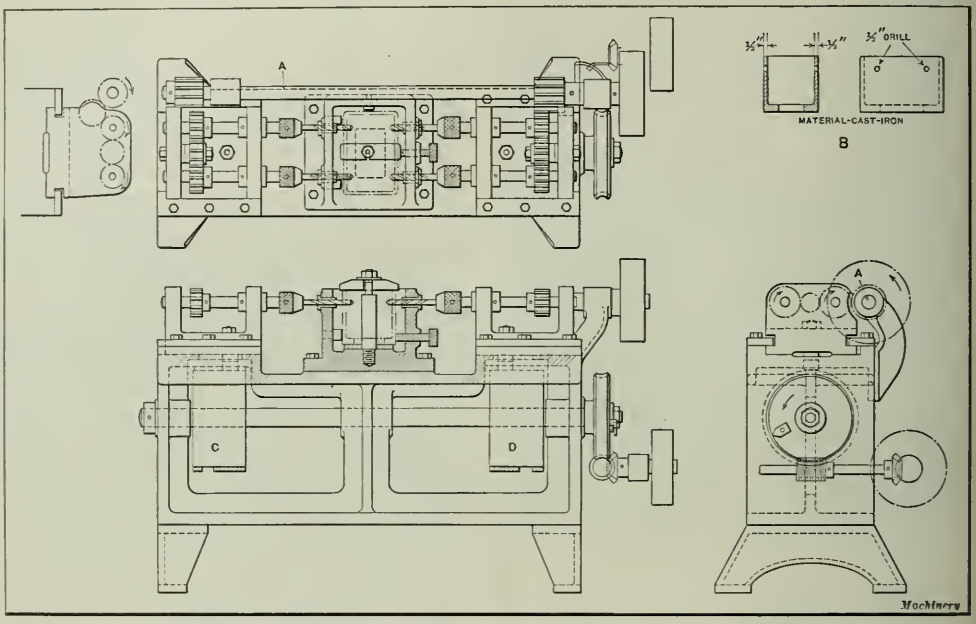


Fig. 3. Special Opposed-spindle Horizontal Drilling Machine, with Cam-operated Tool-slides and Centrally Located Holding Jig

The operator, after clamping the work in place, starts the feed for the drill slides either by throwing the worm into mesh with the worm-wheel or by some form of clutch mechanism. The time required for one revolution of the camshaft is the time consumed in performing the drilling operation and includes the quick-approach time and the time necessary to make the quick-return traverse after the work has been completed, if these features are necessary. With the completion of one cycle of the cams, a dog fixed to the worm-wheel comes into contact with some form of latch or tripping arrangement (provided, of course, that a drop-feed is employed) and drops the worm out of mesh with the worm-wheel. If a clutch is employed to rotate the worm-shaft, this dog will, of course, act upon the clutch instead of upon the tripping arrangement.

In this particular case, the drill-feed movement for the slides is $\frac{3}{4}$ inch; the drills run continuously within their guide bushings in the jig and operate at a speed of 500 revolutions per minute. The feed of the drills is 0.006 inch per revolution, and the time required for the drill-feed movement of the slides is about fifteen seconds. Approximately one second should be sufficient time for withdrawing the drills after the completion of the operation.

Reference to the cam diagrams, Fig. 4, shows that the actual feeding time allowed is $14\frac{3}{4}$ seconds and that $1\frac{1}{4}$ seconds is the quick-return allowance. This modification is the result of requirements developed in laying out the cams. will be found necessary to add a variable-speed or planetary gear arrangement to the camshaft drive in order to accomplish the quick-return of the slide in a reasonable length of time. The diameter of the cam-drum and the length of the back-throw movement are factors which may increase the time consumed in the back-throw movement, if a variable-speed arrangement is not employed. Where the operation of a machine is to an extent dependent upon cam control, it is always advisable to make a preliminary diagram by laying out a development of the cam surface. If this precaution is not adhered to, mistakes in first judgment may make extensive and costly changes necessary after the work has been in progress a considerable length of time. The use of cams offers a convenient method for imparting motions to slides and other such members of a machine. It is good practice to advance the drill slowly if it enters the work at an angle, and then to accelerate the feed after it has been well started. For deep-hole drilling, choking of the drill by chips may be prevented by withdrawing the drill at intervals. An advantage obtained by means of cam-operated machines is that the individual cam may be readily designed to accomplish these features of operation.

Types of Special Vertical Drilling Machines

Heavy-duty vertical-spindle drilling machines are designed, in principle, as shown at the left in Fig. 5. The proportions and general arrangement of the frame are designed to

resist the severe strains that result from driving large high-speed drills at their maximum capacity. The thrust exerted by the drill pressure upon the work-table is partly resisted by an adjusting screw of sufficient strength. A slight deflection of the table or frame is sufficient to create considerable friction upon the sides of the drill. In machining deep holes in tough materials, the result is that the drill sticks and binds so that excessive time and power are consumed in the performance of the operation. The feed for the drill spindle of the machine is obtained through a rack and pinion. The pinion is driven by a worm and worm-wheel and the rack is secured directly to the spindle, the pinion which operates it being small in diameter as compared with the size of the worm-wheel.

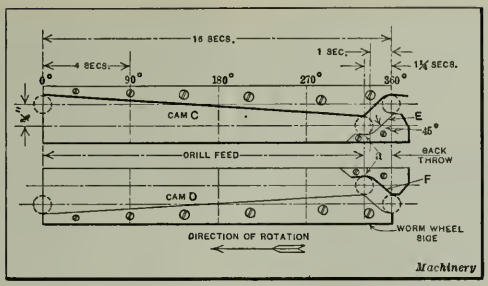


Fig. 4. Development Diagram for Cams used on the Machine shown in Fig. 3

The common arrangement for a cam-operated spindle head, where the drum type of cam is employed, is shown at the right in Fig. 5. The drill slide is operated by means of the cam *E*, which is mounted on the camshaft *C* and driven through worm *A* and worm-wheel *B*. The steel cam-straps *D* are bolted to the drum of the cam and are so formed as to produce the required traverse of slide *F*, through the medium of roller *G*. The various weak points in this design are the distance c of the drill spindle center from the base of the slide; the distance *d* that the worm-wheel is removed from the cam-drum; and the height of the roller stud and roller *G*, the combination of which offers only a single-point contact with the cam-straps.

The end thrust exerted in feeding a drill spindle contained in a slide has a tendency to lift the slide from the gibs. If distance c is excessive and if the end thrust from the drill feed is severe, great pressure is exerted on the gibs and face of the slide in an upward direction along line *X-X*. The result is that wear occurs rapidly and excessive power is consumed through friction of the parts. Severe end thrust from drills, if indirectly transmitted to the straps of a cam-drum, results in setting up torsional strains in the camshaft, provided the worm-wheel is considerably removed from the drum. The result is that smoothness of motion for the cam cannot be obtained. Unevenness of motion in the camshaft is magnified in the drum, increasing directly as the difference in the diameters of the drum and shaft increase. In cases where the load imposed upon a cam is considerable, it is good practice to attach the worm-wheel directly to the drum as shown in the partial sectional view at *H*. The forces applied are then, practically speaking, transmitted directly to the periphery of the cam. This drill-feed arrangement is suitable only for light and medium drilling operations, while the construction shown at the left in this illustration is more especially adapted for heavy drill-feeding pressures.

* * *

ACCIDENT PREVENTION IN STEEL INDUSTRY

The November number of the *Labor Review* of the United States Bureau of Labor Statistics states that, in spite of the war-time conditions and the high pressure under which the industries then worked, the iron and steel industry of the United States, considered as a unit, showed proportionately fewer accidents during the years 1915-1918 than were recorded for the period 1910-1914. This statement is true both as regards the frequency and the severity of the accidents. In other words, the exceedingly unfavorable conditions of the war period were not sufficient to overcome the results of the improved conditions in the industry resulting from the safety movement. Nevertheless, it has been pointed out that many of the accidents during the latter period were of the preventable kind, and that continued vigilance will still further reduce accidents is without question.

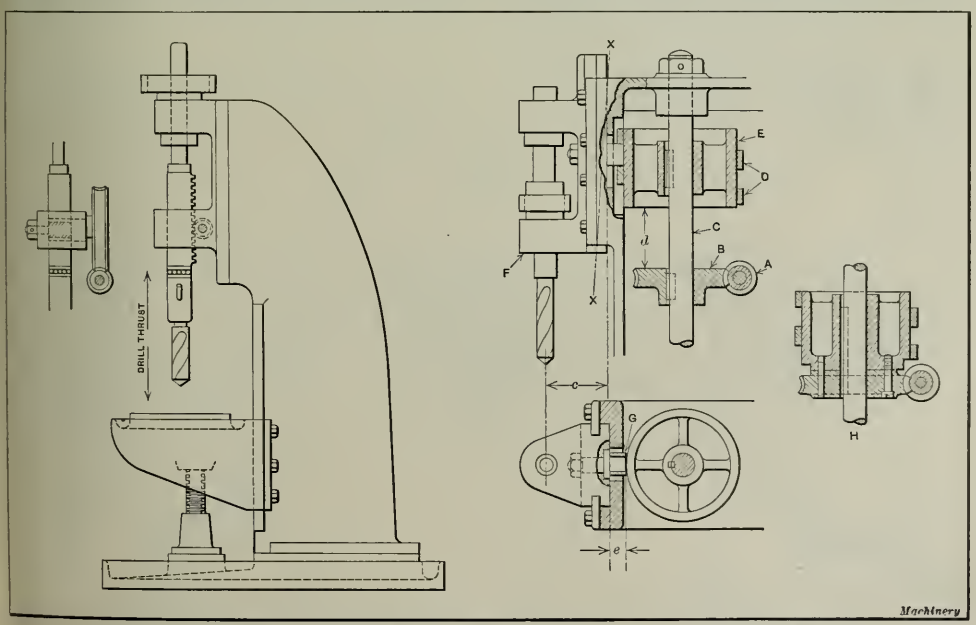


Fig. 5. Heavy-dnty Vertical Type Drilling Machine, and Cam Attachment for Light and Medium Drilling Machines

Turret Lathe Practice



Typical Examples of Work Done on the Turret Lathe—Based upon the Practice of the Warner & Swasey Co., Cleveland, Ohio

THE present article showing examples of work machined on the Warner & Swasey turret lathes deals with chucking work on castings and forgings as well as with bar work. In each example, a lay-out of the tooling equipment is shown as well as halftone illustrations showing the machines set up for, or performing, the operations required. A detailed description of the various steps in each operation or chucking is also included. The actual time required for finishing the parts to be made from castings or forgings, including the time necessary to clamp or chuck the work and to remove it from the machine after the operations have been completed, is given, this being designated as "floor-to-floor" time. The time given for producing parts made from bar stock includes the time required for feeding the stock and for cutting off the finished part. The type of machine employed in each case, is given with each description of the operation. It will be noted that in the details of the castings dealt with, the surfaces finished by the operations described are indicated by heavy lines, so as to make them readily distinguishable. The letters on the detail drawing of each piece of work refer to the same surfaces as similar letters on the illustration showing the tool lay-out for that piece.

Tool Lay-out for Machining Piston Valve Followers

Fig. 1 shows a cast-iron piston valve follower which is finished in one chucking on a No. 3-A universal hollow hexagon turret lathe. A lay-out of the tools used in performing this operation is shown in Fig. 2. The operation consists of finishing surfaces *A*, *B*, *C*, *D*, *E*, and *F*, the sequence of the various steps in the operation being as follows: (1) The work is mounted on a three-jaw chuck equipped with special jaws that expand and hold the work in place by

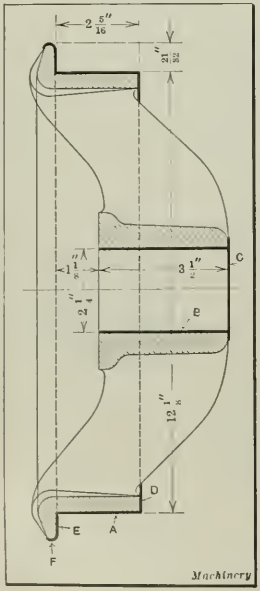


Fig. 1. Piston Valve Follower

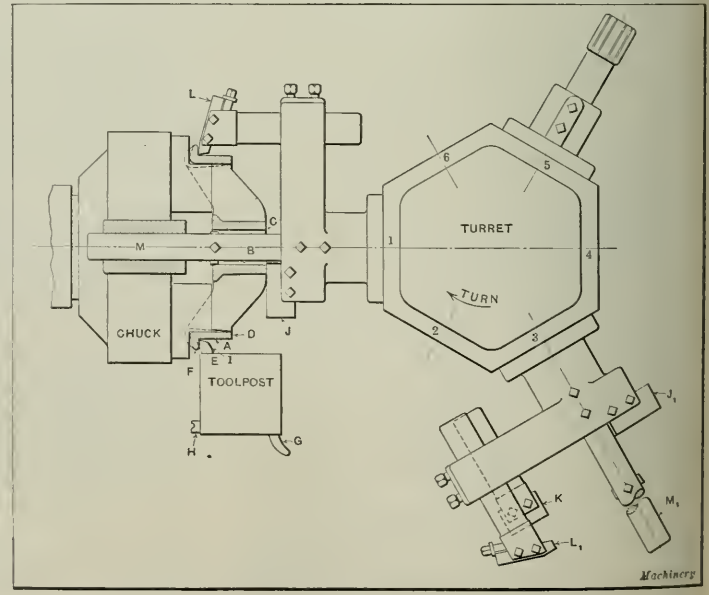


Fig. 2. Lay-out of Tools used in finishing Piston Valve Follower shown in Fig. 1

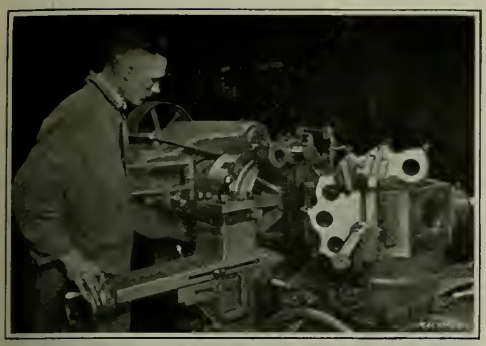


Fig. 3. Machine engaged in taking the Roughing Cuts on the Piston Valve Follower

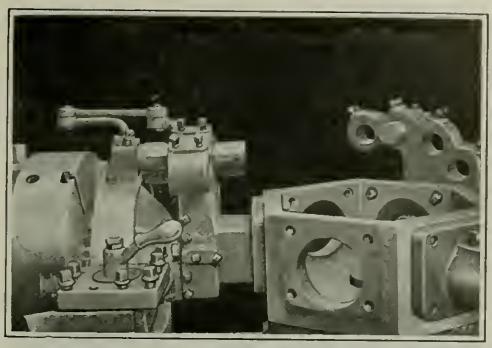


Fig. 4. Close View of Machine shown in Fig. 3, engaged in taking Finishing Cuts

exerting pressure on the inside of the rim. (2) Rim *A* is rough-turned by cutter *L*, which is held in an angle cutter-holder; hole *B* is rough-bored by the cutter held in boring-bar *M*; and hub *C* is rough-faced by cutter *J*, all of these tools being mounted on the turning and facing head which is held in Face 1 of the turret. At the same time, surfaces *D* and *E* are rough-faced by cutter *G*, and surface *F* is formed by cutter *H*, these cutters being held in the toolpost, which is generally known as the "square turret." (3) Rim *A* is finish-turned by cutter L_1 which is held in an angle cutter-holder; hole *B* is finish-bored by the cutter held in boring-bar M_1; surface *D* is finish-faced by cutter *K*; and hub *C* is finish-faced by cutter J_1; all of these cutters are mounted on the turning and facing head held in Face 3 of the turret. (4) Surface *E* is finish-faced by cutter *I* which is mounted in the square turret. (5) Hole *B* is reamed by the reamer mounted in Face 5 of the turret. The total time required for producing one piece of work is 8 minutes when the cutters are made of high-speed steel, and 4½ minutes when they are made of stellite. It will be noted that before the tools on the turning and facing heads commence taking cuts on the work, the pilot on the boring-bar of the head being used, enters into a guiding bushing as shown. Fig. 3 shows a machine engaged in performing the second step in the series, while Fig. 4 shows a machine engaged in performing the third step.

Valve Body Tooling Equipment

Four distinct operations are required to machine the valve body illustrated in Fig. 5, No. 3-A universal hollow hexagon turret lathes being used in each case. This piece of work is made of cast iron. The tool lay-out for the first chucking is shown in Fig. 6, while Fig. 7 shows a machine provided with the equipment for performing this operation. The order of the first operation, step by step, is as follows: (1) The work is first placed on the pilot bar mounted in Face 1 of the turret, Fig. 6, which is then indexed to the position shown in the illustration, after which the work is secured in fixture *W*. The purpose of the pilot bar is to enable the work to be readily placed in the fixture. (2) Holes *B*, *C*, and *D* are rough-bored by cutters mounted on boring-bar *E* which is held in the turning and facing head mounted in Face 2 of the turret, and surface *A* is rough-turned by tool *F* which is also held in this head. At the same time, flange *G* is rough-faced by cutter *H* which is mounted in the square turret. (3) The finish-boring operations on surfaces *B*, *C*, and *D* are performed by cutters mounted on boring-bar E_1; and the finish-turning of surface *A* is done by cutter F_1, this boring-bar and turning tool being held in the turning and facing head in Face 3 of the turret; at the same time, the finishing cut is taken on face *G* by means of cutter *J* in the square turret. (4) Surfaces *K* and *M* are rough-faced and *L* and *N* are rough-formed by a special "disappearing" tool mounted in Face 4 of the turret. (5) Surfaces *L* and *N* are finish-formed by another special disappearing tool mounted in Face 5 of the turret, this operation completing the work done in the first chucking.

A lay-out of the tooling equipment used in performing the second chucking on the valve body is illustrated in Fig. 9, while a machine provided with this equipment is shown in

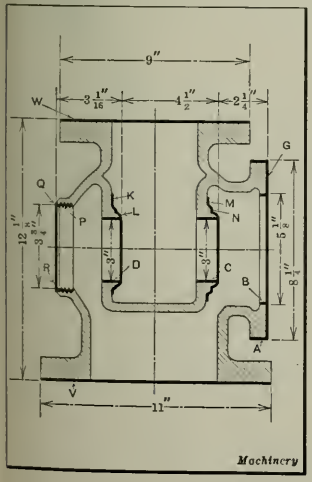


Fig. 5. Drawing of Valve Body

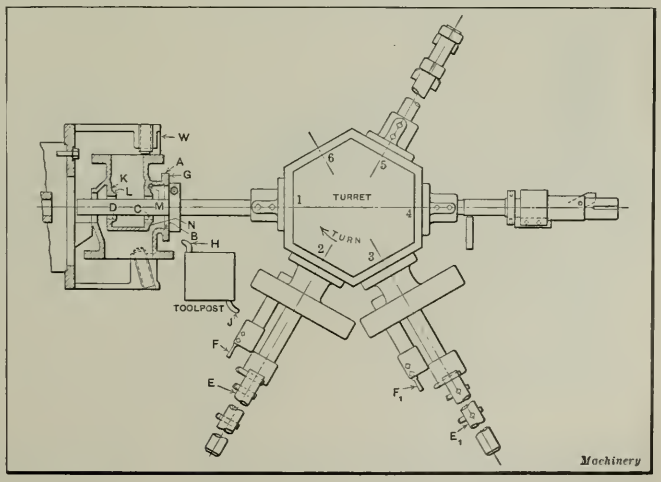


Fig. 6. Tooling Lay-out for First Chucking on Valve Body

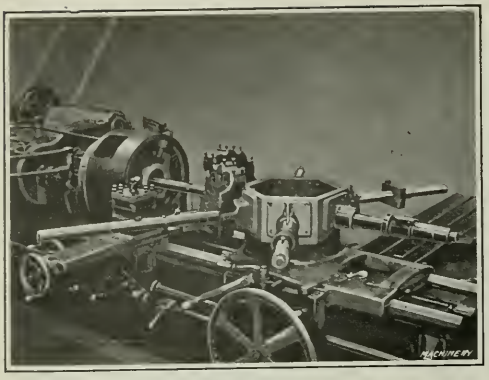


Fig. 7. Machine Set-up for performing the First Operation on the Valve Body

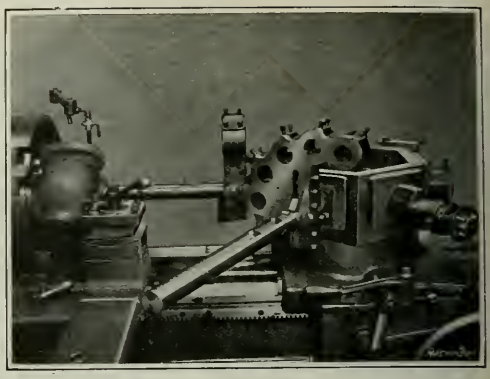


Fig. 8. Set-up of Machine for performing the Second Operation on the Valve Body

Fig. 8. The various steps of the operation are taken in the following order: (1) The work is mounted on the pilot bar in Face 1 of the turret, Fig. 9; then the turret is indexed to the position shown in the illustration, so that the work can be readily secured in fixture *O*. (2) Hole *P*, Fig. 5, is rough-bored by the cutter mounted in boring-bar *S*, and surface *Q* is rough-faced by cutter *T*, these tools being held in the turning and facing head mounted in Face 2 of the turret. (3) Hole *P* is finish-bored by the cutter mounted in boring-bar S_1; surface *Q* is finished-faced by cutter T_1; and bevel *R* is turned by cutter *U*, all of these tools being held in the turning and facing head in Face 3 of the turret. (4) Hole *P* is tapped by the tap mounted in Face 4 of the turret. In the third and fourth chuckings of the valve body, the roughing and finishing cuts are taken successively on flanges *V* and *W*, Fig. 5, by cutters held in the square turret, the work being held in a chuck having special jaws. There are no illustrations given of the tooling equipment used in performing these operations. The total time required to complete the four operations on one piece of work is 27 minutes.

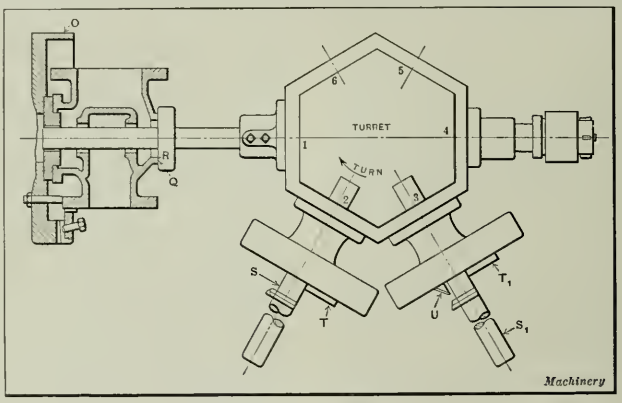


Fig. 9. Tooling Equipment used for Second Chucking on the Valve Body

Equipment Used in Finishing Spur Gears

Cast-iron spur gears of the type shown in Fig. 10 are finished on a No. 2-A universal hollow hexagon turret lathe by means of the tooling equipment illustrated in Fig. 11. The successive steps of this operation are

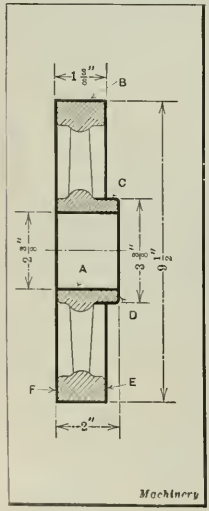


Fig. 10. Detail of Spur Gear

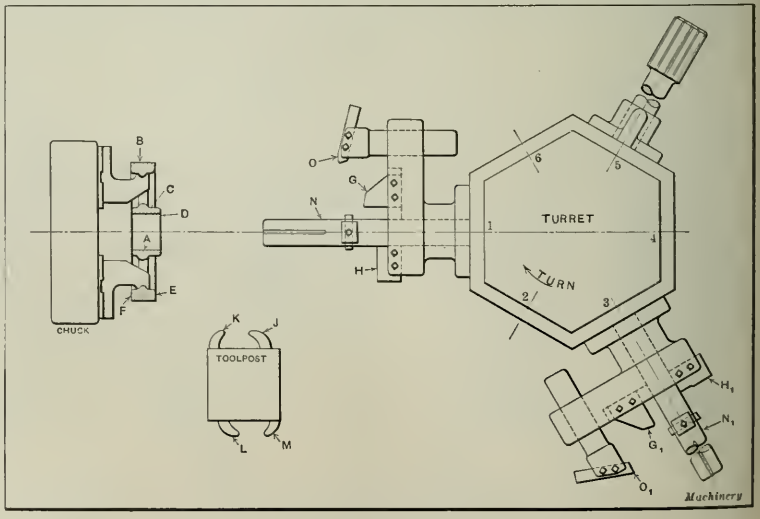


Fig. 11. Tool Lay-out for finishing Spur Gear shown in Fig. 10

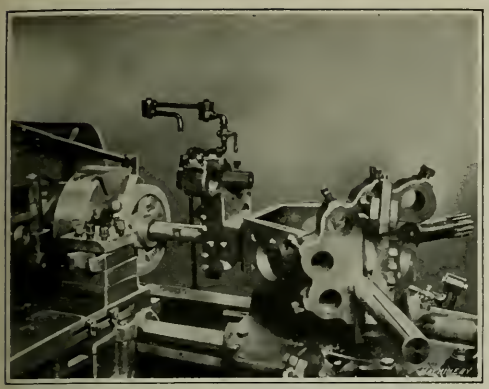


Fig. 12. Machine engaged in taking the Finishing Cuts on the Gear Faces

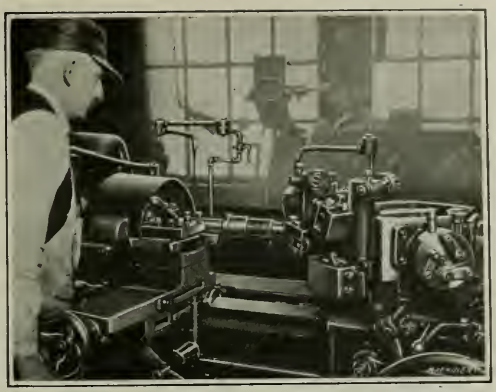


Fig. 13. Illustration showing Machine engaged in turning a Part from Bar Stock

taken in the following order: (1) The gear is held in a chuck equipped with special jaws which, when expanded, grip the gear on the inside of the rim. (2) Hole *A* is rough-bored by the cutter held in boring-bar *N;* rim *B* is rough-turned by cutter *O* held in an angle cutter-holder; surface *C* is rough-turned by cutter *G;* and hub *D* is faced by cutter *H*, all of these tools being mounted on the turning and facing head mounted in Face 1 of the turret. At the same time roughing cuts are taken on faces *E* and *F* by cutters *J* and *K*, which are held in the square turret. A machine engaged in taking the cuts of this step is shown in Fig. 12. (3) Hole *A* is finish-bored by the cutter held in boring-bar N_1; surface *B* is finish-turned by cutter O_1; surface *C* is finish-turned by cutter G_1; and hub *D* is finish-faced by cutter H_1, all of these tools being mounted on the turning and facing head in Face 3 of the turret. At the same time finish cuts are taken on faces *E* and *F* by cutters *L* and *M* which are mounted in the square turret. (4) Hole *A* is reamed by the reamer mounted in Face 5 of the turret. The total time required for finishing this gear is 6 minutes.

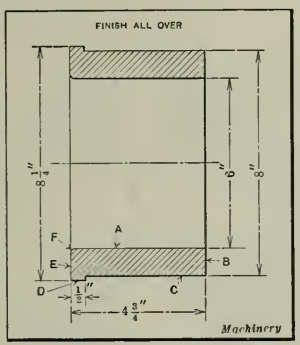


Fig. 14. Drawing of Forged Steel Bushing

Machining Forged Steel Bushings

The forged steel bushing illustrated in Fig. 14 requires two chuckings to finish it all over, a No. 2-A universal hollow hexagon turret lathe being used for this purpose. Both chuckings are performed in 15 minutes. The tooling equipment used in the first chucking is shown in Fig. 15. The various steps of this operation are taken in the following procedure: (1) The work is placed and secured in the chuck. (2) Hole *A* is rough-bored by the cutter held in boring-bar *G*. The pilot of the boring-bar enters into bushing *H*, thus serving to properly locate the cutter for taking this cut. At the same time, surface *B* is rough-faced by cutter *I*, and surface *C* is rough-turned by cutter *J*. Boring-bar *G* and cutters *I* and *J* are held in the turning and facing head mounted in Face 1 of the turret. (3) Hole *A* is finish-bored by the cutter held in boring-bar G_1, the pilot of which also extends into bushing *H* while this step of the operation is being performed; surface *B* is finish-faced by cutter I_1; and surface *C* is finish-turned by cutter J_1. These tools are held in the turning and facing head held in Face 2 of the turret.

A lay-out of the tooling equipment employed in the second chucking on the bushing is shown in Fig. 16. The successive steps in this operation are as follows: (1) The work is placed and secured in the chuck, which is provided with jaws that grip the work on the previously finished surface *C*. (2) Surface *D* is rough- and finish-turned by cutters *K* and *L*, and surface *E* is rough-faced by cutter *M*, these cut-

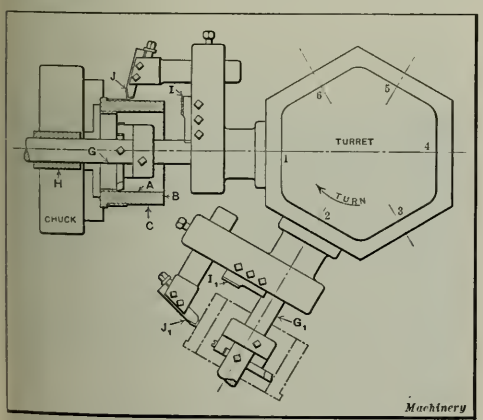


Fig. 15. Lay-out of Tools used in performing First Operation on Bushing

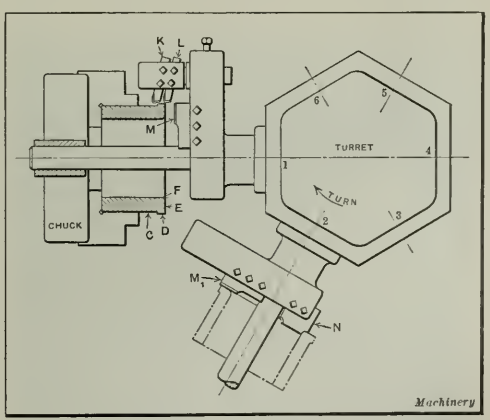


Fig. 16. Tooling Lay-out for Second Operation on Forged Steel Bushing

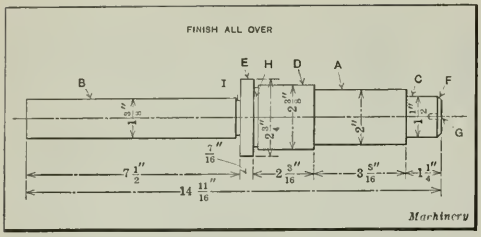


Fig. 17. Dimensioned Drawing of Stud machined from Bar Stock

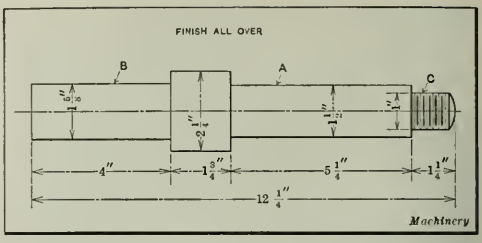


Fig. 18. Detail of Part turned from a 2¼-inch Steel Bar

ters being held in the turning and facing head mounted in Face 1 of the turret. (3) Surface *E* is finish-faced by cutter M_1 and the rounded corner *F* is turned by cutter *N*, these tools being held in the turning and facing head in Face 2 of the turret. The work is also indicated on this head by dot-and-dash lines.

Tooling Equipments Employed in Turning Various Pieces of Work from Bar Stock

The remaining examples of turret lathe practice to be presented in this article consist of parts turned from bar

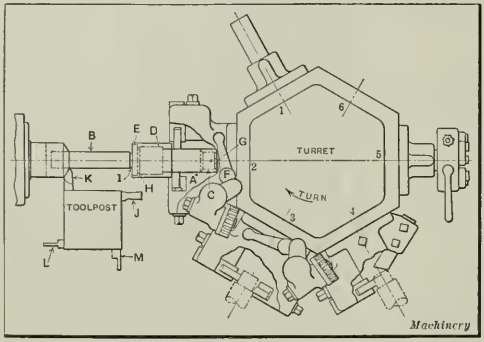


Fig. 19. Tooling Equipment used in producing Work illustrated in Fig. 17

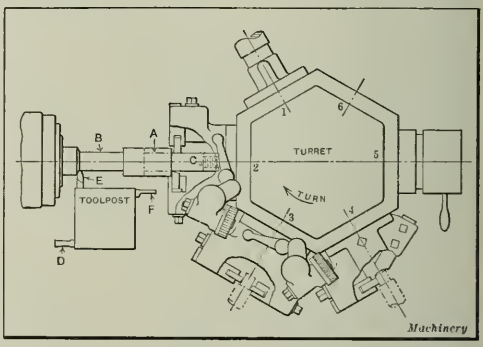


Fig. 20. Lay-out of Tools used to manufacture Work shown in Fig. 18

stock, and in each case a No. 2-A universal hollow hexagon turret lathe is used to perform the operation. In the lay-out of the tooling equipment for each operation, the work is shown partly completed, while the finished piece is indicated by dot-and-dash lines. A machine engaged in producing a stud from a steel bar 2⅞ inches in diameter is shown in Fig. 13, which clearly illustrates the equipment used for manufacturing this piece. A detail of the work is shown in Fig. 17, while a lay-out of the tooling equipment used is shown in Fig. 19. The successive steps in the operation are as follows: (1) The stock is fed up to the stop mounted in Face 1 of the turret. (2) Surface *A* is turned by the cutter held in the universal turner which is mounted in Face 2 of the turret, and at the same time, the work is cut into at the left end of surface *E* with cutter *J*, which is held in the square turret, preparatory to turning surface *B*. The square turret is then indexed and surface *B* is turned by cutter *K*, one half of the surface being turned during this step, while the remainder is turned during the next or third step of the series. (3) Surface *C* is turned by the cutter held in the universal turner which is mounted in Face 3 of the turret, while surface *B* is completed by cutter *K*, as previously mentioned. (4) Chamfer *F* is cut by the pointing tool held in Face 4 of the turret. (5) Center *G* is drilled by the centering tool mounted in Face 5 of the turret. (6) Surfaces *D* and *E* are turned by cutter *K*, and grooves *H* and *I* are cut by cutter *L* which is held in the square turret. (7) The work is finally cut from the stock by cutter *M* which is also mounted in the square turret. The total time required for producing this part is 14 minutes.

In Fig. 18, is shown a piece of work made from a cold-rolled steel bar, 2¼ inches in diameter. Seven minutes is the time required for producing this part. The tooling equip-

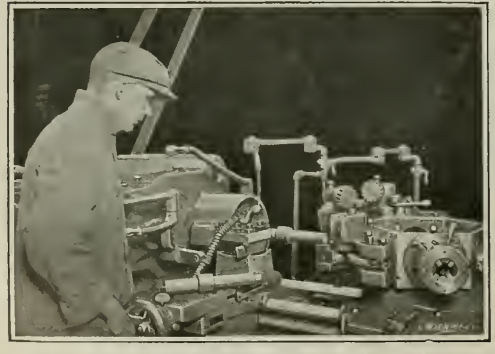


Fig. 21. Turret Lathe machining Work illustrated in Fig. 18

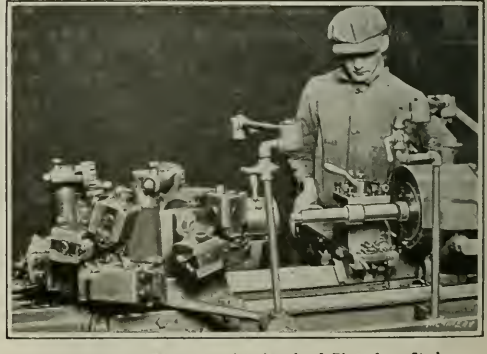


Fig. 22. Same Machine cutting Completed Piece from Stock

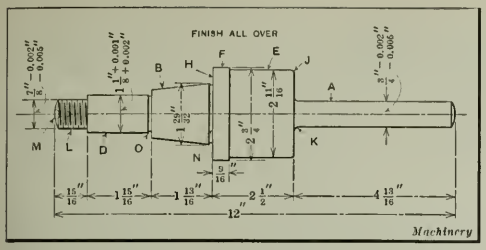


Fig. 23. Drawing of Work which is machined by Tooling Equipment shown in Fig. 25

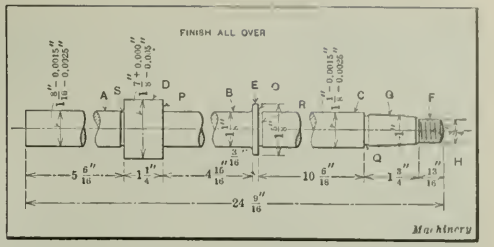


Fig. 24. Pinion-shaft which is manufactured by Means of the Equipment shown in Fig. 26

ment used in this operation is illustrated in Fig. 20. The various cuts are taken in the following order: (1) The stock is fed to the stop held in Face 1 of the turret. (2) Surface *A* is turned by the cutter held in the universal turner mounted in Face 2 of the turret; then cutter *D*, which is mounted in the square turret, is fed into the work preparatory to turning surface *B*, after which this surface is turned by cutter *E* which is also mounted in the square

The piece of work which is detailed in Fig. 23 is turned from a steel bar 2⅞ inches in diameter. Fig. 25 shows the lay-out of the tooling equipment used in producing this piece of work. The various steps in the operation are performed in the following manner: (1) The stock is fed up to stop *T* which is mounted in the corner of the turret adjacent to Faces 1 and 6. (2) The stock is cut into by cutter *P*, which is mounted in the square turret preparatory to turning sur-

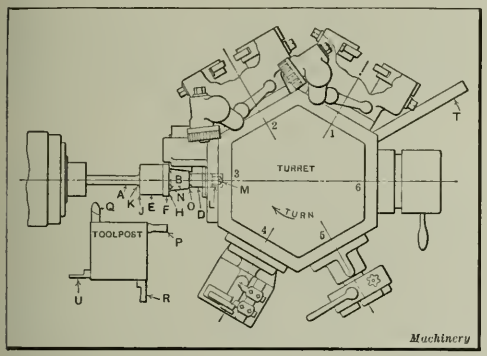


Fig. 25. Tooling Lay-out for machining Part shown in Fig. 23

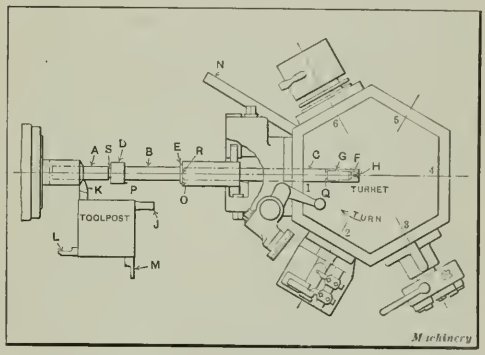


Fig. 26. Equipment for producing Pinion-shaft shown in Fig. 24

turret. (3) End *C* is turned by the cutter held in the universal turner in Face 3 of the turret. The machine shown in Fig. 21 is engaged in performing this step of the operation. (4) End *C* is rounded by the pointing tool in Face 4 of the turret. (5) End *C* is threaded by the die-head held in Face 5 of the turret. (6) The work is finally cut off by cutter *F*, which is mounted in the square turret. Fig. 22 shows a view of the machine at the end of the operation, when the completed work is being cut from the stock.

face *A*; the right end of the work up to face *H* is turned to the largest diameter of surface *B* by the cutter mounted in the universal turner held in Face 1 of the turret; and surface *A* is turned at the same time by cutter *Q* which is held in the square turret. (3) The right end of the work up to the right end of surface *B* is turned to the diameter of surface *D* by the cutter held in the universal turner mounted in Face 2 of the turret, while surfaces *E* and *F* are turned by cutter *Q*. (4) Surface *B* is taper-turned by the

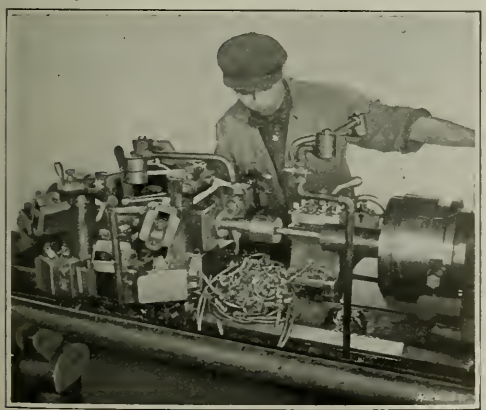


Fig. 27. Machine taking Finishing Cut on Slender Portion of Work shown in Fig. 23

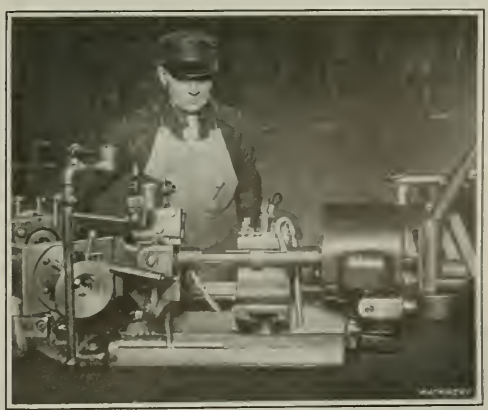


Fig. 28. Rear View of Lathe machining Pinion-shaft illustrated in Fig. 24

taper tool mounted in Face 3 of the turret, the work being supported while this cut is being taken, by extending into a bushing in this tool. (5) Surface *H* is faced; corner *J* rounded; and fillet *K* and surface *A* finish-turned, all of these cuts being taken by cutter *Q*. Fig. 27 gives a close-up view of a machine engaged in taking the finishing cut on surface *A*, the end of the work still being supported in the bushing in the taper tool in Face 3 of the turret. (6) End *L* is turned by the multiple cutter turner mounted in Face 4 of the turret, which also rounds the tip of this end. (7) Center *M* is drilled by the centering tool held in Face 5 of the turret, while grooves *N* and *O* are cut at the same time by cutter *U* which is mounted in the square turret. (8) The threads are cut on end *L* by the die-head mounted in Face 6 of the turret. (9) Finally, the work is cut off by cutter *R* which is mounted in the square turret. The time required to produce this piece of work is 18 minutes.

Fig. 24 shows the detail of a pinion-shaft which is turned from a 2-inch diameter steel bar in 25 minutes, the machine employed for this operation being equipped with the tooling arrangement illustrated in Fig. 26. The various steps in the operation are performed in the following sequence: (1) The stock is fed to stop *N* which is mounted in the corner of the turret adjacent to Faces 1 and 6. (2) Surfaces *A* and *B* are cut into by cutter *J*, which is held in the square turret, preparatory to turning these surfaces; the right end of the work up to face *O* is turned to the diameter of surface *C* by the cutter held in the universal turner mounted in Face 1 of the turret; and surfaces *E*, *B*, *D*, and *A* are turned at the same time by cutter *K*, which is also held in the square turret. (3) End *F* is turned and its tip formed by the multiple cutter turner held in Face 2 of the turret. (4) Center *H* is drilled by the centering tool mounted in Face 3 of the turret. (5) Surfaces *O* and *P* are faced by cutter *J*. (6) A groove is cut into the work at the right end of surface *C* by cutter *J* preparatory to turning surface *G*. (7) Surface *G* is taper-turned by means of a taper attachment mounted on a base attached to the front of the carriage, beneath the cross-slide. (8) Grooves *Q*, *R*, and *S* are cut by cutter *M*, which is held in the square turret. (9) End *F* is threaded by the die-head mounted in Face 6 of the turret. (10) Finally, the work is cut from the bar stock by cutter *L* which is held in the square turret. Fig. 28 shows the rear view of a machine provided with the tooling equipment for producing this piece of work.

* * *

BONUS DISTRIBUTION BASED ON LENGTH OF SERVICE

The Fellows Gear Shaper Co., Springfield, Vt., announces that following a custom inaugurated in 1916 the company has distributed an annual cash bonus to its employes. Approximately 665 men received this bonus which amounted to a total of $25,000. The bonus is governed by the length of continuous employment and is based upon the total wages earned during the past year. For the first and second years it is 2 per cent of the total wages earned and increases by 1 per cent each succeeding year up to 10 per cent. The bonus distribution this year was of special interest to those who were in the government service during the war. To all those who returned to the employ of the company the bonus was calculated from the time of their original employment, so that when they returned, they were not considered new employes, and the time spent in the service of their country was not deducted.

The custom inaugurated by the Fellows Gear Shaper Co. is one that has proved to be very valuable in creating a feeling of cooperation between employers and employes, and it is believed that in carrying out this system to its fullest extent, granting the men that have remained in continuous service of the company for a period of years a higher bonus than those who have only been with the company a short time, an incentive is created for the men to remain with the company, and not to change their employment from time to time.

ELECTRICALLY HEATED PATTERN PLATES ON MOLDING MACHINES

By JOHN M. STRAIT
Westinghouse Electric & Mfg. Co., East Pittsburg, Pa.

The production of clean, smooth castings from molds made with metal patterns depends upon the molding sand not sticking to the patterns when they are removed from the sand. There is a tendency for moisture to collect on the cold metal pattern from the moist sand, or for the cold plate to "sweat." When this moisture collects, the sand sticks to the pattern being removed from the mold, and the mold acquires a rough surface, so that when the metal is poured, the casting will be rough. The pattern will have a rough surface due to the adhering sand, so that the next mold will also be rough unless the pattern is cleaned off and dried. This trouble is experienced in both summer and winter. The collection of moisture can be prevented by heating the pattern. The heat applied, however, must not be so great as to cause the sand in the mold to dry, as it would then crumble away and again the casting would have a rough surface. Furthermore, the heat must be applied in such a way that the pattern can be conveniently changed when desired. The usual method of heating is by means of a gas flame left burning in the space underneath the pattern within the framework of the molding machine. It is difficult to keep the flame low enough so that it will not heat the pattern too much, and a larger flame than necessary is therefore employed at some distance from the surface of application. This makes an inefficient arrangement, as most of the heat is dissipated into the surrounding space. The surrounding air becomes contaminated by the gas fumes, and in summer, there is further discomfort due to the heating of the surrounding air. Difficulty is also experienced from variation of gas pressure, so that at one time the pattern is too hot and at another too cold. When the pattern gets too hot, it is necessary to cut off the gas, and when it has cooled down, the gas must be relit and readjusted.

A much more convenient method of heating is by the use of electric heaters. Two steel-clad heaters are mounted in the space immediately below the metal pattern plate, within the framework of the molding machine. In order to use as little heat as possible, they are located just below the thickest pattern used. They are attached to supporting angles fastened to the frame of the machine. It is obvious that any pattern of any thickness and of any size within the capacity of the machine may be attached to or removed from the molding machine without disturbing the heaters. An asbestos insulating plate is placed just below the heaters, to prevent loss of heat due to radiation downward from the heaters. The entire installation is made in such a way as not to interfere with the usual operation of the machine, and without any modification of the machine other than to drill and tap small holes for attaching the mounting angles.

The advantages of electric heaters over gas flames are obvious. When it is desired to heat the pattern plate, it is not necessary to hunt for a match, and to operate or adjust valves until the correct degree of heat is obtained. Instead, it is only necessary to plug into a wall receptacle and give no further thought to the matter, since but one degree of heat, and that the correct one can be obtained. If for any reason, such as the machine standing idle, the pattern plate should be overheated, it is not necessary to operate any valves, such as shutting off the gas, until the temperature becomes right and then relight and readjust the valves. Instead, it is only necessary to pull the plug from the wall receptacle and leave the heater disconnected until the temperature becomes right, and then plug it in again. Furthermore, there is no trouble from variation of gas pressure.

* * *

Workmen's compensation laws are now in force in forty-two of the states and territories, the only six states not having such laws being Arkansas, Florida, Georgia, Mississippi, North Carolina, and South Carolina.

Practice in Making Component Drawings



By EARLE BUCKINGHAM
Engineer, Pratt & Whitney Co., Hartford, Conn.

Second of Two Articles on the Application of the Principles of Dimensioning Drawings and Indicating Tolerances

IN this article, which is the concluding one on component drawings, additional details of the firing mechanism illustrated in the January number are referred to, this mechanism having been selected as a practical example for illustrating the general principles which govern methods of dimensioning drawings.

Drawing of Primer Extractor

The outside diameter of the primer extractor (see Fig. 8) which is 1.102 inches, plus 0.000, minus 0.006, should approximately match the corresponding diameter on the container shown in Fig. 7 in the January number. The surface should be reasonably smooth. The diameter of the recess for the firing pin guide (0.791 inch, plus 0.01, minus 0.00) is clearance and is unimportant. The depth (0.264 inch, plus 0.005, minus 0.000) is more important, as it controls the amount of surface which engages the head of the primer. A finish cut will be required on this surface.

The width of the extractor slot (0.472 inch, plus 0.004, minus 0.000) is an important dimension and the surface must be smooth. A finish cut will be required. The bevel at the end of this slot is at an angle of 30 degrees and is located from the center of the extractor at a distance of 0.236 inch, plus 0.01, minus 0.01. The exact dimensions of the bevel are unimportant, as it is provided merely to facilitate assembling the primer. The surfaces must be smooth, however, even if an extra filing operation is needed to match the cuts.

The distance across the flats (0.945 inch, plus 0.00, minus 0.01) is for the wrench used in assembling and is unimportant. No finish cuts are required. The length of the extractor is 0.394 inch, plus 0.00, minus 0.01. The front face must clear the rear face of the spindle plug when the primer is seated; therefore, no plus variation is permissible. Any great minus variation will weaken the extractor. The tolerance given should be liberal enough for all normal manufacturing purposes. Both the front and rear surfaces should be reasonably smooth. This will require finishing cuts.

The depth of the tapped hole is 0.209 inch, plus 0.00, minus 0.01, and the width of the thread under-cut, 0.06 inch, plus 0.005, minus 0.000. Enough threads must be secured to hold the extractor firmly in position, yet the depth must be shallow enough to permit the extractor to seat on the front face of the container. It is permissible to make the depth of the thread under-cut not over 0.005 inch below the bottom of the threads to provide clearance for the tap. A greater diameter of under-cut than 1.042 inch (maximum outside diameter of thread or 1.032 inch plus 0.01 in diameter allowed for tap clearance) would weaken the extractor to such an extent that it would not be safe to use it in service.

The location of the bottom of the primer slot from the rear face is 0.248 inch, plus 0.000, minus 0.005. This surface should never come below the corner on the firing pin guide, for if it did, it would be difficult to insert the primer. The surface should be smooth and all corners about this slot must be carefully broken.

Method of Dimensioning to Prevent Compound Tolerances

The countersink which merges into the beveled surface on the under side of the primer head is located from a theoretical point, where its angle of 35 degrees intersects the center line of the extractor. The distance from this intersecting point to the front face is 0.306 inch, plus 0.005, minus 0.000. Such a method of dimensioning is necessary to prevent compound tolerances. It will be noted that no dimensions are given for the intersections of this angle with the primer slot or bottom of the recess. Such dimensions are unnecessary and could not be measured directly in any event. The dimensions given locate this surface definitely and completely. It will be necessary for the manufacturer to compute the diameters on this countersink to suit his own particular needs. This surface must be smooth and will require a careful finishing operation.

No tolerances are given on any of the angles or radii because none are needed. Sufficient variation on these surfaces is permitted by the tolerances given on other dimensions.

Drawing of Locking Latch, Spring, and Pin

The surfaces of the locking latch (Fig. 9) must be smooth, as they bear on the sides of the slot in the container. This part has a tolerance of minus 0.01 inch on the entire contour. This means that the piece may vary 0.01 inch normal to the profile at any point in the direction that will make the piece smaller, or, in other words, any variation from the normal dimensions must remove more metal. The diameter of the pin hole (0.092 inch, plus 0.004, minus 0.000) corresponds with the pin hole in the container. The diameter of the spring hole (0.175 inch, plus 0.01, minus 0.00) also corresponds with the spring hole in the container.

The locking latch spring (Fig. 9) is a part of minor importance. It is made of No. 10 music wire, and no tolerance is specified for its diameter. This means that commercial music wire bought in the open market will be satisfactory. No difficulty should be experienced in maintaining the limits given.

The thread of the locking latch pin is a No. 5-44 U. S. form. This is a standard A. S. M. E. thread, and dies should be available in stock at any reliable die manufacturer's. After this pin is assembled into the container, the end thread of the tapped hole in the container should be upset slightly with a punch to prevent this pin from falling out. It should be understood that it is permissible to bevel at both ends of the thread to facilitate the threading. The surface of the

stem forms a bearing for the latch and should receive a finish cut. This part should be completed in a single operation on a screw machine.

Drawing of the Housing

The outside diameter of the housing (Fig. 10) is 2.638 inches, plus 0.00, minus 0.01. This is an atmospheric fit and requires no finishing cut, which also applies to the shoulder, the diameter of which is 1.925 inches, plus 0.00, minus 0.01. The Whitworth thread, the full diameter of which is 2.100 inches, plus 0.012, minus 0.000, must assemble on the hinged collar (Fig. 11). The Whitworth form of thread is used to suit other types of firing mechanisms now in service; otherwise the U. S. form of thread would be preferable.

The counterbore in the front end (diameter 1.502 inches, plus 0.02, minus 0.00) must clear the spindle plug. No finishing cut is required. The counterbore in the rear end of the same size must clear the flange on the container. The minimum clearance is 0.007 inch and the maximum clearance, 0.047 inch. No finish cut is required. The full diameter of the container thread is 1.425 inches, plus 0.006, minus 0.000. A sector of this thread is removed to permit the assembly of the container. All of these surfaces require finishing cuts. The rear flank is the bearing flank and the most essential. The requirements were previously given in connection with the firing mechanism container. The front face of the housing should be reasonably smooth, as it seats against the hinged collar and is the most important working point for other machining operations.

The depth of the Whitworth thread is 0.80 inch, plus 0.02, minus 0.00. The hole must be deep enough for the hinged collar and enough threads must be maintained to hold the firing mechanism in position during the firing of the gun. This thread is subjected to a considerable strain at this time. The depth of the counterbore in the front end is 1.08 inches, plus 0.02, minus 0.00. This surface must clear the end of the spindle plug. No finish cut is required.

The location of the thread for the container is 1.987 inches, plus 0.005, minus 0.000 from the front end. This is an important functional dimension and must be carefully watched, as it controls the angular position of the firing mechanism when it is screwed home. A minus variation on this dimension would prevent the mechanism from locking. A slot is shown in the lower right-hand side of the housing for the safety mechanism. The safety bar should be a very free fit in this slot. The slot is 1.59 inches, plus 0.01, minus 0.01 from the front end; the length, 0.75 inch, plus 0.02, minus 0.00; and the width, 0.375 inch, plus 0.02, minus 0.00. The surface in the slot should be reasonably smooth. A tapped hole, having a full diameter of 0.50 inch, plus 0.01, minus 0.00, is shown in the bottom of the housing for the firing mechanism pin. It is permissible to run the tap drill below the thread, provided that this drill does not break through into the hole in the center of the housing.

A recess is milled in the rear face of the housing to engage the locking latch. This recess allows for a possible

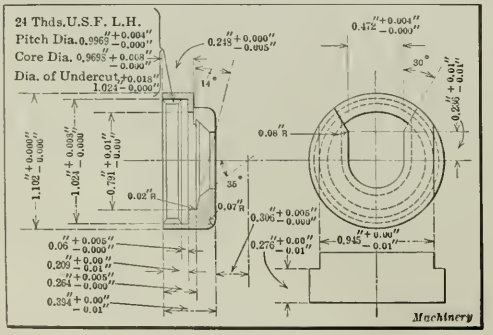


Fig. 8. Primer Extractor

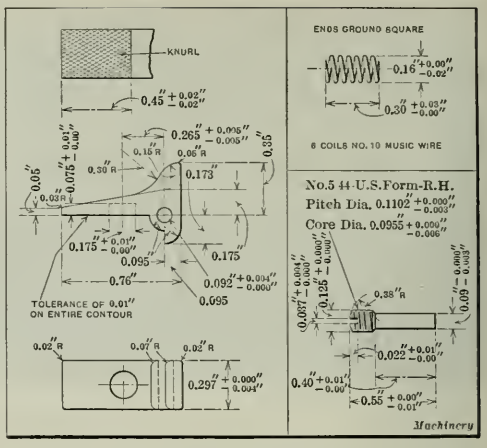


Fig. 9. Locking Latch, Spring, and Pin

variation in the locked position of the container of 90 degrees. The tolerances given on the various controlling dimensions will permit a variation of approximately 30 degrees. The variations on the primer plug and the primer will permit approximately 30 degrees more. This leaves the remaining 30 degrees to allow for wear. The depth of the recess is 0.10 inch, plus 0.02, minus 0.00 and the ends of the recess are located 0.15 inch, plus 0.01, minus 0.00 from the center lines through the rear face, 90 degrees apart.

The hole and counterbores for the collar-catch (shown in Fig. 12) are located from the center of the housing because these holes will be drilled in a jig which should locate the housing centrally. The counterbores are 1.088 inches, plus 0.000, minus 0.005, and the hole, 1.183 inches, plus 0.005, minus 0.000 from the center line (see end view Fig. 10). The diameter of the hole is 0.16 inch, plus 0.006, minus 0.000. This hole should be a free sliding fit for the stem of the collar-catch. The minimum clearance is 0.002, and the maximum clearance, 0.014 inch. The full diameter of the tapped hole is 0.375 inch, plus 0.008, minus 0.000, and the pitch diameter, 0.3417 inch, plus 0.004, minus 0.000. No core diameter is given as the small counterbore, which is a few thousandths inch larger than the theoretical core diameter, limits the height of the threads. The V-form of thread is used to obtain as great an area of contact as possible. After assembly of the collar-catch screw, the metal should be upset slightly with a cold chisel into the slot of the screw to prevent disassembling. The bottom of the counterbore is 0.125 inch, plus 0.02, minus 0.00 from the rear face of the body. This counterbore receives the head of the collar-catch screw and also forms a groove in the stem which provides clearance for drilling and tapping.

The width of the thread for the container is 0.41 inch, plus 0.01, minus 0.00. A 45-degree bevel (0.03 inch, plus 0.02, minus 0.00 wide) is required on the corner of this thread to facilitate the insertion of the container. This bevel may be made with a file; the tolerance should be great enough to cover this method of manufacture. The ends of the thread sector are located from the 45-degree center line of the housing (see end view) at 0.02 inch, plus 0.02, minus 0.00. This sector is at an angle so as to always insure a minimum contact on this thread of 135 degrees. No tolerances are given on the various angles and radii, as none are required.

Drawing of Hinged Collar

The hinged collars and housings are not interchangeable and must be furnished in pairs. To make these parts interchangeable and insure that the housing would be screwed tightly against the shoulder on the hinged collar when the locking holes in each part were in correct alignment, would require very expensive manufacturing methods. In such a

case, the position of the start of the Whitworth thread in the housing would have to be held very closely in relation to the position of the locking hole. The same would be true on the hinged collar. Some variation must of necessity be allowed. This would introduce a further variation longitudinally of the position of the firing mechanism. The effect of such a variation would be an additional angular variation in the locked position of the mechanism. If the original pairs of housings and hinged collars become separated, an additional locking hole will have to be drilled in the flange of the collar, Fig. 11, transferring it from the housing which is to be used. The diameter of the locking hole is 0.160 inch, plus 0.006, minus 0.000. This hole should be drilled in a single operation by using its companion housing as a jig.

Drawing of Collar-catch

For convenience of manufacture, the collar-catch (see Fig. 12) is made in two parts which are permanently assembled. The stem and the finger piece may be made interchangeable, or a system of selective assembly may be employed. This is a matter to be determined by the manufacturer to suit his own convenience. Therefore no tolerances will be given on the dimensions of the riveted end. The stem must be a snug fit in the finger piece, and the two parts must be solid after riveting. Any parts made within 0.01 inch of the nominal dimensions and which meet the above conditions will be acceptable. The rear face of the finger piece will be finished after riveting.

As the diameter of the stem is 0.158 inch, plus 0.000, minus 0.006, it should be possible to secure drill rod well within these limits; no further machining will be required on this surface. The length of the stem is of minor importance. The surface left by the cutting-off tool will be satisfactory. The length of the finger piece (0.525 inch) is an atmospheric fit; no tolerances are given, because the note in regard to the profile gives a tolerance of minus 0.04 inch.

The thickness of the flange (0.125 inch plus 0.00, minus 0.01) is of minor importance; hence the flange can be completed in a single operation after the stem is riveted. The width of the flange (0.245 inch, plus 0.00, minus 0.01) must be free in the slot in the housing. The minimum clearance is 0.005 inch and the maximum clearance, 0.035 inch.

The dimensions of the profile of the finger piece are given without tolerances, but a note is added: "Tolerance plus 0.00, minus 0.02, as shown by dotted line." The entire upper part of the finger piece is an atmospheric fit. It must be reasonably smooth because the finger operates this part. The note permits a minus variation of 0.02 on this profile where no other tolerances are given. This variation is measured as normal to the profile at any point. If a clean drop-forging is secured, this surface may be finished by removing all rough scale, flash, and other rough spots with a file or on a polishing wheel. The contour of this surface is not important enough to require expensive form milling cuts.

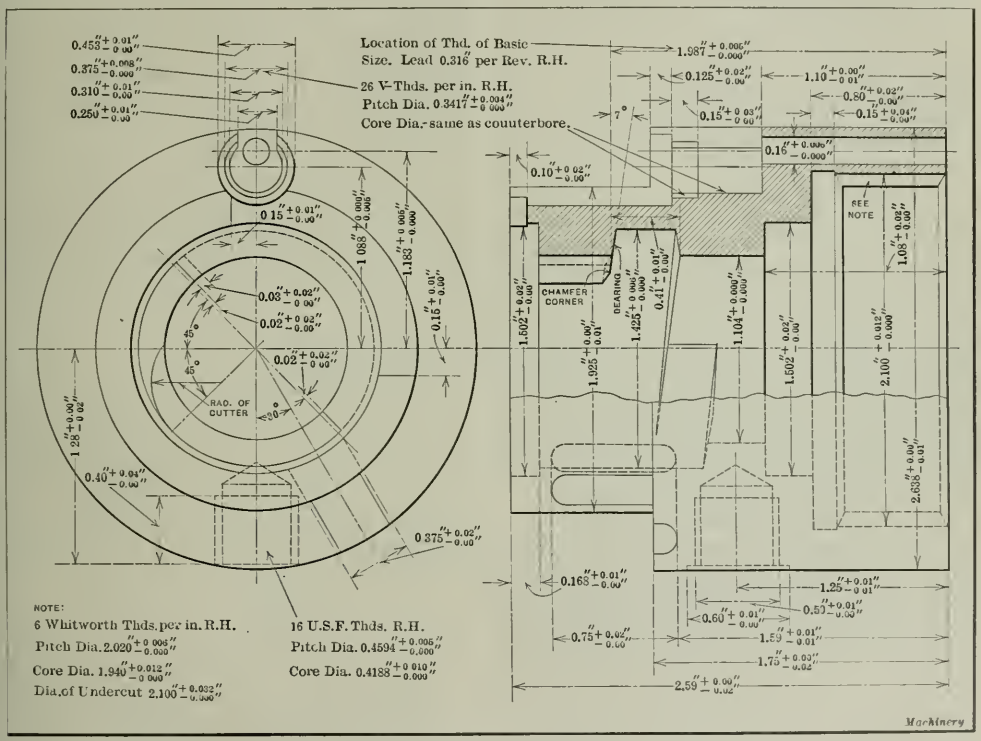


Fig. 10. Housing of Firing Mechanism

Drawing of Firing-pin Guide Spring and Firing Pin

The diameter of the wire for the firing-pin guide spring (Fig. 13) is 0.04 inch, plus 0.00, minus 0.002; the outside diameter of the coils, 0.464 inch, plus 0.00, minus 0.01; and the free height, 0.69 inch, plus 0.02, minus 0.00. These limits should be readily maintained under normal manufacturing conditions.

The firing-pin flange is 0.582 inch in diameter, plus 0.000, minus 0.003. This surface must be a free sliding fit in the firing-pin guide. The surface will require a careful finishing cut. The diameter of the front end (0.117 inch plus, 0.000, minus 0.003) must be a free sliding fit in the firing pin guide. This surface requires a careful finishing cut.

The surface of the rear end clears the hole in the container by 0.050 inch and requires no finishing cut. The diameter of the large end of the taper is an unimportant clearance surface. The taper is provided to strengthen the end of the firing pin. No finishing cut is required on this

tapered surface. The length over all is an important functional dimension and, in part, controls the force of the blow on the primer. The front face of the pin must be as smooth as possible, and a polished surface is desirable. The rear face should be as smooth as a careful finishing cut will leave it.

The location of the rear face of the flange (0.525 inch, plus 0.000, minus 0.003) is important, as this dimension controls the location of the end of the firing pin. The surface should receive a finishing cut. The distance to the front face of the flange is an important functional dimension which controls the protrusion of the firing pin, as noted in connection with the firing-pin guide. A finishing cut is

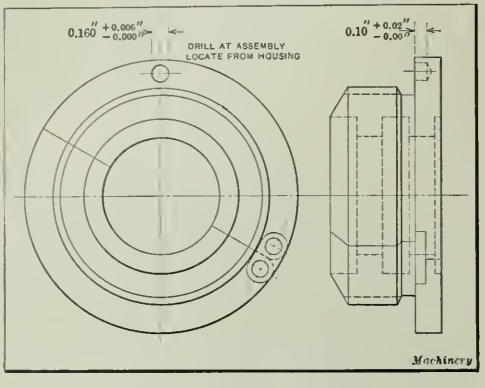


Fig. 11. Hinged Collar assembled

required on this surface. The location of the beginning of the taper is relatively unimportant. This dimension maintains clearance with the bottom of the counterbore in the firing-pin guide.

No tolerances are given for the radii because none are needed. Attention is called, however, to the radius of 0.04 inch at the front end. This must not be exceeded. The purpose of this radius is to remove the sharp corner, but care must be taken to remove as little material as possible.

Drawing of Collar-catch Screw and Spring

The collar-catch screw is shown in Fig. 14. The diameter of the head must enter the counterbore in the housing. The thread, which is a sharp V-form, must assemble into the tapped hole in the housing. Sufficient threads must be secured to hold the screw in position. It is permissible to bevel both under-cut and end to facilitate threading. This screw should be completed in a single operation on a screw machine.

No. 15 music wire is specified for the collar-catch spring. Commercial wire of this number will be satisfactory. The function of this spring is to hold the collar catch in its locked position. The limits given should be maintained readily under normal manufacturing conditions.

All dimensions and tolerances given on these drawings represent limit gage sizes. If a hole is given as 1.25 inches,

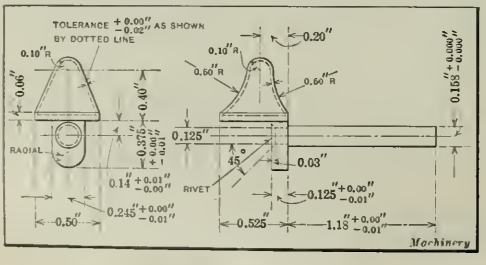


Fig. 12. Collar-catch

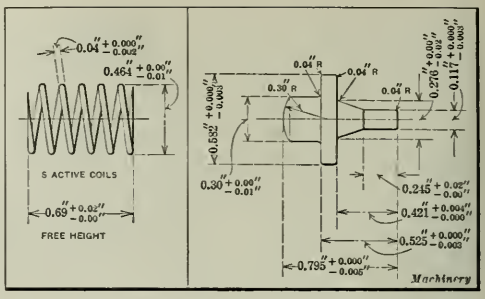


Fig. 13. Firing Pin Guide Spring and Firing Pin

plus 0.01, minus 0.00, this means that the hole must be made so that a plug gage, 1.25 inches in diameter will always enter, while a plug gage, 1.26 inches in diameter will not. In general, the extent of the tolerances allowed on any surface is a good index of the character of the finish required. All burrs, fins, etc., and unnecessary sharp corners must be removed. All cuts and surfaces, whether rough or finished, must show no evidence of carelessness. All cuts must be made with clean and sharp tools. Gouges, tears, and unnecessary scratches produced by dull or improper tools and careless workmanship or careless handling should be sufficient cause for rejection.

Unless noted otherwise, common manufacturing practices, such as under-cutting and beveling for threads, extending the tap drill a reasonable amount below the threads in tapped holes, countersinking to guide the tap, providing reasonable grinding clearances where necessary, burr-beveling corners

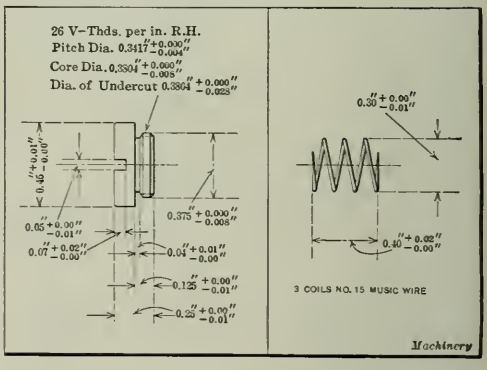


Fig. 14. Collar-catch Screw and Spring

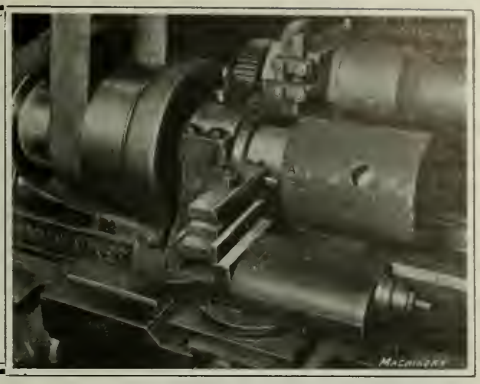
on screw machine parts, etc., are permissible. Whenever any differences exist between the dimensions and tolerances expressed on the drawing and the above specifications, the figures on the drawing should be used. The dimensions and tolerances given on the component drawings should be strictly maintained. If modifications are possible which will relieve the situation, they should be made. No deviations from the specified requirements are permissible, however, until definite modifications are authorized.

* * *

Trade commissioner Wilbur J. Page reports that German exports are severely hampered by the lack of certain raw materials and the shortage of coal. There was, however, a remarkable evidence of the revival of the German industries at the German national fair at Leipsig. Most of the 10,500 firms exhibiting were German, and 7000 foreign buyers are said to have been present. It was evident that the German manufacturers are concentrating on such products as require mechanical precision and where the cost of the raw material is a small percentage of the cost of the finished article.

Boring and Facing Pistons in a Lathe

A Description of Special Equipment for Performing Preliminary Operations on Pistons in an Engine Lathe



At the motor works of the Avery Co., in Milwaukee, Wis., several Potter & Johnston piston turning automatics have recently been installed. In turning pistons on machines of this type, it is necessary to first perform a preliminary operation which consists of facing and boring the piston skirt. Owing to difficulty in obtaining prompt delivery on the particular type of machine required for the performance of this preliminary operation, James H. Pinson, general manager of the plant, designed and had built under his personal supervision special fixtures for use on standard 16-inch engine lathes; and after this equipment was placed in operation, it proved so efficient that its use is now regarded as a permanent feature of the piston department.

The heading illustration shows a close view of the boring and facing tools, and of the piston which is to be machined; and in Figs. 1 and 2, the mechanism of the facing attachment is fully illustrated. A feature of this method of machining is that the boring and facing operations are performed simultaneously, thus enabling a higher rate of production to be attained than would be possible if the two operations had to be performed independently. Also, the possibility of both boring and facing the work at a single setting is not only a means of saving time, but it also assures having the bore at an accurate right angle to the finished face. A special expanding chuck, illustrated in Fig. 3, is used to hold the work.

Reference to the heading illustration will make it apparent that the boring tool *A* is carried in a special form of offset tool-block supported on the compound rest, which is swung to an angle of 90 degrees with the direction of travel of the lathe carriage. By using the regular feed mechanism on the lathe, it is possible to feed tool *A* into the work to provide for boring out the flange that runs around the inside of the open end of the piston. In order to provide for performing this operation, the expanding chuck is so designed that the necessary clearance is provided for the boring tool and the slight amount of overhang of the block by which this tool is carried. Attention is called to the form of the tool-block, which has been so designed that provision is made for holding tool *A* by means of two set-screws, with very little of the block projecting beyond the tool.

The attachment that provides for facing the open end of the pistons is the most interesting part of this special equipment which is used by the Avery Co. for performing the preliminary machining operations on pistons. In Figs. 1 and 2, it will be seen that this consists of a pivoted lever *B*, at one end of which there is mounted a facing tool *C*, with a cam roller *D* mounted at the opposite end of the lever. Roller *D* runs in contact with a cam *E*, and as the roller rises over the lobe on this cam, it causes lever *B* to swing around its pivotal support, with the result that facing tool *C* is fed across the open end of the piston. Power for rotating the cam is derived from the lathe spindle, but it will be quite obvious that the speed of rotation must be substantially reduced in order to obtain a suitable rate of feed for the facing tool. This result is accomplished by a triple train of spur gears which effect a reduction of 168 to 1 in the speed. These gears are clearly shown in Fig. 1, where it will be seen that the final gear is mounted on the end of the cam hub. This cam rotates on its shaft.

In Fig. 1 it will also be noticed that a lever *F* is bolted to the top of arm *B*, with the outer end of this lever pivoted in a yoke at the upper end of rod *G*. Secured to the bed of the lathe, there is an inverted cup *H* that contains the compression spring *I*, which is depended upon to always keep roller *D* in contact with cam *E* so that a uniform feed movement of the facing tool is assured, and also the return of this tool to the starting position after the facing operation has been completed. It will, of course, be apparent that bracket *J*, which is machined to fit vees on the lathe bed, is bolted in place and furnishes the pivotal support for arm *B*.

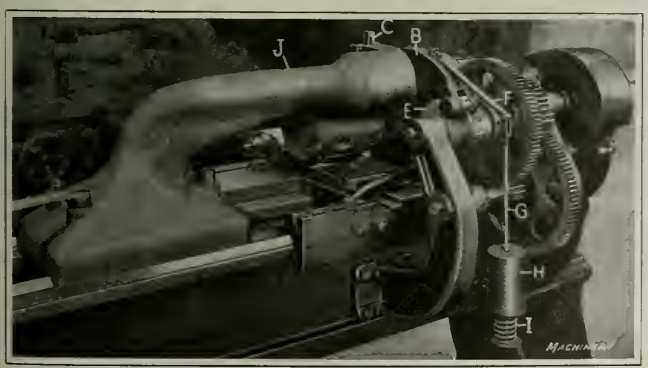


Fig. 1. Arrangement of the Cam-actuated Mechanism of the Piston Facing Attachment

An air cylinder is placed at the left-hand end of the lathe headstock to provide for manipulating the expanding chuck on which the work is carried. It will be seen from Fig. 3 that this chuck is arranged with plugs *K* at each end to grip the inside of the work and bring it into accurate alignment. Inside the bore of the chuck body there are two conical shaped members M_1 and M_2 that slide in opposite directions to engage the inner ends of plugs *K* and push them into firm contact with the inside of the work. These conical shaped members are caused

to slide in opposite directions by admitting air to cylinder N. Rod O is fastened to the piston in this air cylinder and sleeve P is fastened to the cylinder wall. At its right-hand end, rod O has threaded in it the chuck expanding member M_1; and similarly, sleeve P is threaded into the conical member M_2. Movement of rod O to the right caused by admitting air to cylinder N, allows the conical members M_1 and M_2 to expand plugs K inside the work and secure it firmly for the performance of the boring and facing operations. When the operation has been completed, it is merely necessary to reverse the air valves so that air will be admitted to the opposite side of the piston in cylinder N.

To fully understand the way in which movement of the piston in cylinder N is responsible for accomplishing the movement of the two chuck expanding cones M_1 and M_2 in opposite directions, it must be explained that rod O first moves to the right and carries M_1 with it. During this movement, collar Q compresses spring R. When cone M_1 has reached the limit of its travel, air pressure in cylinder N causes sleeve P by which the cylinder is carried to move to the left, thus carrying the chuck expanding member M_2 to the left. From this description it will be evident that the movement of cones M_1 and M_2 in opposite directions does not occur simultaneously. After the machining operation has been completed, the valve which governs admission of air to cylinder N is reversed, so that pressure is applied at the right-hand side of the piston in this cylinder instead of at the left. This results in withdrawing the conical member M_1 through movement of the piston and rod O toward the left; and at the same time the tension in spring R results in moving conical member M_2, sleeve P, and cylinder N carried by this sleeve, toward the right, thus returning the entire apparatus to the starting position. The bored and faced piston casting can now be removed from the chuck ready to have a fresh piece set up for the performance of the next machining operation.

* * *

SIZES OF CATALOGUES

The National Association of Purchasing Agents, having headquarters at 25 Beaver St., New York City, recommends that catalogues intended for purchasing agents be confined to one of the following three sizes: 6 by 9 inches, 7½ by 10⅝ inches, and 8 by 11 inches. It is further recommended that of these three sizes, the medium, or 7½ by 10⅝ inches, should be considered standard, the half size of this—that is, 5¼ by 7½ inches—being also considered standard. It is somewhat questionable, however, if so large a size as that recommended by the Association of Purchasing Agents is really desirable. It would seem that catalogues could well be confined to a size of 6 by 9 inches. It would make them handier to use, more compact, and they would occupy less space when filed. The general tendency of late years, of course, has been to increase the size of catalogues in order to afford more display, but when properly handled, it is possible to produce very good effects with both illustrations and text in the 6- by 9-inch size.

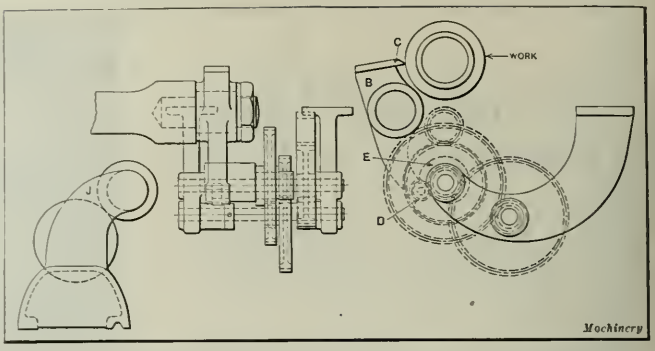


Fig. 2. Views of the Piston Facing Attachment from the Front and Ends, showing Details of the Mechanism

CURIOUS EFFECT OF LOW GERMAN EXCHANGE RATES

German industrial interests have of late been employing an unusual method for overcoming the difficulties due to the low value of the mark in foreign exchange, reverting, one might say, to the old methods of barter, or the direct exchange of goods. As an example, it is stated by the *Board of Trade Journal* that German industries have obtained from Holland untanned hides, taken them to German tanners and converted them into leather, returning them again into Holland with a certain number of hides deducted as payment for the tanning. In certain cases, however, the leather would be kept in Germany and turned over to a shoe manufacturer, where it would be converted into shoes; afterward the manufactured product would be sent to Holland, a certain quantity of the shoes made being retained by the manufacturer as payment for the making of the shoes. Aside from the amount of leather and manufactured goods thus retained in Germany, there is the advantage of being able to keep the German industries at work, which would be practically impossible if raw materials had to be bought at the present rate of exchange. It is not inconceivable that with the present low exchange rate of French money, similar methods of trading will have to be adopted between France and the United States. Direct exchange of goods may have to be resorted to rather than actual buying and selling in dollars and cents.

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AERONAUTICAL EXPOSITION

At the second annual Aeronautical Exposition which will be held at the Seventy-first Regiment Armory, New York City, March 6 to 13, an opportunity will be afforded those interested in aeronautics to see what American designers have accomplished in developing commercial airplanes. While the airplane owes its development principally to the war, American manufacturers have concentrated their efforts on airplanes for pleasure and commercial use since the hostilities ceased. It is expected that the exhibition will represent all the producing airplane factories in the United States. Many of the models to be exhibited have enclosed cabins with reinforced glass windows, and seat from four to twelve passengers in comfortable upholstered chairs. The noise from the motors is deadened, and the passengers are enabled to enjoy a flight much as they would if they rode in a limousine. Several flying boats will also be exhibited. The larger airplanes have a carrying capacity of from 3000 to 6000 pounds and are driven by three or four motors. It is stated by optimistic airplane enthusiasts that the cost of operating airplanes has been reduced during the last year from the almost prohibitive figure of from $1 to $2 a mile, until now it may be compared with motor truck or railroad transportation.

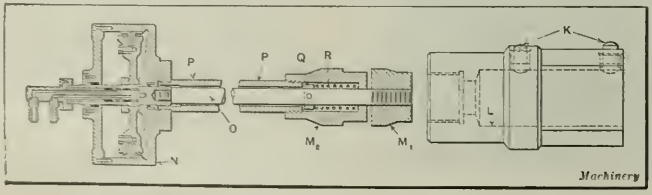


Fig. 3. Special Type of Air-operated Expanding Chuck used to hold the Pistons while the Boring and Facing Operations are performed



Fig. 1. Indexing Work-holding Fixture for straddle-milling Camshafts

Indexing Milling Fixtures

First of a Series of Three Articles on the Use of Indexing Fixtures for Obtaining Increased Production in Milling Practice

IN setting up milling machines for quantity production there are a number of fundamental principles which must be observed in order to obtain maximum production and quality workmanship. These points are briefly outlined in the following paragraphs, and it is likely that every skilled mechanic will say, after looking over this matter, that nothing in the way of new information has been brought to his attention. Despite this fact, it is entirely probable that an investigation of the condition of milling machines used in the shop where he is employed would reveal the fact that a number of the points mentioned have been overlooked, with the result that there has been a serious reduction in the number of pieces produced per day and in the accuracy of the work. Too much emphasis cannot be laid on the importance of observing all of the following simple and obvious principles.

When making arbors for use on milling machines, do not attempt to use soft machine steel. In order to give satisfactory service, arbors should be made of machine steel and first carburized to increase the carbon content at the surface of the metal. After receiving this treatment, the arbors are hardened, with the result that their entire surface is covered by a skin of hard steel, which protects them from becoming bruised or nicked; at the same time, the inner metal is left soft and tough so that it has ample strength to resist severe shocks. It may be that an arbor is required for immediate use, making it impracticable to take the time for the carburizing operation. In such a case, a fairly satisfactory arbor can be produced from 60-point carbon or chrome-nickel steel. An arbor made of this material is not as good as one made of machine steel and casehardened, because when it is heat-treated the hardness extends all of the way through the steel, and without the tough inner core there is more danger of the arbor breaking.

When setting up a milling machine, the arbor should be put in place in the spindle and carefully tested with a sensitive indicator to make sure that it runs true. It is obvious that if the arbor does not run accurately, a uniform action of the milling cutters cannot be obtained. For the same reason, it is necessary to take great care of the taper hole in the machine spindle. When setting up the arbor, a point should be made of seeing that there are no chips in the spindle socket or adhering to the shank of the arbor. The presence of chips will not only throw the arbor off center, but they will also prevent a close engagement between the arbor shank and the spindle socket, and thus make it impossible to secure the required frictional resistance between the arbor and the milling machine spindle in which it is mounted.

There is some difference of opinion as to the best form of outboard support for a milling machine arbor. It is quite general practice to use a split cylindrical bearing for this purpose, the claim being made by advocates of the straight bearing that if a tapered bearing is used to provide means of adjustment to compensate for wear, the mechanic will in many cases set the bearing too tight, and thus produce a condition that is far worse than would result from the slight amount of lost motion in a cylindrical bearing. This argument is adequately met by advocates of the tapered bearing, however, by stating that a set-up man who has charge of a milling machine department should certainly have the necessary skill and experience to adjust a tapered bearing properly. Dependence cannot be placed upon cold-rolled steel for making keys for securing milling cutters on their arbors. A good grade of key stock should be used for this purpose and the finished keys should be drawn to a spring temper. When the cutters have been set up on an arbor, care should be taken to see that they run true and that all of the teeth do their proper share of the work. Where these conditions are not obtained, accurate work will not be produced and the life of the cutters will be greatly reduced. A full discussion will be presented in a later section of this article, of methods of designing work-holding fixtures, which is a point of equal importance to those just given in regard to cutters and arbors. The information presented on these topics may be summarized by saying that it is absolutely essential for both the cutters and the work to be properly "housed" in order to get the best possible results.

Before leaving this subject, attention should also be called

to the necessity of inspecting the milling machines at specified intervals. If bearings or slides fit badly, or if there is lost motion between feed-screws and their nuts, accurate results cannot be obtained; also, such conditions will adversely affect production, because when a machine which is in poor condition is run at a high speed and heavy feed, there will be a tendency for the cutters and work to chatter. When this kind of trouble is experienced, the natural thing is to slow down the speed and feed in order to eliminate the chattering of the cutters and work; but this also reduces the rate of production secured from the machine. In many cases such a loss could be avoided by making the necessary adjustment of bearings, slides, gibs, etc., on the milling machine.

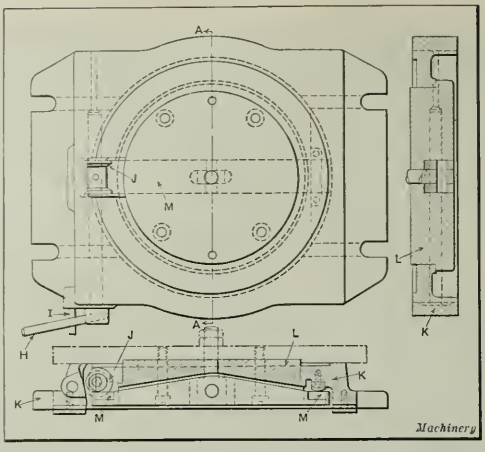


Fig. 2. Plan and Cross-sectional Views of the Standard Type of Indexing Milling Fixture used by the Studebaker Corporation, also shown in the Illustration Fig. 3

General Types of Indexing Fixtures

On small or medium sized machines, it will frequently be found advantageous to make use of indexing fixtures for holding the work. Such fixtures may be designed to carry two or more pieces according to conditions; but the general arrangement is to have two stations, so that the piece or pieces which are mounted in one station may be milled while the operator is removing finished parts from another station and setting up fresh blanks in their place. Then, after milling the parts held in the operating position, the fixture is indexed to bring the blanks which have just been set up into position for milling. The operator then proceeds to remove the freshly milled pieces from the fixture. This sequence of movements can be constantly repeated, with very little loss resulting from idle time of either the machine or its operator.

Many successful modifications of design have been worked out for indexing fixtures that are to be used for holding pieces of work on milling machines. The simplest of these is represented by a case in which provision is made for merely holding two pieces of work, so that the milling operation may be performed on a piece held in one station of the fixture, while the other station is unloaded and a fresh blank set up ready for milling. It is a common practice, however, to arrange indexing fixtures in such a way that two or more parts are mounted at each station, examples of such fixture designs being shown in Figs. 1 to 6, inclusive. Another commonly used type of indexing fixture is that employed for turning pieces of work for successive operations on the different sides, in order to bring the work to a square, hexagon, or some other desired form. Examples of this method of designing indexing fixtures are shown in Figs. 7, 8, and 9. Fixtures of this kind may be made with a number of collets or other means for holding the work; and a gang of cutters may be mounted on the milling machine arbor, one or more of these cutters engaging each piece of work. The work-holding devices and the indexing mechanism of the fixture should preferably be geared together so that turning a single handle provides for simultaneously indexing all of the pieces of work.

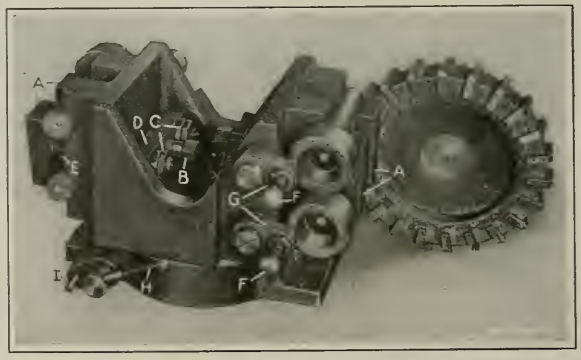


Fig. 3. Indexing Fixture of Standard Design, equipped for holding Transmission Pinion Forgings for milling them to the Specified Length

Another method of indexing fixture design is that of combining with the indexing principle the features of a string fixture, which tends to increase rates of production. An example of such a design will be shown in the next installment of this article. Such fixtures consist essentially of a plate, carrying two strings of work-holding clamps, which is mounted on a pivot at a point midway between the two ends of the fixture. Not only does such a method of design make it possible to take advantage of the string-fixture principle, but it also avoids practically all the idle time which is involved in unloading and resetting fresh pieces of work before the next operation can be started. After the pieces in one station of the fixture have been milled, the operator simply releases the lock-pin and swings the baseplate around, end for end, so that the string of parts held in the second station of the fixture are brought into the milling position. Then he is able to occupy his time unloading the milled parts and setting up fresh pieces of work, while the milling operation is being performed on those pieces held in the other station.

Still another useful application of the indexing type of fixture can be made for milling parts of small or medium size. This consists of making two duplicate indexing fixtures which are mounted at opposite ends of the table. There are many shops using this method of performing machining operations with very satisfactory results. This method is used where both ends of the work have to be milled. The method of procedure is to first mill one end of the work held in the fixture at the left-hand end of the table and after this has been done, the table is moved over to allow the cutters to start milling the work held by the right-hand fixture. While this cut is being taken, the left-hand fixture is indexed into position for taking a cut at the opposite end of the work held by this fixture. The table is then moved back to take this cut and the right-hand fixture is indexed. While the second cut is being taken on the work held in the right-hand fixture, the finished work is removed from the left-hand fixture and a new piece is set up in its place.

Standard Design of Indexing Fixture Used in Studebaker Plant

Substantial savings may often be made in the cost of special tool equipment required for the performance of a variety of machining operations by adopting standard tool parts which may be adapted to the requirements of a specified job. A case in point is seen in the

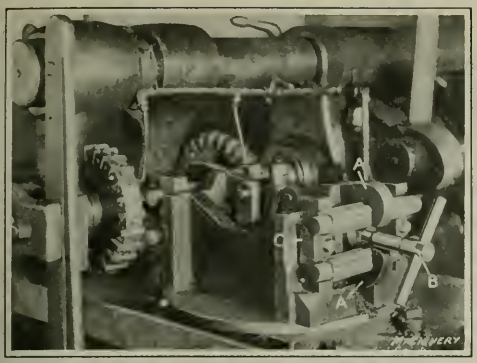


Fig. 4. Milling Machine equipped with Indexing Fixture for straddle-milling Transmission Shafts

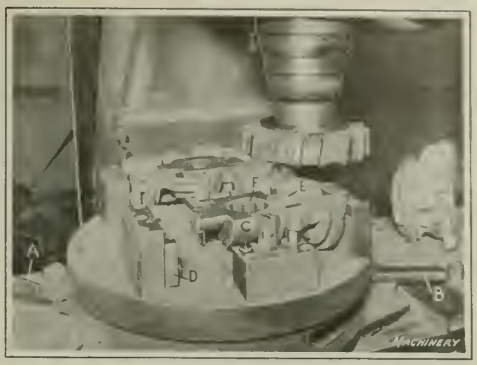


Fig. 5. Vertical Milling Machine equipped with Indexing Fixture for facing Joints of Bearing Caps

indexing milling fixture illustrated in Figs. 2 and 3. The body of this fixture is now used in most cases where an indexing type of work-holding fixture is required for the performance of a milling operation in the Detroit plant of the Studebaker Corporation. Such fixtures are made in quantities, and then when it is required to provide for handling a specific job, it is only necessary for the tool-room to provide, on the body of the fixture, suitable clamps and locatiug devices for handling the work in question. When a fixture of this type becomes obsolete, it is only necessary to discard the special clamp and locating device. The body of the fixture can be utilized for another job.

As an example of the work which must be done in the tool-room to adapt one of these standard fixtures for the performance of any specified milling operation, attention is directed to Fig. 3, where a fixture is shown that has been arranged to provide for milling off the end of the shank of transmission pinion forgings to provide for reducing them to the required length. Two forgings are set up in the V-blocks on each station of the fixture and held in position by means of straps *A*, which are drawn up by means of a bolt *B*. The two bolts *C* extend through the body of the fixture and are secured to straps *A*. Bolt *B* is threaded through bar *D* and abuts against the wall of the fixture, so that when bolt *B* is tightened it pulls back bar *D* and through the action of bolts *C*, causes straps *A* to clamp the work in the V-blocks. It will be evident that compression springs *E* are placed under straps *A* so that when bolt *B* is loosened, these straps are lifted out of engagement with the work without requiring attention from the operator.

The purpose of this milling operation is to reduce transmission pinion forgings to the required length, and as a result accurate endwise location of the work is a matter of importance. Such location is accomplished by means of two stop-screws *F* which are carried by swinging brackets *G*. In setting up the work, each forging is pushed up into contact with screw *F*, after which bolt *B* is tightened to clamp the two forgings in place ready for milling. The reason for having the end-stop mounted on swinging straps *G* is that a practice is made of only loosening bolt *B* sufficiently to allow the forgings to be drawn through the V-blocks to remove them from the fixture. As the size of the heads on the work makes it necessary to push these pieces through from the end at which stops *F* are located, it is obvious that provision must be made for getting these stops out of the way while the milled pieces are being withdrawn from the V-blocks and fresh forgings set up in their places. On this operation, the milling cutters rotate at a speed of 57½ feet per minute and the work is fed to the cutters at a rate of 1 inch per minute; the production obtained is 200 pinions per hour.

The important feature of design of the indexing milling fixture which has been adopted as a standard by the Studebaker Corporation is that it is only necessary to manipulate a single handle in order to locate this fixture in either of its two working positions and to lock it in place. Referring to Figs. 2 and 3, it will be seen that this locating and locking of the fixture is accomplished by means of lever *H*. In the position in which the lever is shown in Fig. 3 the fixture is locked; and when it becomes necessary to release the fixture in order to bring the opposite station around into the working position, lever *H* is swung over against pin *I*, after which the fixture may be revolved by hand. When brought to approximately the required position, lever *H* is pushed back, thus obtaining an accurate location of the fixture and locking it in the position so obtained.

A better idea of the way in which this fixture is designed will be obtained by referring to Fig. 2. In this illustration it will be apparent that lever *H* is carried by a cross-shaft on which there is mounted a cam *J* that has eccentric beveled flanges around its ends. The fixture consists of a stationary base *K* and a table *L* which may be indexed to bring the work carried on it into either the milling or the unloading position, as desired. This table *L* has a slot cut in its under side, in which there is mounted a bar *M*, projecting outward at each side, so that it may be engaged by the tapered flanges on cam *J*. Consequently, when an approximate location of the table has been

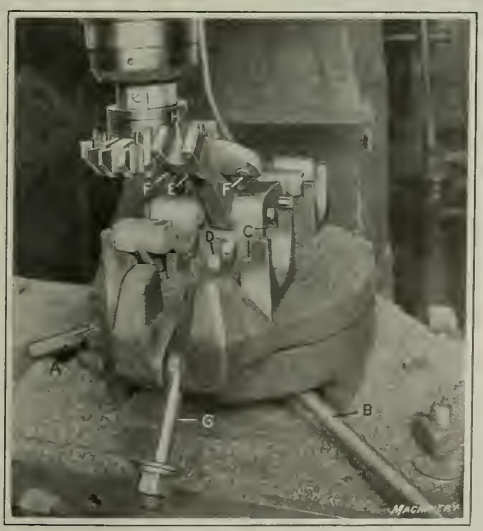


Fig. 6. Vertical Milling Machine equipped with a Special Indexing Fixture for a Similar Job to the One shown in Fig. 5

secured through rotating it by hand, the turning of lever *H* causes cam *J* to be rotated so that the eccentric beveled flanges on this cam engage bar *M* and turn table *L* the slight distance, in either direction, that is required to locate it accurately, after which further turning of cam *J* results in clamping the table firmly in place. It will be apparent from the cross-sectional view that the flanges on cam *J* are cut away at one side, so that when lever *H* is swung over into contact with pin *I*, the cut away section of the cam allows the table to be rotated for indexing. Then when lever *H* is swung in the opposite direction, the flanges on the cam come into engagement with the bar *M*, locating and locking it in the manner just described.

Straddle-milling Transmission Main Shafts to Length

Fig. 4 shows a Becker-Brainard No. 4 milling machine equipped with one of the standard indexing fixtures used by the Studebaker Corporation, which has been adapted for straddle-milling transmission main shafts to length. It will be apparent from this illustration that two forgings are mounted on each station of the fixture, and that these forgings are held by V-blocks, in which they are secured by means of hooks *A*, that are tightened on the work by turning a socket wrench *B*. This socket wrench turns a screw

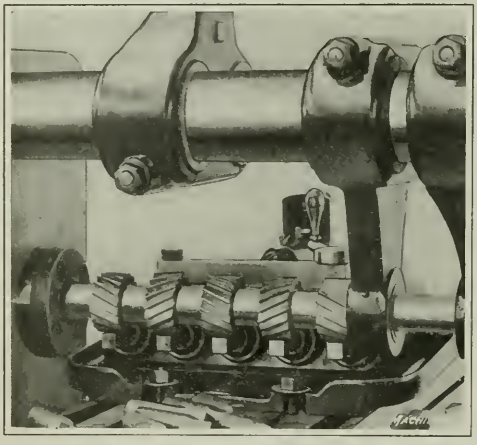


Fig. 7. Milling Machine equipped with Indexing Fixture for simultaneously milling the Sides of Five Square Piercing Punches. Details of this Fixture are shown in Fig. 9

which pushes back a rocker link located inside of the fixture, that, in turn, is connected to the rear ends of the two hooks *A*. When this rocker link is manipulated through the screw turned by socket wrench *B* it pulls hooks *A* back on the forgings and draws them into their seats in the V-blocks. A sufficiently accurate location of the work may be obtained from the end of one of the splines on each forging, which is brought into engagement with a locating plate *C*. The remainder of this fixture is of standard design, so that it calls for no further description. In the performance of this operation, the rate of production obtained is 135 transmission shafts per hour.

Straddle-milling Camshafts to Length

The first operation performed on camshaft forgings as they come to the machine shop of the Studebaker Corporation is to straddle-mill them to the specified length. This operation is performed on a duplex milling machine built by the Becker Milling Machine Co., of Hyde Park, Mass., which is shown in Fig. 1. This machine is equipped with an indexing fixture of different design from the standard type used by this company. In this case, it will be apparent that two forgings are held in each station of the fixture, one of the forgings having been removed from the V-blocks at the front and laid on the bed of the machine, in order to show the fixture more clearly. Endwise location of the work is accomplished by means of gages *A* which fit over one of the bearings on the camshaft. It will be evident that at both ends of the fixture there are straps *B* which hold the two forgings back into their V-blocks. At each end of the fixture there is a lever. Lever *C* at the left-hand end is employed to pull a locking pin which slides through holes located at 180 degrees from each other, one of these holes being shown at *D*. Lever *E* at the opposite end of the fixture is used to manipulate a tapered index-pin, that is depended upon to locate hole *D* in accurate line with the locking pin, so that this pin may always find its way "home." About the only exceptional feature of this equipment, aside from those already mentioned, is that it was necessary to build an extension at the right-hand end of the milling machine bed in order to enable the required spacing to be secured between the cutters. As in the case of all operations where forgings have to be milled, a practice is made of delivering a copious flow of coolant to the cutters. The rate of production obtained is 50 camshafts per hour.

Special Indexing Fixtures

Figs. 5 and 6 illustrate the use of two indexing fixtures at the Studebaker plant, which are of different design from

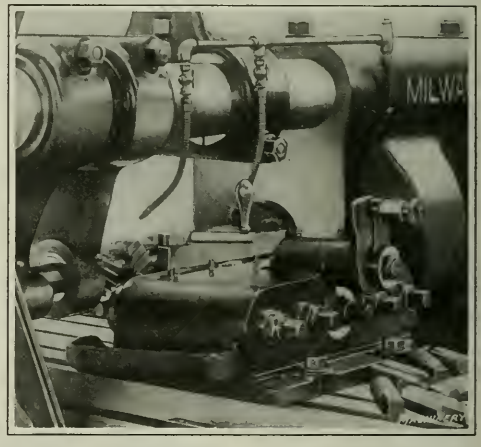


Fig. 8. Opposite Side of Work-holding Fixture shown in Fig. 7, showing the Single Crank for indexing the Work and Individual Bolts for operating the Collet Chucks

the standard form used by this company. It will be seen that both of these fixtures are employed for the performance of face-milling operations on cast-iron crankshaft bearing caps. Both of these operations are performed on Model C vertical milling machines built by the Becker Milling Machine Co. Instead of having a single lever which provides for locating and locking the milling fixture in either of the two available positions, it is necessary to manipulate two levers in order to accomplish these results. On both of these fixtures, lever *A* manipulates a tapered pin which provides for locating the fixture in exactly the desired position; and after this has been done, lever *B* is swung over to bring an eccentric binder into action, which provides for locking the fixture in place ready for performing the milling operation.

Attention can now be directed to the means provided on the fixture shown in Fig. 5 for locating and clamping the bearing cap castings in place. In setting up the work in both of these fixtures, an arrangement of supporting points is provided, which constitutes the equivalent of the three-point suspension used for holding large sized castings on planer type milling machines. On the fixture shown in Fig. 5, each casting is supported by means of two fixed points, one of which is shown at *C*, and by two points on a pivoted block *D*. Owing to the way in which block *D* floats, it is able to adjust itself for slight variations in the size and shape of

the castings so that assurance is obtained that both of the supporting points at the top of block *D* will come into engagement with the work. Were it not for having this block mounted on a pivotal support, there would be considerable probability of the work being supported by means of the two points *C* and one of the points at the top of block *D*.

After two of the castings to be milled have been set up on the supporting points on one station of the fixture, a half round strap *E* is dropped into place in the bearing grooves in the two pieces of work, and the clamping nut is tightened down on screw *F* to secure these two castings in place. During the time that the castings are being set up on one station of the fixture, the other two castings in the second station are being milled; and when the milling operation has been completed, the fixture is indexed to bring the two fresh castings into the operating position. On this operation, the material is cast iron, and so no cutting oil or coolant is necessary. The rate of production obtained is 40 bearing caps per hour.

Fig. 6 shows a fixture of somewhat different design from the one shown in the preceding illustration, which is used for milling a smaller size of crankshaft bearing caps. A statement has already been made that the method of indexing and clamping these two fixtures is the same. In the fixture shown in Fig. 6, each of the castings that is set up in one of the stations on the fixture is carried by two knurled shoulders *C* and a V-block *D*, the arrangement constituting the equivalent of the three-point suspension used for supporting pieces of work for the performance of a first operation. After the castings have been dropped into place, strap *E* is tightened down in order that the two knurled points *F*, which are provided on this strap, may come into contact with the top of the work and provide for holding it down on the suspension points. To secure strap *E* down on the work, a pivoted bolt *G* is swung up into place in the slot *H*, after which the nut is tightened on bolt *G* to hold the strap down. The slot provided to receive bolt *G* makes it unnecessary to do more than loosen the nut in order to remove the work from this fixture. In the performance of this operation, the pieces of work are smaller than those shown in the preceding illustration, as a result of which the rate of production obtained is twice as high, or 80 bearing caps per hour.

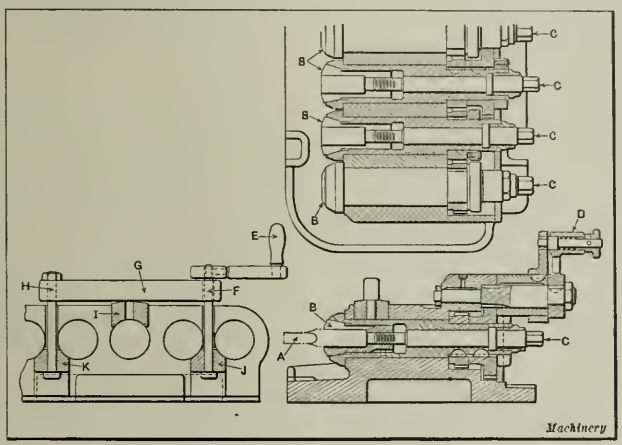


Fig. 9. Sectional Views of Indexing Work-holding Fixture shown on the Machine in Figs. 7 and 8

Indexing Fixture which Governs Form of Work

The term "indexing" is quite generally understood to imply the rotation of the work through part of a turn, in order to provide for taking the next cut, as, for instance, cutting the next tooth of a gear blank or for milling the next side of a square or other shaped piece of work. In any case, the indexing principle of fixture design as so employed is responsible for the final form to which the piece is milled. In Figs. 7, 8, and 9 there is shown an indexing fixture of this kind. The pieces to be milled are piercing punches which are required to be square in shape, with a 5-degree clearance extending back from the cutting edges. Four milling operations are performed with the work indexed through an angle of 90 degrees between successive operations, in order to obtain the square end for these punches; and by having the milling fixture tilted at an angle of 5 degrees, provision is made for obtaining the necessary clearance behind the cutting edges. On this operation, the material being milled is tool steel, and a liberal amount of coolant is delivered to the milling cutters and work, in order to prevent overheating. The double-arm Milwaukee milling machine built by the Kearney & Trecker Co., Milwaukee, Wis., on which this operation is performed, is used at the plant of the Portsmouth Steel Co., Portsmouth, Ohio, for making punches that are used to pierce the spike holes in railroad tie-plates. The punches are ¾ inch square, and are made from 1½-inch round bar stock.

A better idea of the design of the work-holding fixture will be gathered from Fig. 9, which illustrates the mechanism that is provided for tightening the four collets in which the work is held, and for indexing the work to take four successive cuts that are required to complete the milling of these punches. It will be seen that each of the four piercing punches *A*, which are set up to be milled in this fixture, are carried by split collets *B* which are closed on the work by means of screws *C* at the back of the fixture. Each of these collets is manipulated independently by means of a wrench that fits over the square end of the screw. After the work has been secured in the collets, the milling operation is started, so that the first of the square sides is produced on the work. Then the milling machine table is backed away, and index lever *D* is turned through one revolution. This motion is carried to the collets by spur gears having a ratio of 1 to 4, so that one complete turn of handle *D* results in rotating the work through 90 degrees. The collets are then locked in this position, after which the feed mechanism of the milling machine is engaged to provide for finishing the second of the square sides. By repeating this indexing and milling operation four times, the square ends of the punches are completely formed.

The clamping of the collets for the performance of each successive operation is accomplished by means of crank handle *E*. It will be seen that this handle is secured at the top of the screw *F*, which passes through a hole in one end of bar *G*. At the opposite end, this bar is held by a bolt *H*. Bar *G* is supported by a fulcrum *I*, that is formed by the top of a sliding block, the under side of which bears against the top of the central one of the five collets. At the lower end of bolt *F* there is a shoe *J* which is formed to engage the under sides of two other collets, and a similar shoe *K* at the opposite end of the fixture engages the under side of the two remaining collets. It will be quite evident from the illustration that turning crank handle *E* results in screwing the threaded hub of this handle down on bolt *F*, causing bar *G* to swing on its fulcrum. The first effect of turning lever *E* is to screw the threaded end of this lever down on bolt *F*, and, as pressure is exerted, shoe *J* is pulled up between two of the collets, thus locking them in place. Similarly, downward pressure is provided on shoe *I* for locking the third collet, and the tendency for bar *G* to swing over this fulcrum causes shoe *K* to be drawn upward, thus locking the two remaining collets.

Sale of Business and Good-Will

By CHESLA C. SHERLOCK

THERE is no business custom presenting legal complications that involves so many problems as the sale of a business and the good-will of the sellers. Business men have always assumed that upon the sale of the good-will of a business, the seller binds himself not to engage in the same business again in the same locality. This assumption seems to have been the outgrowth of an erroneous conception of the meaning of the term in its legal significance and to pure ignorance of the law. It is also due to a change in the attitude of the courts toward the subject, which has contributed in no small degree to the existing confusion. The courts at one time took the view that if a business man sold his business and the good-will thereof, he also sold his right to re-engage in the same business in the same locality, but recent decisions have materially broadened this conception. In more remote times, the courts were unfamiliar with the term, as it had not come into the usages of business. The practice of the sale of good-will is of comparatively modern origin and may be said to have been an outgrowth of modern business methods, taking cognizance of the rigors of competition and of effort, upon the purchase of a business, to remove the seller from the field of competition.

Definition of Good-will

Lord Eldon, an early English authority, defined good-will as "the probability that old customers will resort to the old place." Lord Hatherly, a more recent English authority, gives the following definition, as embracing the modern view of good-will: "Good-will . . . must mean every advantage—affirmative advantage if I may express it, as contrasted with negative advantage of vendor not carrying on the business himself—that has been acquired by the old firm by carrying on its business, everything connected with the premises, or the name of the firm, and everything connected with or carrying with it the benefit of the business." Construed in a liberal sense, this definition would seem to preclude the seller of the business from further engaging in a competing business, but the American courts, at least, do not go that far in their construction of the matter.

Court Decisions on Rights Transferred by Sale of Good-will

It has been established as a general rule in recent decisions in Iowa, Massachusetts, Missouri, Nebraska, New Jersey, New York, Ohio, Tennessee, Texas, and Ontario, that in the absence of an express covenant, the sale of a business together with the good-will thereof, does not impart an agreement by the seller not to engage again in a competing business. In a Texas case, it was shown that a salesman who had been a representative of a number of dealers and manufacturers in an exclusive territory for a number of years, had assigned his agency with the good-will of the business to a corporation of which he became manager. Shortly after the deal was transacted he was deposed from his position in the corporation and the corporation sought to enjoin him from again representing the dealers and manufacturers he had previously represented and from handling their goods in the same territory. In this case the court held that the assignee could not be enjoined from representing these dealers and manufacturers so long as he did not solicit their business or attempt to induce the old customers from doing further business with the corporation.

In an Ontario case, it was held that the partner in a manufacturing company who sold his interest in the business, might engage in the business of manufacturing a similar product, the ingredients of which were the same as those of the old firm, provided they were compounded differently; and so long as he did not use the secret formulas of the old firm, he was not debarred from engaging in a similar business, and from using the usual methods of doing that business, even though it involved use of knowledge gained as a partner.

In an Iowa case, it was held that the seller of a mail-order business is not subject to an injunction by the purchaser enjoining him from engaging in a similar business 200 miles from the former place of business. It was shown in this case that the seller had used advertising methods similar to those he had formerly used and that he had continued to conduct his new business in precisely the same manner that he had the old one, using the same name and methods. The court hinted that the damage thereby caused to the purchaser undoubtedly gave him a cause for action, but that since there was nothing in the evidence to show the amount or extent of such damage, the court was powerless to act on that score.

In a Massachusetts case, it was held that one who sold all right, title, and interest in a fire and casualty insurance business was not precluded from engaging in the same business, or from using her own name or that of her father, the former owner, in conducting it. In Nebraska, a stock of merchandise was sold together with the good-will, and it was held that such sale does not imply an agreement that the seller would not re-engage in the same business again in the same town. In Tennessee, it was held that the sale of the good-will of a business and no more did not preclude the seller from setting up in precisely the same business in the same city, or even in the same vicinity; and that the only way the purchaser can forestall such a step is to stipulate precisely against it in the contract of sale.

In Massachusetts, the rule has been laid down that a sale of good-will imposes upon the vendor an obligation to refrain from doing anything which deprives the buyer of the benefit and advantages which belong to the business, and if a competing business is set up by the vendor, the question of whether or not an agreement not to compete (where none has been expressed) is to be implied, is a question of fact for the jury to determine.

Infringement of Rights Transferred by Sale of Good-will

It is pointed out that in England the purchaser of good-will gets nothing but the right to keep the vendor from soliciting old customers of the business, while in Massachusetts no competing business can be set up if it derogates from the grant of the good-will of the old business. This distinction is worthy of consideration. It implies, and such implication seems to be found in all cases, that the mere fact that the vendor or seller has engaged in a competing business is not, in itself, ground for an action for damages or for an injunction. The real test of the right of the purchaser for relief lies in the manner and the methods in which the vendor conducts his competing business. He cannot, for instance, treat the old business firm as he would other competitors and use the same means and methods in winning business from it that he could use without restriction in the case of other competitors. He must not do anything to affirmatively win the old trade away from the old business, but in regard to new trade, he seems to have a free and unrestricted hand.

In New York, it was held that where a partner sold his interest in the firm business to his partner and thereafter engaged in a competing business, he should be restrained from attempting to procure the benefit of patterns, the exclu-

sive use of which by the old firm's manufacturers was a valuable asset of the business. This decision was made regardless of the fact that the firm did not have binding agreements with the manufacturers whereby the manufacturers could reserve these patterns for the trade of the old firm. This was held to be an element which entered into the old firm's business with which the retiring partner, by his transfer of his interest in the good-will, had bound himself impliedly not to interfere.

Use of Firm Name

The question of whether the vendor of a business and the good-will thereof can establish a competing business under his own name, which happens to be the same or identical with the old firm name, is a matter which has caused no little attention from the courts. Business men have always asserted that they have the right to use their own name in their business, and they have further asserted it to be a fundamental right of a man to use his own name, even in case he has sold the good-will of a business bearing that name.

Purchasers, on the other hand, often contend that if the vendor of a business starts a competing business under the same name or under one similar to that of the old firm, then he is not dealing fairly toward the purchasers in respect to the trade of the customers of the old firm. And there seems to be a great deal of truth in this contention. For, if a man associated with a business uses a similar name, it seems that it will be conducive in itself to the deception of old customers and lead them to believe that he has either reorganized or changed his location. If this is true, then he has no right to do it, for he is not giving the old firm every affirmative advantage it is entitled to in respect to the old customers that he has conveyed to the old firm in the grant of the good-will.

In a Federal case, it was held that an individual cannot be prevented from carrying on business in his own name, and that a purchase of the good-will of a business carried on in the name of an individual will not, as a general rule, prevent that individual from carrying on business in his own name thereafter, but in such cases the courts usually require that the later business shall be carried on in such a way as not to produce confusion with the business of which the good-will has been sold. In this particular case the firm name adopted by the vendor when he established a competing business was the same as that of the old company with the simple addition of the word "Sons" before "Company." The court held that the purchaser was entitled to an injunction restraining the new firm from soliciting business from old customers and from simulating letter or bill heads, and papers of the former corporation, and further held that the new firm should either change its name, or else change its place of doing business.

Good-will in Case of Involuntary Sale

Another phase of the matter is presented in cases where the sale has been involuntary, as in bankruptcy proceedings and the vendor has been forced, often against his will, to part with the good-will of the old business. The question then arises: Does the purchaser of good-will under such circumstances acquire the same rights he acquires where the sale has been voluntary and for a consideration? In New York, the court said: "The good-will which the owner thereof parts with in *invitum*, as in bankruptcy proceedings or by operation of law, as in the liquidation of a partnership by lapse of time or its termination pursuant to the articles of agreement, is a lesser property than the good-will which is the subject of a voluntary sale and transfer by the owner for a valuable consideration. In the first class of cases, the former owner remains under no legal obligation restricting competition on his part in the slightest degree; in the second class of cases, the former owner, by his voluntary act of sale, has excluded himself from competing with the purchaser of the good-will to the extent of having impliedly agreed that he will not solicit trade from customers of the old business. To this extent this good-will is a more valuable property than the good-will of a business which goes to a trustee in bankruptcy, or a receiver or survivor of a partnership in liquidation."

In England, it was said: "There is no question as to the general principle that if a man sells the good-will of his business to a purchaser and receives the purchase money, he cannot afterward destroy that which he has sold by soliciting his old customers, but that principle has never been extended to any case except that of a sale, or of some construction equivalent to a sale." Good-will has come to be recognized by the courts as a valuable trade asset, and while there formerly was a struggle over this contention, all question as to its reasonableness seems to have passed. It is a trade asset in one sense, but it is well to keep in mind that it cannot be disposed of independently of the other assets of the firm.

When and how Good-will may be Transferred

Good-will must always follow the other tangible assets and the seller cannot separate it from such assets and convey it to another party independent of them, although he may reserve it to himself while conveying the assets to other parties. As to when good-will exists, there is some contention. Many courts have said that where a monopoly is enjoyed and there has been no competition that there is no good-will, but this cannot be taken too literally or difficulties will arise on all sides. It cannot be said, where the good-will involves the sale of patents and trade-marks as the tangible assets, that no good-will exists, even though a monopoly was enjoyed. While good-will may be sold and transferred as an incident to the business, it cannot be reached by a creditor's bill, and it is well settled that a stockholder in a corporation has no interest in the good-will of the corporation sufficient to make it the subject of sale. Partners cannot sell the good-will of the partnership unless every partner joins in the conveyance, although a partner may assign or sell his own *interest* in said good-will, either to the surviving partners or to other persons, provided he is not restricted by the partnership agreement.

Where the contract of sale of a business fails to mention the good-will thereof, it is presumed by the courts that it was intended to follow the other tangible assets of the business, and there is no presumption that it was reserved by the seller. Good-will is reserved to the seller only when expressly so stipulated in the contract of sale, and the purchaser of the business acquiring the good-will along with the other assets can prevent the seller setting up a new business only when he has expressly so stipulated in the contract of sale. Infringing on the conveyance or grant of good-will consists of the use of any method on the part of the seller which threatens to destroy the property which he has granted to another by his conveyance. He cannot engage in *unfair competition* with the old firm, which means that he cannot attempt to hold or win back the old customers by deceit, artifice, or direct solicitation on his own part.

There are two remedies open to the purchaser of a good-will which has been infringed. They are either an action to recover payment for damages to the amount of the injury caused by such infringement, or an injunction to prevent a continuance of such unfair methods. In the case of damages, the purchaser must be able to state a specific amount of damage caused by the infringement and prove it. When an injunction is granted no sum is awarded for damage, the seller merely being stopped from further infringement by legal proceedings. Another remedy is sometimes recognized which relates to the specific performance of the contract whereby the seller has agreed to convey the good-will of the business. This remedy is not, however, as effective as those previously mentioned. The general legal principles involved, as explained above, may prove of value particularly to men who are more closely in touch with mechanical problems than with business procedure.

Carburizing and Casehardening

Second of a Series of Articles Describing Methods of Carburizing, Determining Depth of Carburization, Protecting Portions of Work in Local Carburizing, and Cleaning of Carburizers After Use

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THE temperatures used in universal practice for carburizing vary greatly. It is customary to find temperatures ranging from 1400 to 1900 degrees F., and every firm will give valid reasons why the temperature used is the best. Examination of these reasons usually shows that the degree of heat used is based either on the furnace operation or production. Some furnaces, due to their construction and fuel, are unable to produce high temperatures, and of this order are notably the old type of coal-fired furnaces. Lack of furnace space in relation to the amount of work often forces the operator to raise the temperature higher than good work calls for, in order to enable him to keep up production. Sometimes no regard is given to variable temperatures in the furnace during the period of carburization. It is, of course, impossible to entirely eliminate variable temperatures in different parts of a furnace, especially in large furnaces. The proper design of furnace and kind of material used in its construction will, however, reduce this trouble to a minimum. It is readily seen that considerable temperature variation in the different parts of the furnace will directly affect the depth of penetration of carbon in the work, and likewise the amount of carbon or percentage of intensity. This is due to the fact that steel is more susceptible to carbon penetration at high temperatures than at low temperatures, and also because the amount of carbon in the carburizing gases varies with the temperature.

Importance of Constant Temperatures

Variable temperatures during the carburizing operations should be avoided for the following reasons: (1) The furnace lining is subjected to unnecessary strain by cooling and heating. (2) It is difficult to keep track of the progress of the carburizing operations. (3) The steel is subjected to various intensities of carbon in the carburizing gases which make a non-uniform case. (4) The dangers of enfoliation or separation of the carbon into layers are increased. (5) The carburizing material is strained at the high temperatures and will give off so much gas that its efficiency at the lower temperatures will be impaired, and hence the variable temperature seriously interferes with the results.

There are, of course, certain classes of work on which hardness is the only thing desired, and where accurate control of the furnace temperature is not always necessary. For the general class of work, however, it will be found that uniformity of temperature is wise, as it will save in many ways, and will tend to eliminate mental vexation of the hardeners.

When deciding what temperature to use for carburizing, the following factors must be considered: Depth of penetration, carburizing material, size of pot, and class of work. Other points which have some bearing are the steel, furnaces, fuel, and production.

Factors Influencing Carburizing Temperature

Depth of Penetration—The man in charge of the heat-treatment should know to what depth the work is to be carburized. Experience is of the greatest value in determining this, not necessarily experience with other identical parts, but with parts bearing similar relationship as regards strain, shock, and wearing qualities. For work requiring a slight depth of 1/32 inch and less, low temperatures of from 1450 to 1550 degrees F. are perhaps advantageous if the carburizing material is not considered. The reasons for this are that initial penetrations take less time than final penetration; in other words, each succeeding 1/64 inch of penetration takes a longer time than the preceding 1/64 inch. The low temperatures allow the operator to regulate the depth with greater exactness, and for parts of small cross-section this close control is vital, as high temperatures cause the depth to go beyond that desired before the work can be removed from the furnace. High temperatures for slight depth work will cause pots to lag in heat from the outside to the center, the result being great uneveness in the depth of carburization between the outer and center pieces. For work requiring a depth of from 1/32 to 1/8 inch, a temperature range of from 1550 to 1650 degrees F. is desirable, as this will allow sufficient control of the latter part of the penetration, and the heat lag from the outside to the center of the pot will be negligible. For work requiring a depth of ⅛ inch and over, a temperature range of from 1650 to 1750 degrees F. will answer the purpose. There are very few instances where it is wise to use a temperature in excess of 1750 degrees F., as the steel becomes porous from the extreme grain size and the carbon intensifies on the surface, forming free cementite or freckled edges. The extreme grain and free cementite are only removed with difficulty by subsequent heat-treatment, so that what is saved in time in the carburizing is lost by the time and cost of restoring the damage done.

Carburizing Material—Bone, leather, and commercial carburizers containing these products in a great part as a base are most efficient up to 1550 degrees F. Beyond this point they rapidly lose their efficiency and after a few hours of use they become dead. Bone has a total life of about ten

TABLE 4. DEPTHS AND PERCENTAGES OF CARBON ON WORK TREATED BY VARIOUS CARBURIZERS AT DIFFERENT HEATS AND TEMPERATURES

Kind of Carburizer and Temperature of Heat in Degrees F.	Length of Heat, Hours	Depth of Carburization in Inches of Layers Containing Different Percentages of Carbon			Total Depth of Carburization, Inch
		More than 0.9 Per Cent	0.8 to 0.9 Per Cent Inclusive	Less than 0.8 Per Cent	
Bone, 1600.....	5	0.0066	0.0066	0.0192	0.0324
	10	0.0030	0.0144	0.0190	0.0364
Bone, 1750.....	5	0.0126	0.0180	0.0216	0.0522
	10	0	0	0.0612	0.0612
Oil Hydrocarbon, 1600.....	5	0.0012	0.0072	0.0174	0.0258
	10	0.0090	0.0120	0.0280	0.0490
Oil Hydrocarbon, 1750.....	5	0.0144	0.0168	0.0235	0.0547
	10	0.0252	0.0252	0.0384	0.0888
Chemical, 1600..	5	0.0084	0.0108	0.0216	0.0408
	10	0.0025	0.0144	0.0300	0.0469
Chemical, 1750..	5	0.0230	0.0145	0.0276	0.0651
	10	0.0250	0.0169	0.0540	0.0959

Machinery

hours at 1600 degrees F. at which time it will become completely exhausted. Other commercial carburizers containing charcoal, coke, and coal as generators, and chemical and oil hydrocarbons as energizers should be used at temperatures of from 1500 to 1750 degrees F., the best efficiency being obtained at about 1600 degrees F. Granular or pellet carburizers are liable to be burned to ash by the use of too high temperatures, especially if the sealing of the pot is poor and allows the entrance of the oxygen of the air. This would result in exposed work which would be spoiled by decarburization and oxidation. For low temperatures, the size of the pot is immaterial except for slight-depth work. For combinations of high temperatures and slight depth, the smaller the pot, the better; otherwise, the lag of the heat from the outside to the center of the pot will over-carburize the work near the outside before the work at the center has started to carburize. As a general rule, small pots are to be desired for high temperatures, especially for slight-depth work. For low temperatures, the same holds true to a less degree.

In commercial practice, as a rule, no annealing precedes the final machining operations. Because of this, the work, when received for carburizing, contains mechanical strains that are relieved by heat and cause warpage during the carburizing operations. The higher the temperature, the more readily the strains are removed; further, the higher the temperature, the greater the work expands and the greater the grain size becomes, while distortion and warpage are more likely to occur. This is especially true with fluctuating heat. Where large grinding tolerances are left on the work after final machining, the warpage of the work is secondary, but for delicate fixtures having a great variety of cross-section sizes, low temperatures will give by far the best results. Alloy steels will, as a rule, stand more abuse in heating than straight carbon steels, inasmuch as alloy steels are denser and the grain size is less liable to be abnormally increased, which helps to decrease distortion.

Where furnaces are uncertain in their operation, so that it is hard to hold the temperatures uniform, the low temperatures are safest. Such furnaces and their operation, however, should be investigated, as such conditions should not exist. The operation of the burning apparatus should at all times be controlled to give a combustion of gases slightly rich, as lean or dry combustion gases contain an excessive amount of air, which retards carburization, scales the pots, etc. A low temperature is usually richer in carburizing gases than a high temperature. High sulphur fuels are always harmful to steel in a heated condition, and the higher the temperature, the greater the danger. In carburizing, this is not important except from a fuel cost standpoint, as the gases generated by the carburizer are in excess of the furnace gases, and there is at all times a slightly greater pressure within the pot than in the furnace, which prevents the sulphur from coming in contact with the work. Heavy production and inadequate facilities force shops to use high temperatures for carburizing. When this occurs, extra care should be taken to guard against unforeseen happenings, as the high temperature may be close to the danger point. At the end of the increased production period, lower temperatures should be used so as to increase the factor of safety even though no apparent harm has resulted.

Determination of Carburization Depth

No special rules can be given for determining the depth of carburization required for different articles. This can only be determined by experience, so the hardener and the designing engineer should be consulted when deciding this. They should know what shock or strain the work is to be subjected to, and if the strain is great and the cross-section of the part is comparatively small, their decision will undoubtedly be to give a slight depth. If, however, the work has a large cross-sectional area and the strains are not very great, a greater depth may be allowable. The question of the amount of surface to be removed by grinding, as a result of warpage, shrinkage, and expansion of the work, will govern the minimum depth of carburizing. It would be undesirable, of course, to grind through the case at any point due to a high spot caused by warpage.

The desirable carbon case contains from 0.8 to 0.9 per cent carbon. The longer the heat and the higher the temperature, the higher the percentage of carbon becomes on the surface of the work. If the work requires grinding after carburizing and hardening and the high carbon is ground off to the zone containing from 0.8 to 0.9 per cent carbon, best results can be obtained and great-depth carburizing can be done. If, however, the work is not ground after carburizing and hardening, slight-depth carburizing is safest, unless care is taken in the selection of the carburizer and in the heat-treatment after carburizing.

Table 4 shows the depths and percentages of carbon in work exposed to three kinds of carburizers for five- and ten-hour heats at two different temperatures. This table gives the depths of various layers containing different percentages of carbon and also the entire depth of carburization. These figures were obtained by microscopic examination, and for such an examination the work should be cooled in the carburizing pot, sawed in two pieces, polished, etched with a 10 per cent solution of nitric acid in alcohol, and then examined under about 100 diameters, which will allow the total penetration of the different layers to be distinguished. The layer containing more than 0.9 per cent carbon had free cementite and pearlite; the layer containing from 0.8 to 0.9 per cent consisted of pearlite, and the layer having less than 0.8 per cent consisted of pearlite and ferrite. It will be noted that, in several instances, long heats at high temperatures caused zones of less measurement than shorter heats at lower temperatures. This was especially true when bone was used, as that material played out and lost its ability to give high amounts of carbon during long heats at high temperatures. A close study of this table will give an idea of the carburizer and the temperature to use for certain variables of high percentages of surface carbon and total depths.

Such parts as gears, cams, and gages are usually carburized to a depth of about 1/32 inch. Greater depths of about 1/16 inch are used for ball bearings, arbors, plug gages, etc., while depths up to ½ inch are used on large sizes of ball bearings. The reason for this is that the load is supported on a very small area and the shell must be heavy enough to prevent a small section of it from pushing into the core. Greater depth than this is limited to armor plate, etc. It is expensive to carburize work of great depth, and when the depth is more than ⅜ inch it will be found more economical to use tool steel.

Observation of Carburization Progress

It is usually necessary to control the depth of carburizing operations closely, and as the depth is affected by the carburizing material, temperature of the pot, length of the heat, and method of packing and sealing, it is necessary to have some knowledge of the progress of this work. There are a number of ways of doing this, but if the work is small and the cost of the individual pieces trifling, the most satisfactory way is to remove a piece from the pot, let it cool in the air, reheat it to about 1450 degrees F., quench in water, and break to judge the depth of case. When no previous experience has been had in this work or when a new carburizer or heat is being used, or other conditions vary, it would be well to break specimens at stated intervals of time and plot from them a rough time penetration curve. This will give an approximate idea of how long it will take to carburize to a given depth. However, there are so many conditions entering into the carburizing operations, such as, for instance, the operation of furnaces on different days under varying weather conditions, that it is impossible to judge the depth of carburization accurately for a stated number of hours. It is best to take a sample from the pot after it has been carburized for three-quarters of the time shown by the penetration chart and break it as described above. From observing this sample and by comparison with the chart, it will be possible to determine if the work is ahead of or behind the schedule. From this sample a very close approximation can be made as to when to complete the heat. The charts shown in Figs. 3 and 4 in the article published in the January number of MACHINERY will be found of assistance in making up the chart just described.

In the charts just referred to, Curves 1, 2, 3 indicate how it is possible to be mistaken as to the depth of carburization for various lengths of time. A study of these charts will show that the apparent depths secured vary according to the method of depth examination and the shape of the work. Polishing and etching or bluing will show the depth approximately right, because the acid or heat acts only on the higher carbon of the case, whereas, a rough fracture will indicate a deeper carburization. Round rods carburize deeper per unit of time than rectangular rods, and both carburize deeper than concave surfaces. This is due to the fact that convex surfaces fill up more rapidly with carbon than concave surfaces, because with the concave surfaces, the carbon, after it has entered the work has to spread out to cover more case area.

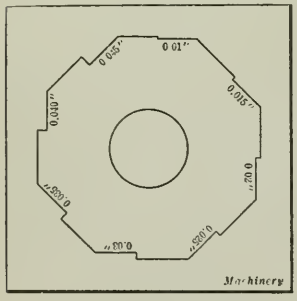


Fig. 8. Octagonal Scale for measuring Depth of Case on Hardened Work

If it should be considered too costly to break a sample for testing purposes, it would be well to put into the pot some of the scrap pieces of steel from which the work is made. These steel pieces could be attached to wires which would reach up under the cover so that they could be readily reached and removed, or better still, holes could be drilled through the cover of the pot and some of the same steel in rod form could be stuck through the cover into the pot, so that it could be withdrawn at any time. Such pieces are called "tell-tale" pieces and can be used in determining the depth of the operation at different times, and if placed in different positions in the pot can be used to tell the rate at which the pot is heating up, by comparing the color of the "tell-tale," immediately after withdrawal from the pot, with the color of the pot or the furnace. In this way, it is possible to tell whether or not the inside of the pot has the same temperature as the furnace. All carburizing operations should be tested from the time that the pot has reached the temperature of the operation, inasmuch as some concerns charge their furnaces when cold and others when heated. The difference in the sizes of the pots and the form of material, that is whether it is granular or powdered, cause a great variation in the time required to bring the pot to the desired temperature. After this has been reached, the rate of carburization is equal, regardless of the form of material or size of the pots, provided the materials are of the same chemical composition and the pots are sealed equally.

Observation of Carburization by Quenching Sample Piece Directly from Pot

Another method of determining the depth of the carburization is by quenching the sample piece directly from the pot in either oil or water. If oil is used, it should be carefully wiped from the piece before the fracture is made, or the oil will discolor the fracture and give misleading results. Although this is quite a good method, it is not as good as the method previously explained, due to the fact that the grain of the case and core is coarse and very nearly of the same crystalline size, which makes it hard to note the line of demarcation. However, if this method is used, and the piece is held in front of the fire and tempered to a slightly blue color, it will be found that the high carbon of the case will take on the temper colors more rapidly than the low carbon of the core and the result will be that the case will show up a deep blue, while the center of the core will be a straw color. For the same purpose the sample could be immersed in a 10 per cent solution of nitric acid, after which the case would appear much darker than the core. The previous method of reheating to 1450 degrees F. and quenching in water, gives a better and truer idea of the actual conditions which have taken place and shows results that may be expected in the finished product.



Fig. 9. Section of Ball Races showing Appearance of Hardened Surface

If the seal or luting of the pot is broken when the test samples are removed, the pot should be luted up again before being put back into the furnace, or else the rate of carburization in that pot may be retarded, and if the same pot is tested again, it may not be representative of the rest of the pots in the heat. It is well, if there is a variation of temperature in the furnaces, to take the test samples from a pot which has an average temperature. Fig. 8 shows an octagonal disk which may be used for measuring the depth of case. The edges of this disk are notched for this purpose, the depth of the notch being given in each instance.

Value of Local Carburizing

Local carburizing, or the process of carburizing only those areas which are to be increased in carbon content so as to obtain the desired hardness while the remainder is left soft, is one of the most valuable features of the carburizing process. The following are some of the products on which this treatment is invaluable: (1) Ball bearing races, on which a deep backing of soft metal is desired for strength and toughness while the surface in contact with the ball is extremely hard. Fig. 9 shows two ball races cut in half on which the depth of the case can be readily seen. (2) Carburized taps and drills, where production precludes handling the parts separately in the hardening operation, in order to keep from heating and quenching the shanks. (3) Delicate tools or gages on which the thickness of the metal would be carburized clear through and thus cause brittleness. (4) Work which distorts in hardening and must be reshaped by machining or bending, such as arbor shafts, camshafts, etc.

Methods of Preventing Carburization of Certain Portions of the Work

There are numerous ways of preventing portions of the work from being exposed to the carbon-carrying gases. The

sections that are to be kept free from an increase in carbon may be covered with fireclay mixed with water to the consistency of putty, then dried by moderately slow heat, and finally packed in the pots with a carburizer in the ordinary manner. Drying before packing is usually necessary because when the water in the fireclay is exposed to the high heat of the carburizing furnace it will cause the fireclay to crack, permitting the carburizing gases to enter the fissures thus made and cause partial carburization. Salt is often mixed with the fireclay, which lowers its fusing temperature and acts as a binder. After carburizing in the usual manner, the clay is cracked off and the work treated in the hardening operation the same as carburized work. This method is successful for small shops where the demand for local carburizing is not great.

The metal protecting sleeve is especially practical where the form of the work warrants its use. This method consists of slipping a sleeve or collar over the part required to be free from an increase of carbon. The sleeve is either a push or loose fit, and if the latter, it can be wired in place. If the sleeve is too loose, the carburizing gases will enter between the sleeve and the work, but this may be satisfactorily avoided by daubing a thin mixture of fireclay on the inside of the sleeve before putting it on the work. After carburizing, the work may be hardened in the regular way either with the sleeve left on or removed. Leaving the sleeve on insures softness of the covered section, but if the sleeve fits on the work too tightly, trouble may be experienced in its subsequent removal, due to shrinkage. The sleeve may be of iron or steel and can be made in sections for ease in applying, in which case the sections may be wired together and covered with fireclay at the joints, or it may be cut away as the work demands.

Asbestos is often used in local carburizing by wrapping it around the section desired to be kept free from an increase in carbon and binding it in place with bundling wire. Sand can be used for the same purpose by placing it in the bottom of the pot and imbedding in it the section of the part desired to be kept free from an increase in carbon, permitting the section to be carburized to extend above it and be packed with carburizing material in the regular way. This method is usually not desirable because the sand becomes mixed with the carburizing material, and with the iron scale which accumulated from the pots, will eventually form glass or silicate deposits on the work.

A thin paste of water glass (sodium silicate) and kaolin (a fine grade of clay) is often painted on sections of the work that are to be kept free from an increase in carbon. Used sand-blast sand in a finely divided state is often mixed with this. This mixture is dried on the work by air, after which the work is packed in pots in the regular way. Local carburizing is also effected by the application of a compound called "enamelite," which is applied and used in the same manner as the preceding preparation. These various methods are more efficient for slight-depth than for great-depth carburization. The skill of the operator in applying them affects the final results. In carburizing to great depths, the long heat eventually breaks the protection, and penetration of the carbon results, the sand method being probably the only exception. An excellent and sure method of keeping a desired section free from hardening is to leave sufficient metal on the sections that are to be soft and then after carburizing and hardening, this excess metal can be machined from the piece. It is evident that more time will be required by this method and the cost will be greater.

Local Carburization by the Copper-plating Method

The most satisfactory method of local carburizing, when the volume of the work warrants it, is the copper-plating method. It is well known that it is impossible to harden copper by heat-treatment, because carbon is the chief hardening element in metals, and there is no affinity between copper and carbon. The copper is plated on the work by the electroplating process. A coating of copper sulphate is unsatisfactory, as there is no bond between the steel and the copper coating, and because of this, the coating will peel off under certain conditions, such as too heavy a copper coating, lack of density, or different expansions of copper and iron due to heat. The copper electroplating process consists of chemically cleaning the work, copper electroplating it, and then mechanically removing the copper at the parts that are desired to be hardened. The process of mechanically removing the copper also removes some of the steel, so it is necessary to have a sufficient allowance of metal to be removed. The copper may be ground or machined off, but the former method is unsatisfactory, as minute particles of copper are replaced and imbedded by the wheel in the surface to be hardened, thus giving to the hardened finished surface a semi-softness that is often puzzling as well as serious. The following is an actual occurrence:

A certain concern making airplane engines experienced trouble in getting sufficient hardness on the cams of camshafts. Their method was to copper-plate the shaft and cams and then grind off the copper on the surface of the cams. The fault was laid to the carburizer, and various commercial grades of materials were experimented with, but no improvement resulted. The writer investigated the trouble and with the aid of a magnifying glass, noted tiny specks of copper on the surface of the cams. One of these cams was then heated to a cherry red and quenched in oil, which brought out the copper very plainly. The copper appeared as yellow specks while the steel had turned black. The grinding wheel was examined next, and its surface was found to be full of copper, so it was assumed that the wheel removed the copper in small particles and replaced some of these particles by imbedding them in the soft steel. The effect, when carburized, was that there were small soft spots which had been protected from the carburizing gases so that the hardened work was a mosaic of minute hard and soft spots which could be filed.

Japanning the Portion of the Work to be Carburized

In order to eliminate mechanical removal of the copper, japanning of the surface desired to be carburized is often resorted to before copper-plating. After baking the japan on, the work is plated, but the copper does not adhere to the japanned portion. The japan burns off in the carburizing process, and the steel formerly covered by the japan becomes carburized. The following method is used by a large concern doing local carburizing, the work being protected by electro-copper-plating. The grease is first removed from the work by cleaning with sal soda or gasoline, according to the amount of grease, after which the work is thoroughly cleaned by washing successively in potash, hydrochloric acid, cold water, potash, cold water, cyanide solution, cold water, and finally hot water. The work is then covered with two coats of japan, being baked at 400 degrees F. after each coating. The same routine of washing is then gone through as before, but omitting the hot water. The work is then placed in a cyanide copper solution for ten or fifteen seconds, or until a copper color is barely obtained. This solution is kept lukewarm and used with electric current of about 5 volts. The formula for this solution is as follows: 50 gallons of water; 25 pounds of copper carbonate; and 50 pounds of cyanide of potassium (or enough to bring the carbonate into solution). The solution is kept at from 8 to 10 degrees Baumé. After the work is thoroughly rinsed in cold water, it is transferred to a nickel-plating bath, used with a current of about 3 volts and having a scant anode surface. The bath is not allowed to become hot, and the work is plated for from ten to fifteen minutes to give a good foundation. The work is again rinsed thoroughly in cold water and transferred to a cold acid copper solution, used with a current of 5 volts, in which it is plated for twenty or thirty minutes. The formula for this solution is to add to 50 gallons of water enough copper sulphate to give a reading of 18 degrees Baumé, and enough sulphuric acid to give a reading of from 20 to 22 degrees Baumé, care being taken to keep the acidity and specific gravity correct. The work is then washed in cold water, hot water, and finally dried.

The ability of the plate to resist the action of carburizing materials does not depend upon the thickness—from 0.001 to 0.0015 inch is sufficient for any purpose—but on foundation and density. The cleaning before and after japanning, keeping the solution cool enough, and the density of the plate, are the important factors in electroplating. The nickel-plate might be omitted in some cases, but it eliminates the necessity of the work remaining a long time in the cyanide-copper solution and the consequent effect on the japan and steel. It also gives a good foundation which is resistant to the action of the acid copper solution. The method of plating just described is used for work requiring over a hundred hours of carburizing and is very satisfactory.

Importance of Taking Proper Care of Carburizing Material

The carburizing operation often meets with a lack of success and this is due, in the majority of cases, to not taking proper care of the carburizing material. This material should be considered as important as the furnace, any piece of machinery throughout the factory, or the cutting lubricants used for machining purposes. During the use of the carburizing material, it is giving off gases, a certain proportion of which are absorbed by the steel. A greater proportion, however, is lost through the sealing or luting of the pots. It is impossible to prevent this loss unless the carburizing is done under pressure, and then such a pressure could be generated as to blow the pot apart unless some type of safety valve were arranged. This is not practical for the shop, and is therefore only a laboratory proposition. In consequence, with the release of the carburizing gases, there must be a deterioration of the material.

Methods of Cleaning Carburizers

All material, whether in pellet or powder form, is made up of distinct particles. In the pellet form they are the pellets themselves but in the powder form these particles are very small in size. When the pots are cooled before the covers or luting is removed the deterioration of the material will take place by a shrinkage of the particles, either through throwing off the gases or by a surface loss. In either case a certain amount of ash is formed which is a dead material and must be removed before the material can be used again; with pellet materials, the natural handling, through dumping of the work, will cause this ash to fall away from the pellets, and it can readily be separated by sifting. This ash may be of a dust nature, or it may consist of small granules. As the latter is often true, it is best to sift this material through a fairly coarse mesh. This sifting will remove all the dust and a considerable proportion of the smaller pellets which possibly would have become dust themselves before the end of the next heat, and would clog the circulation of the heat-conducting gases. For this purpose the ordinary fly screen netting is very satisfactory.

With a pellet material there should be enough space between the pellets to allow the gases generated at the outside of the pot to circulate through to the center. Therefore the dust not only is dead material and takes away the strength from the whole, but it also clogs up these spaces between the pellets and prevents the proper circulation of the gases. For the same reason too small pellets are not desirable in a pellet material.

With a powder material, this circulation of heat-conducting gases throughout the pot is not as perfect as with the pellet material. The heat is conducted throughout the pot by conductivity, and the dust which is generated through the use of the small particles merely weakens the strength of the whole. It is impracticable, of course, to sift such a material. It will also be found that as this material packs denser in the pot and the space between each particle becomes minute, air will not readily be conveyed into these spaces, and in consequence the loss due to the dead dust will not be as great as with a pellet or granular material. The particles, however, will continue to become smaller and make the contents slightly more dense. It will be found, also, that dead dust will be generated on the surface of the pot to varying degrees of depth, due to greater exposure to air and furnace gases, and it is therefore the usual practice to discard a certain amount of the surface layer of this material, usually from about one-third to one-fifth of the total volume.

When work is quenched directly from the pot and the carburizer is subjected to the air, it will be found that due to the greater exposure to the air, the material will be subjected to a greater strain than by keeping sealed in the pot. The particles will dust and shrink more, and with a pellet material, sifting should be very carefully done, while with a powder material, more material should be discarded from the surface of the pile than was discarded when the work was cooled in the pot. In most materials the remainder is of approximately the same carburizing strength as when it was first used, except, of course, in the case of materials that employ as an energizer chemicals which are regenerated by air exposure, and also materials that are regenerated by hydrocarbon oils. It is more satisfactory, and usually the custom, to add to this material enough new material to make up the original volume used. If this system of sifting the old material and adding enough new material after the first heat to make up the original volume is followed, it will be found that the carburizing material after a second heat, will begin to approach a constant carburizing strength and give uniform results. There are, however, some materials which are exceptions, and which will be mentioned in a subsequent article.

Often the carburizing material is dumped directly into either oil or water with the work when hot. When dumped into oil, this material will usually have added strength. The material should be removed, drained, and then before being used again, mixed with a like amount of dry material. If more than 50 per cent of this mixture is material that has been dumped in oil, it will be found that more smoke will be given off into the furnace than the flues can take care of. As this material has more strength than new material, due to the hydrocarbons of the oil, it has been found practical to mix the two together. The correct proportions can be determined after a few experiments, and then if conducted properly each time, uniform results will be obtained. When the material is dumped in water it is neither harmed nor improved. It should be dried thoroughly, sifted, and then mixed with new materials as if it had been cooled in the pot or subjected to the air.

* * *

HEATING MOLDING PRESSES FOR BAKELITE

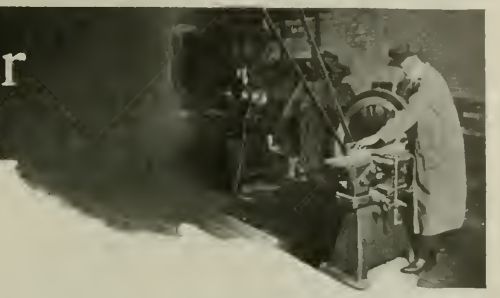
Steelclad electric heaters have been employed successfully for the heating of molding machines used in the manufacture of bakelite products, and it has been found that the superiority of electric heat over steam is very pronounced. The saving in rejected material contributes in a large measure to the success of the electric heaters used for this purpose. One of the newest applications consists in applying steelclad heaters to molding machines used in the manufacture of radiator caps for automobiles. A single press will mold sixteen radiator caps at one time, each press being equipped with eight steelclad heaters rated at 625 watts each. With a machine thus equipped, the production is increased sixteen times over the former method, and the percentage of rejections is reduced to a minimum.

* * *

When a steel article having a metallic coating is scratched or abraded so that a small area is exposed, the two metals, in the presence of atmospheric moisture, will form a galvanic couple, or cells, in which a current will be set up. The metal which is electro-positive relative to the other will be oxidized while the electro-negative metal will remain uncorroded. When the coating is zinc, the zinc will be oxidized. If, however, the coating is made from tin, which is electro-negative to iron, the steel will be attacked by rust; hence, tin as a protective coating is useful only as long as the coating remains everywhere continuous.

Pattern Lumber

By Joseph A. Shelly



THE best lumber for patterns, or in fact for any other purpose, is always cut from mature trees, the fibers of which have become compact through the drying of the sap as well as the external pressure exerted by the bark. For this reason, wide boards are invariably superior to the narrow ones that are milled from immature trees.

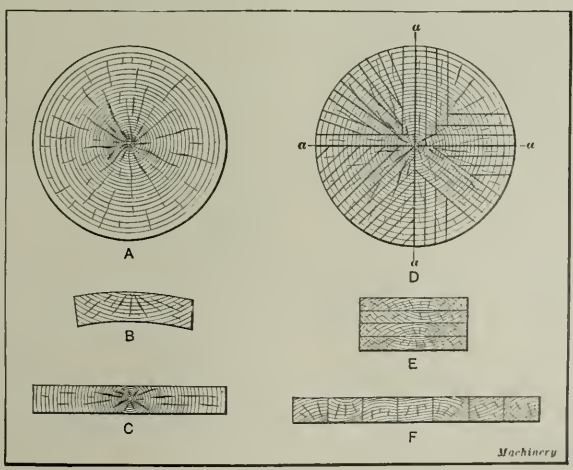
A section of a log (see sketch *A*) on examination will disclose a series of concentric rings extending from the center of the log to the outside. These are called year or "growth" rings, and as one is added each year that the tree lives, its age can be determined by counting these rings. The variations in the amount of each year's growth can also be noted by the varying spaces between these rings. Radiating from the center of the log, and extending to the outside in broken lines, are what are known as the medullary or silver rays. The "heart wood" is that which lies nearest the center of the log; it is darker in color and superior in quality to the "sap wood" which lies directly inside of the bark.

Varieties of Lumber Used in Pattern Work

Many different varieties of lumber have been used in pattern work, and some of them possess admirable characteristics. Of the softer woods, white pine, white wood, poplar, Washington fir, and red wood, are the most common varieties. The list of harder woods used for this purpose includes mahogany, baywood, cherry, maple, and birch. Of the softer woods, all of those mentioned, except white pine, are too easily affected by atmospheric changes to be entirely satisfactory. They shrink and swell, warp and twist; and red wood is one of the few woods that shrinks lengthwise or with the grain. Mahogany is preferable among the list of harder woods, with baywood and cherry next in order. Maple and birch are well suited for small turned patterns but are too hard to be worked economically with hand tools.

The Ideal Pattern Lumber

An ideal pattern lumber should be fairly soft and straight-grained without being splintery. It should be porous enough to take glue well, allowing it to soak into the fibers of the wood in order to make strong glue joints, and when properly seasoned it should not change its form much with exposure to heat, cold, or dampness. White or "cork" pine, as it is sometimes called from the appearance of the bark, is the only lumber that comes anywhere near filling the above requirements. It is easily the best lumber for all but the smallest patterns, being easy to work and durable enough to stand a considerable amount of hard usage. It may be procured in wide boards of considerable length and of different thicknesses. It shrinks but little across the grain, has no perceptible shrinkage lengthwise, and is porous enough to take glue well.



(A) Section of Log showing Growth Rings. (B) Warped Lumber. (C) Quarter-sawn Lumber. (D) Method of obtaining Quarter-sawn Lumber. (E and F) Pieces joined so as to offset the Effects of Shrinkage

Selecting Pattern Lumber

In selecting pattern lumber, care should be exercised to use only those boards that are dry, straight-grained and free from loose knots and excessive sap wood or worm holes. A board, however, should not be condemned if its appearance is marred by a few small tight knots, or a little sap wood at the edges, or even a few worm holes, as these are often found in lumber of good quality.

Kiln-dried lumber is lumber in which the seasoning or drying process is hastened by placing the boards in an oven or kiln. Seasoned or air-dried lumber is lumber that is permitted to dry naturally under sheds so arranged as to have a free circulation of air in good weather. Seasoned lumber is superior to kiln-dried lumber, as the rapid drying destroys much of the natural elasticity of the fibers of the wood, making them brittle and harder to work. The dryness of a board is determined largely by its weight and "feel." A dry board will feel dry to the hand and be reasonably light in weight.

The weights in pounds of various kinds of woods (commercially known as dry timber) per foot-board measure are as follows: White pine, 1.98; Spanish mahogany, 4.42; Honduras mahogany, 3; poplar, 3.25; Washington fir, 2.65; cedar, 1.93; California spruce, 2.08; cherry, 3.5; maple, 4.08.

The straightness of grain in a board is determined by the appearance of the sawn face which should present a uniform roughness over its entire surface. Boards with a twisted or fancy grain should always be avoided.

The presence of an unusual amount of pitch in a board is betrayed by its weight which will be excessive. Such a board will prove hard to work and will not make a dependable pattern. Sap is easily detected, as it will stand out on the surface in small sticky or resinous globules. The sap wood along the edges of the board will either show white or have a brownish tinge.

Sizes of Sawn Lumber

Lumber is the result of sawing trunks of trees into boards or planks that are usually cut to even feet in length and to inches in width. The thicknesses

start at one inch and advance by quarter-inch increments. Pieces less than 1¾ inches thick are called boards and the thicker pieces, planks, while those 4 inches and over in thickness are known as timber.

Lumber that is planed is said to be "dressed" and it may be dressed on one or both sides or edges. A 1-inch board dressed on both sides will be ⅞ inch in thickness. Resawn lumber is sawn again from the mill sizes in order to save stock. For example, a 1¼-inch board may be split lengthwise and planed or dressed on both sides to ½ inch instead of planing two 1-inch boards to the same thickness.

Straight- and Quarter-sawn Lumber

There are two general methods followed in sawing a log into boards or planks: One is known either as straight, bastard, or tangent sawing; and the other is called quarter-sawing. In straight sawing the log is put through the saw without regard to the relation between the longitudinal fibers and the year rings (see sketch *B*), while in quarter-sawing the log is split radially as shown at *C*. The section of year rings on the end of a quarter-sawn board will stand very nearly at right angles to the face of the board. This effect is secured by sawing the log in quarters on the lines *a-a* (see sketch *D*) and then dividing three quarters by one of the methods indicated.

Shrinkage of Lumber

A log in drying does not reduce in diameter as a result of the shrinkage that follows. This shrinkage is always in the direction of the year rings and results in the longitudinal cracks or checks that appear in telegraph and other poles. These checks are radial and follow the lines of the medullary rays as well as the line of least resistance, and occur always on the side of the log that is the shortest distance from the heart. They do not run in straight lines, as a rule, but follow the longitudinal growth of the tree, which is slightly spiral in direction. This is the reason why the grain on two sides of a board will always run in opposite directions.

The effect of shrinkage on straight- and quarter-sawn boards is quite different, as may be seen by reference to the sections *B* and *C* of the accompanying illustration. The straight-sawn board, owing to the shortening of the sections of year rings by shrinkage, becomes concaved on one side and convexed on the other, the convexed side always being the one that faced the heart of the tree. This shrinkage does not affect the face of the quarter-sawn board at all, except on thick pieces which will in time become slightly thinner on the edges. Quarter-sawn lumber is, therefore, the best for light pattern work, but the cost would be too great for its general use in patterns of large size, so the skillful patternmaker who understands the effects of shrinkage will so combine the various pieces that go into a pattern as to minimize, or if possible, eliminate the undesirable results caused by shrinkage. Examples illustrating how pieces are put together to offset the effects of shrinkage are shown at *E* and *F*. Section *E* shows four pieces combined with the grain arranged to counteract the shrinkage strains, while *F* is a standard method of arranging the grain in narrow pieces combined to form wide boards or plates.

Storing and Measuring Lumber

Lumber is usually piled on the flat side with three or four strips about a half inch thick between each board to insure a free circulation of air. This is perhaps the best plan for storing lumber in quantities, as the weight of the pile tends to hold the boards straight. The different thicknesses should be kept in separate piles and the storage room should be dry, warm, and light. Lumber for immediate use should be placed on edge in racks where boards of any size can be conveniently removed without disturbing an entire pile.

Boards are usually sold at a certain price per hundred (C) feet or per thousand (M) feet; the price is usually quoted by the M feet. A board foot measures 12 by 12 by 1 inch in thickness. To quickly measure boards 1 inch thick, multiply the length in feet by the width in inches and divide by 12; the result will be the board measure in feet. If the boards are 1¼ inches thick, add one-quarter of the quotient to the result, or if 1½ inches, add one-half. For boards 2 inches thick divide by 6, or if 3 inches thick divide by 4, etc.

Life of Wood Patterns

The length of time that a wood pattern will last, and the number of castings that can be made from it, will depend entirely on how, and of what materials, it was made in the first place, and on the amount of care given it later on. Patterns that are in constant use should be returned at intervals to the pattern shop for repairs or for revarnishing if no repairs are required. Aside from a certain amount of wear and tear due to carelessness or abuse, there are a number of legitimate reasons for causing patterns to wear out when in constant use. The vent rod which is plunged through the cope of the mold to provide outlet for the gases is usually allowed to strike the pattern and results in pockmarking the cope side; and the practice of driving large nails into the cope side of parted patterns to prevent their falling out when the cope is lifted away results, in time, in making a large hole that must be filled up. Failure on the part of the pattern shop to provide suitable means for rapping and drawing is very damaging, as the molder is likely to use a sledgehammer and crowbar as a substitute for rapping and lifting plates. In every foundry there should be someone whose business it is to take care of the patterns when the molder finishes with them, as permitting a pattern to lie for hours on a pile of wet sand or in the gangway, usually results in a badly twisted or burned pattern. Hard wood patterns will, of course, last longer than those of softer wood if given the same care; large patterns made of soft wood are often reinforced with hard wood corners and loose pieces or are faced with hard wood on the cope and drag sides.

* * *

THE "TECHNOLOGY PLAN" OF THE MASSACHUSETTS INSTITUTE

The new plan of the Massachusetts Institute of Technology for selling services to industry in definite contract form is attracting considerable attention in the business world. Among the forty odd corporations which have signed contracts with the institute are the following concerns: The American International Corporation, E. B. Badger & Sons, Utah Copper Co., Goodyear Tire & Rubber Co., Pierce-Arrow Motor Car Co., Lackawanna Steel Co., Stone & Webster Affiliated Co.'s, Stone & Webster, U. S. Rubber Co., and U. S. Smelting and Refining Co. The "Technology plan" is, in substance, that industrial organizations shall retain, consult, and work with the Massachusetts Institute of Technology under a contract which will bring them into the closest association with the institution—that is, in the future the institute is to be a technical consulting bureau as well as a technical school. Certain advantages which will accrue to the industries are obvious. A scientific library unsurpassed in the world will be available, with experienced men to guide the reader in finding the knowledge sought. Special apparatus and machinery, with assistants familiar with its operation and use, will be found of the greatest aid in the technical development of new ideas. A classified list of graduates and former students, with their experience and major qualifications, will be a real help to those seeking the solution of special problems or the way out of a difficult technical situation. A knowledge of the particular facilities of commercial laboratories and engineering offices throughout the country will be accumulated and placed at the disposal of the corporations in readily usable form. While many factors contributed to the commercial supremacy of Germany before the war, none was more potent than the close cooperation between the individual manufacturing concern and the scientific institutions of learning. The contract proposed will bring about this close relationship between the Institute of Technology and the manufacturers.

INSPECTION OF TAPERED PLUGS

By V. E. AYRE

The inspection of a single tapered plug may be made by taking micrometer readings over two wires of equal size, the top wires being placed on equal stacks of size blocks, and the lower wires on the same surface that the plug rests on.

Let

T = taper per inch established by two diameters at a given distance apart;

C = amount to be subtracted from the micrometer readings in order to determine the actual diameters of the plug at the small end and at the same distance from its base as the height L of the surfaces on which the wires are resting.

Referring to the diagram Fig. 1,

a = angle of taper;

M = greater micrometer reading over wires;

m = smaller micrometer reading over wires;

G = diameter of wires; g = corresponding radius.

Then

$$T = \frac{M - m}{L} \qquad \tan a = \frac{T}{2}$$

$$X = g \cot \tfrac{1}{2} (90 \text{ degrees} - a)$$

$$C = 2g + 2X = G + 2X$$
$$= G + 2g \cot \tfrac{1}{2} (90 \text{ degrees} - a)$$
$$= G + G \cot \tfrac{1}{2} (90 \text{ degrees} - a)$$
$$= G [1 + \cot \tfrac{1}{2} (90 \text{ degrees} - a)]$$

The diameter of the plug at the small end and at the height L may be found by subtracting the correction C, from the two measurements taken over the wires; thus

$$d = m - C \qquad D = M - C$$

$$D \text{ (Go)} = D + hT \qquad D \text{ (Not Go)} = D + HT$$

If the diameter of the plug is required at a point other than that at which it has already been measured, multiply the distance between the required and the measured diameter by the taper per inch, and either add the product to or subtract it from the measured diameter, according to its location. For example, $W = d + TY$, or $D - TZ$

Chamber Checks with Two Tapers

In inspecting chamber checks containing two tapers, the tapers can be determined in the same way as for a single tapered plug. For each measurement both wires must be at the same height from the base as shown for the measurement m_1, Fig. 2. The wires may rest on equal stacks of size blocks, or anything that is convenient so that the distances of the measurements from the base will be known.

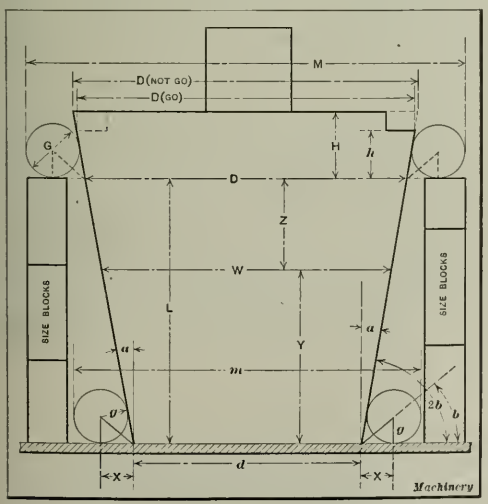


Fig. 1. Diagram used in Connection with Inspection of Single Tapered Plug

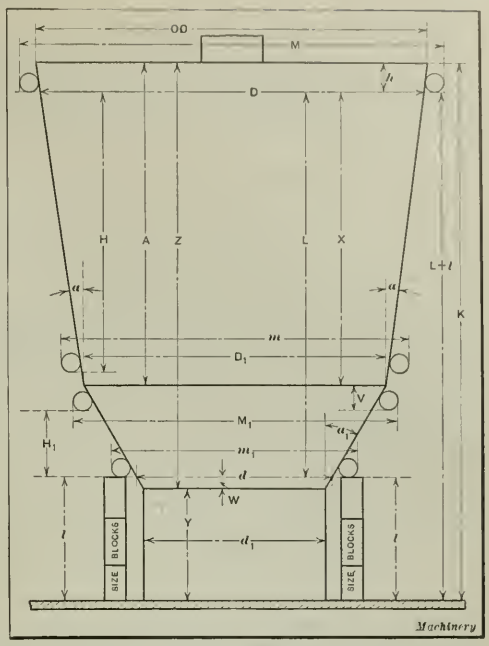


Fig. 2. Method of taking Measurements when inspecting a Double Tapered Chamber Check

Referring to the diagram Fig. 2, the long and short tapers per inch may be expressed by the equations:

$$T = \frac{M - m}{H} \qquad T_1 = \frac{M_1 - m_1}{H_1}$$

$$\tan a = \frac{T}{2} \qquad \tan a_1 = \frac{T_1}{2}$$

The amount to be subtracted from the micrometer readings may be determined from the general formula, as evolved in connection with Fig. 1. $C = G [1 + \cot \tfrac{1}{2} (90 \text{ degrees} - a)]$ = correction for taper T; $C_1 = G [1 + \cot \tfrac{1}{2} (90 \text{ degrees} - a_1)]$ = correction for taper T_1, in which G equals the diameter of the measuring wires.

The diameters which are being calculated may be expressed in the following manner:

$D = M - C$ = diameter of plug at height $(L + l)$

$d = m_1 - C_1$ = diameter of plug at height l

To find A, the distance from the point of intersection of the two tapers to the top of the plug, first find X, the distance from the point of intersection to the measured diameter D. Since L = the distance between the two measured diameters D and d, determined by the difference in height of the stacks of size blocks on which the wires rest when taking the measurements M and m_1, then, by applying the general formula for finding the point of intersection of two tapers as published in the November number of MACHINERY, page 267,

$$X = \frac{LT_1 - (D - d)}{T_1 - T}$$

and

$$A = X + h$$

Now the diameter of the plug at the intersection of the two tapers may be found by either of the formulas:

$$D_1 = d + T_1 (L - X), \text{ or } D_1 = D - XT$$

and the diameter at the large end of the plug may be found

by the formula:

$$OD = D + hT$$

To find Z—the distance to the large end from the intersection of the short taper and the straight part—first find the distance between the measured diameter d and the diameter at the point of intersection d_1. This distance is expressed as follows:

$$W = \frac{d - d_1}{T_1}$$

$$Y = l - W$$

$$Z = K - Y$$

Practical Application of the Formulas

Assume that the diameter D_1 has been found by the use of the foregoing formulas to be 1.5018 inch. Assume, further, that $l = 0.20$ inch; $l + H_1 = 0.75$ inch; $d_1 = 1.452$ inches; and that the readings over the wires placed at these heights are $m_1 = 1.6488$ inches, and $M_1 = 1.69$ inches.

If the diameter G of the wires is 0.0962 inch, then according to the formula, the taper per inch of the lower taper equals

$$T_1 = \frac{1.6900 - 1.6488}{0.75 - 0.20} = \frac{0.0412}{0.55} = 0.0749 \text{ inch}$$

The angle of taper may be found from the formula:

$$\tan a_1 = \frac{T_1}{2} = \frac{0.0749}{2} = 0.03745$$

$a_1 = 2$ degrees 8 minutes 40 seconds

The amount to be subtracted from the micrometer readings in order to determine the actual diameters at the heights of the size blocks which support the wires, is found from the formula:

$$C_1 = G\,[1 + \cot \tfrac{1}{2}\,(90 \text{ degrees} - a_1)]$$
$$= 0.0962\ (1 + \cot 43 \text{ degrees } 55 \text{ minutes } 40 \text{ seconds})$$
$$= 0.0962 \times 2.0381$$
$$= 0.19606 \text{ inch}$$

The diameter at distance l from the small end is, therefore:

$$d = m_1 - C_1 = 1.6488 - 0.19606 = 1.45274 \text{ inch}$$

and in like manner the diameter at distance $l + H_1$ from the small end is

$$M_1 - C_1 = 1.6900 - 0.19606 = 1.49394 \text{ inches}$$

The distances $K - A$ and Y are then determined as follows:

$$K - A = 0.75 + V$$

$$V = \frac{1.5018 - 1.49394}{0.0749} = 0.1049 \text{ inch}$$

Therefore,

$$K - A = 0.75 + 0.1049 = 0.8549 \text{ inch}$$

Also

$$Y = 0.20 - W$$

$$W = \frac{1.45274 - 1.4520}{0.0749} = 0.0099$$

Therefore,

$$Y = 0.20 - 0.0099 = 0.1901 \text{ inch}$$

* * *

For five years, transmission lines in Southern California have proved successful for transmitting electric current at 150,000 volts. The total power developments from hydraulic sources in California now equal 325,000 kilowatts. There are four large projects that could be developed to give 1,500,000 kilowatts additional within a few years. It has been suggested that the power from these projects could be distributed over a large area by 220,000-volt transmission lines. By using 60 cycles, all the power stations of the state could be linked together.

TENDENCIES IN ELECTRICAL POWER DEVELOPMENTS

In a summary of the past year's activities furnished by the Westinghouse Electric & Mfg. Co., East Pittsburg, Pa., the following main facts are mentioned as indicating the trend of the present practice in the application and use of electricity in various forms: (1) A growing tendency toward the centralization of power generation for large areas, evidenced by the ever-growing loads on the stations of public utility companies, with a consequent demand for larger power units. (2) A generally acknowledged preeminence of electric drive in the industrial field, most modern factories and mills now using this form of power in preference to steam. (3) An increasing use of electric power for electric welding and electric furnaces. (4) A revolution in agricultural life, not only by making it more profitable, but by providing it with many of the comforts and conveniences heretofore found only in the city. (5) The increasing application of electric appliances to domestic purposes.

The use of the electric arc as a practical and economical method of fusion of metal in manufacturing processes has extended so rapidly during the past two years that new types of equipment have been developed to meet the particular requirements of the service. Although the arc welding process has been used for years on special applications, for repair work, and in general foundry work on the repairing of defective castings, its economy in replacing riveting and other means of fastening metals, in general manufacturing processes, has only lately been realized. The tendency in arc welding equipment is toward units of a capacity large enough for one operator only. These units may be stationed about the shop or yard at points where they are to be used or are readily made portable so that they can be moved to the point at which work is to be performed.

* * *

NEW DEVELOPMENT IN TRANSMITTING SPEECH

In an article in the *Proceedings of the Physical Society*, A. O. Rankine calls attention to some new and very remarkable developments in scientific research. Selenium changes in electrical resistance according to the light flux incident upon it. For several decades attempts have been made to transmit speech by using this fact. A beam of light is made to vary in intensity by the changes of pressure in a sound wave. This beam is received upon a selenium cell in circuit with a telephone receiver and a source of current. As long as the intensity of the light is constant so long is the current through the receiver constant. When, however, the intensity of the light changes, the resistance of the selenium changes and in consequence the current varies and the diaphragm of the receiver is made to move and to emit a sound wave.

There are two methods of making a beam of light fluctuate in intensity in accordance with the sounds of the voice. One is by controlling the light emitted by a source such as an arc lamp, by microphone action or otherwise. It is said that this method has been used with success in the German navy over a distance of seven miles. The other method is to keep the source of light constant but to vary the intensity of the beam after it has started. The first method can, of course, be used only with artificial sources, while the second is applicable to sunlight. By the use of a seven-inch lens and a "pointolite" lamp, the range is half a mile. More intense sources, of course, extend the range. Using the sunlight, the faintest whisper was heard at a distance of one and a half miles.

* * *

A bill has been introduced in the British Parliament to prevent "dumping." This bill proposes to prohibit the importation into Great Britain of goods at prices below the selling prices in the country of manufacture. This bill also provides for the prohibition of the importation of specified classes of goods under the designation of key industries.

Combating Excessive Manufacturing Costs

By S. P. KEATOR

IN the profitable operation of a factory, several cardinal points must be considered. Many of these points are not generally given the thorough study merited by their importance.

The accounting department of practically every company carefully accounts for each dollar spent. The cash-paid-out records have every expenditure annotated in its proper place, and all accounts are checked as carefully as are bank accounts. After the money has been converted into raw stock or work in process, however, (although the full purchase value is still there), it rarely happens that careful consideration is taken to insure the accounting of every dollar's value. Work in process increases in value in proportion to the number of operations or amount of work performed upon the part or machine in question. This is a further argument for guarding against loss of stock through either workmen's carelessness or defective material. If a lot of 1000 castings is started through a shop, and on account of breakage and spoiled work only 800 perfect pieces are completed, the cost of material must certainly be the original cost of 1000 pieces, pro-rated among the 800 perfect ones. The greater the spoilage, the greater is the material cost per unit. Even though the individual may not believe in the logic of thus apportioning spoilage costs against direct production costs, this additional cost must be carried as an overhead expense and must eventually be applied to the production costs.

Conservation of Raw Material

Care in the conservation of raw material should be exercised from the time it is received at the plant. A rigid inspection of all incoming materials before signing carriers' receipts should be insisted upon. Considerable damage is often caused by the rough handling of shipments, and sometimes the nature of the damage is such that it is not detected during the inspection made by the shipping clerk. For instance, a certain plant which purchased castings weighing approximately 100 pounds, found that due to rough handling or poor casting methods a large percentage of the castings received contained fine cracks which were hardly perceptible to the naked eye. These castings were often snagged or cleaned and partially machined before the defects were detected, and a considerable amount of labor was thus uselessly expended upon them. A claim was made against the foundry supplying the castings for the losses sustained, but the foundry (with considerable justification) claimed that the castings were cracked in transit and on these grounds refused to make restitution. A plan for rigid inspection was then instituted whereby the castings were thoroughly gone over before the freight receipt was signed. The castings rejected effected a tremendous saving, and the spoilage in this type of castings dropped from twelve castings a day to an average of less than two castings per day. The castings were valued at $6 each; the saving through inspection, therefore, amounting to about $60 a day.

Ordering and Inspecting Raw Materials

Inspection at the receiving room of the plant is the first step and one of the most important safeguards against spoilage and waste. The amount of money saved through the rejection of defective raw materials will more than pay the maintenance cost of an inspection force; in fact, an inspection force properly directed will pay large dividends in time, money and trouble saved. Careful planning of production schedules and care exercised in routing work while in process, coordinated with the prompt follow-up of purchased material by purchasing departments, are also important factors of economical operation.

Thorough study of part lists is required of the routing engineer, so that no part may be neglected. A knowledge of the usual percentage of spoilage is absolutely essential. For example, consider two bronze bushings, one 6 inches long and one ⅛ inch long. The waste or crop ends from each bar of raw stock required for the longer bushings will be far greater than the waste from the stock required for the short bushings. In the case of the longer bushings, the waste ends of stock may be from 2 to 3 inches long, or even more, while the length of the crop ends from the short bushing stock will be negligible. All this must be taken into consideration when planning for stock, because in lists calling for several thousand units, the waste from crop ends plus the machine spoilage is considerable, and full allowance must be made to cover it when ordering stock.

Importance of Follow-up

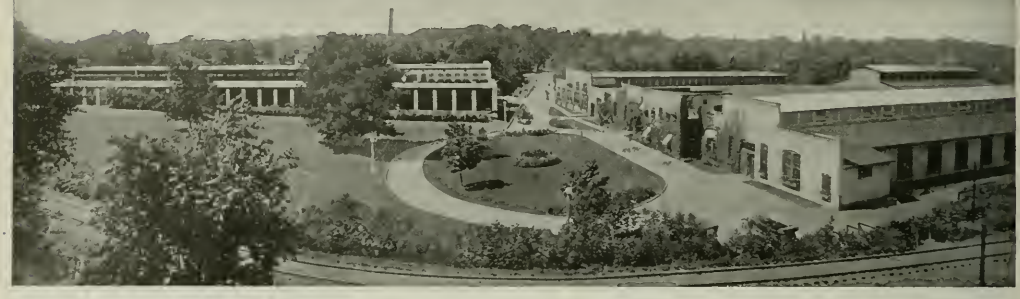
Without an accurate system of following up orders, the purchasing department has no reliable data which can be used as a guide in purchasing and planning for production. The writer recalls an instance where, through lack of coordination between production and purchasing departments, several hundred dollars worth of expensive bronze was converted into chips simply because in order to sustain production and supply a needed part, it was necessary to use 1½-inch diameter rods to make an article ½ inch in diameter. In this instance, not only was the bronze wasted, but also the labor required to reduce the bronze to the specified diameter. A loss of over $1500 was experienced in this case, which could have been prevented if the purchasing department had properly followed up the purchase order. Production had to be maintained, of course, but the loss could have been avoided by proper teamwork between production and purchasing departments.

Much can be accomplished in preventing waste and production spoilage by encouraging the workmen to guard against the breakages and spoilage, and by rewarding them when any considerable saving is effected through their efforts. Analysis of the spoilage of parts and a compilation of these data will constitute an easily understood report. Such reports should be made available for use by the production engineer and superintendents, and should also be used to bring the facts before the foremen and workmen.

Value of Cost Reports

Another aid to economical operation is an accurate cost report. Many plants maintain elaborate cost systems and tabulated reports, but many times these reports do not reach the men who would be influenced by them to cut down production costs. The writer believes that the superintendent and production men would be greatly aided in their work if kept constantly advised as to production costs. Great care should be taken to see that cost reports sent to shop executives be in as simple a form as possible, as most factory executives have not the time to study complicated reports. Material and labor costs are of most importance to the operating executive. Therefore it is a good plan to limit reports to these two direct cost elements. The shop superintendent and the production man are the executives directly responsible for gain or loss and should be entitled to a general knowledge of the results of their efforts.

Stimulating Cooperation Between Employer and Employe



Based on an Interview with Eugene B. Clark, President of the Clark Equipment Co.

AN authority on industrial management recently expressed the opinion that a factory worker earns his wages and pays his proportion of overhead expenses by the purely mechanical performance of an allotted task, while the return on the capital invested is measured by the degree of enthusiasm with which the work is performed. Another business man of national prominence stated that any principle of business administration which is to prove permanently beneficial to both employer and employe must tend to advance the interests of both. Granting the truth of these statements, it will be of interest to consider how the interests of both the management and the workers are affected by the carefully thought out plan of the Clark Equipment Co., in Buchanan, Mich., gradually developed during the past ten or twelve years with a view to creating industrial relations which would keep the employes satisfied and thus tend to heighten the enthusiasm with which they perform their daily work.

Of late, we have heard of many applications of industrial democracy; and it may be truly stated that the methods adopted by this company represent a true application of democratic principles. Direct primary elections are held in each department of the plant to nominate three candidates for election to membership on the Employes' Council; and subsequent elections determine the selection of one of these three men to serve for a period of one year. The men employed in each department of the plant are personally acquainted with their councillors and express freely to them their opinions concerning all matters pertaining to working conditions. Hence the councillor forms a direct line of communication between the men and the management. Council meetings are held once a week, and it is the duty of the councillor to present for consideration any matters affecting the men employed in the department which he represents; and all decisions reached at each council meeting are posted on bulletin boards provided in each department of the plant. The work of the Employes' Council and the suggestion of matters deserving its consideration form a topic of "shop politics" which makes a far more interesting noon-hour discussion than federal or municipal politics, because it has a more direct bearing upon the conditions surrounding each man's means of earning a livelihood.

Unless a man takes an interest in his work, he will seldom be satisfied; and conversely, any plan which tends to stimulate a man's interest in his work is also likely to assist in keeping him satisfied with working conditions. The man who is satisfied and does his work enthusiastically is not only going to be happier and healthier than the fellow who has a chronic grouch, but, other things being equal, he is the type of man who is most likely to acquire a fund of mechanical knowledge and develop a capacity for managing men that will warrant his advancement to a more responsible and better paid job.

Conscientious efforts made by the executives of manufacturing plants to evolve methods of management that will be mutually satisfactory to the employer and his employes, may prove unsuccessful through failure of men in charge of an industrial enterprise to understand the workmen's point of view. Factory officials who worked in the shops before being placed in charge of more responsible work, will find this experience of great value in enabling them to understand the workmen's attitude toward the management of the plant in which they are employed. Eugene B. Clark was graduated from the Engineering College of Cornell University in 1894 and entered the employ of the Westinghouse Electric & Mfg. Co., Pittsburg, Pa., where he was engaged for two years on engineering work both inside and outside the plant. While gaining this experience, Mr. Clark worked with the men in the shops. In 1896 he went to the Illinois Steel Co., Chicago, Ill., where 10,000 to 12,000 men were employed, and his duties there gave constant opportunities of gaining a knowledge of the workmen's viewpoint. After eleven years spent with the Illinois Steel Co., Mr. Clark had risen to the position of assistant manager. He resigned in order to purchase the Celfor Tool Co., and later organized the Buchanan Electric Steel Co. On January 1, 1917, these two companies were consolidated under the present name of the Clark Equipment Co.

Basic Principles in Creating Cooperative Industrial Relations

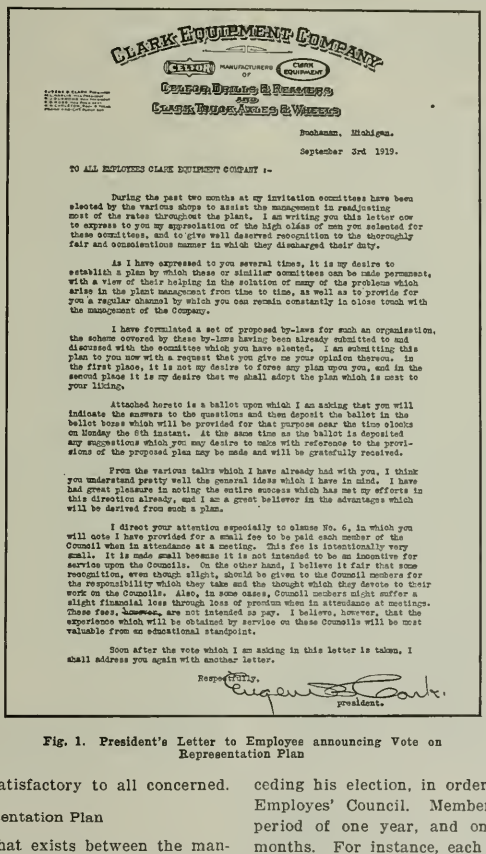
Most work of permanent value has been done slowly, and this is true of the Clark Equipment Co.'s efforts to steadily improve the working conditions of its employes and to provide facilities for their entertainment and physical development. But at the stage which has at present been reached in carrying on this work there are two fundamental principles of management which are largely responsible for the successful results that have been obtained. These principles are as follows:

To adhere to a uniform policy in dealing with employes, so as to gain and retain their confidence in the intention of the company to be fair; and to foster the idea that employes are working *with* the company as partners rather than *for* the company as employes.

To provide well lighted and efficiently ventilated workshops that are equipped with drinking fountains, locker rooms, adequate toilet facilities and all other necessary conveniences required to bring working conditions up to the highest level consistent with the nature of the work to be done.

Confidence of Employes Easy to Maintain but Difficult to Regain

Probably there is no one factor which has a more adverse effect upon the industrial relations than to have a condition arise which causes employes to lose faith in their employer. So long as the employer deals fairly with his men and they have confidence in his intention to continue doing so, little trouble is likely to be experienced; but if this confidence is once lost, it may take a long time to restore it. It has been a uniform policy of the Clark Equipment Co. to take pains to have its employes feel that they will always be fairly treated. If any group of men believes that there is reason to be dissatisfied with certain working conditions, the management does not take the word of foremen or other subordinate executives as to the feeling of the employes working in their departments. The employes' representation plan makes it easy for the men to appeal to the higher officials, and any complaint will receive careful consideration and be dealt with strictly upon its individual merits. By following such a plan the men have come to know that the company is not only willing to pay them a fair rate of wages, but that it is anxious to have all questions concerning working conditions adjusted upon a basis which is satisfactory to all concerned.



CLARK EQUIPMENT COMPANY

CLARK MANUFACTURERS OF CLARK EQUIPMENT

CENTER DRILLS & REAMERS AND CLARK TRUCK AXLES & WHEELS

Buchanan, Michigan.

September 3rd 1919.

TO ALL EMPLOYEES CLARK EQUIPMENT COMPANY :-

During the past two months at my invitation committees have been elected by the various shops to assist the management in readjusting most of the rates throughout the plant. I am writing you this letter now to express to you my appreciation of the high class of men you selected for these committees, and to give well deserved recognition to the thoroughly fair and conscientious manner in which they discharged their duty.

As I have expressed to you several times, it is my desire to establish a plan by which these or similiar committees can be made permanent, with a view of their helping in the solution of many of the problems which arise in the plant management from time to time, as well as to provide for you a regular channel by which you can remain constantly in close touch with the management of the Company.

I have formulated a set of proposed by-laws for such an organization, the scheme covered by these by-laws having been already submitted to and discussed with the committee which you have elected. I am submitting this plan to you now with a request that you give me your opinion thereon. In the first place, it is not my desire to force any plan upon you, and in the second place it is my desire that we shall adopt the plan which is most to your liking.

Attached hereto is a ballot upon which I am asking that you will indicate the answers to the questions and then deposit the ballot in the ballot boxes which will be provided for that purpose near the time clocks on Monday the 8th instant. At the same time as the ballot is deposited any suggestions which you may desire to make with reference to the provisions of the proposed plan may be made and will be gratefully received.

From the various talks which I have already had with you, I think you understand pretty well the general idea which I have in mind. I have had great pleasure in noting the entire success which has met my efforts in this direction already, and I am a great believer in the advantages which will be derived from such a plan.

I direct your attention especially to clause No. 6, in which you will note I have provided for a small fee to be paid each member of the Council when in attendance at a meeting. This fee is intentionally very small. It is made small because it is not intended to be an incentive for service upon the Councils. On the other hand, I believe it fair that some recognition, even though slight, should be given to the Council members for the responsibility which they take and the thought which they devote to their work on the Councils. Also, in some cases, Council members might suffer a slight financial loss through loss of produce when in attendance at meetings. These fees, however, are not intended as pay. I believe, however, that the experience which will be obtained by service on these Councils will be most valuable from an educational standpoint.

Soon after the vote which I am asking in this letter is taken, I shall address you again with another letter.

Respectfully,

Eugene [illegible] Clark.

President.

Fig. 1. President's Letter to Employes announcing Vote on Representation Plan

Employes' Representation Plan

A great deal of the trouble that exists between the management and workmen in many manufacturing plants arises from taking the word of foremen and superintendents in regard to the sentiment of employes, instead of having the management make a conscientious effort to obtain first-hand information. The employes' representation plan of the Clark Equipment Co. provides a means for obtaining this information. Under this plan regular meetings by two councils composed entirely of employes are held, at which measures for improving working conditions, manufacturing efficiency, etc., are formulated and brought to the attention of the management of the company. In line with the company's policy of giving employes the fullest possible voice in determining matters affecting working conditions, a meeting was first held at which the features of this employes' representation plan were explained. Then a letter from the president of the company, reproduced in Fig. 1, was mailed to the home of every employe, giving a brief outline of the proposed plan and calling attention to a vote that was to be taken in the shop to gain an idea of the consensus of opinion among the men regarding the desirability of adopting such a measure. This vote expressed a strong sentiment on the part of employes to have the new system adopted.

In addition to the committee's preliminary work in readjusting rates throughout the plant, as mentioned in the president's letter, the permanent maintenance of the committee or council affords a channel through which any man or group of men in the plant may readily express to the management an opinion concerning any situation affecting his working conditions. Under this plan there have been established what are known as an Employes' Council and a Joint Council. It is proposed to divide the plant up into districts composed of each department of the plant employing a large number of workers, or several departments in those cases where the number employed in each department is small. The Employes' Council is composed of two representatives elected by the men of each district. Elections for this purpose are held in January and July of each year, and every employe who has been in the service of the company for three months, provided he is not a foreman, is entitled to vote.

Voting is accomplished by secret ballot, and the election is divided into two parts with at least three days intervening. The first part of the election is for the purpose of nomination, and the three candidates having the greatest number of votes in each department or district are declared nominated; the names of these three candidates are then posted in the plant until the second part of the election, the result of which elects one of these three employes who were nominated by the direct primary election. An employe must have been in the service of the company for six months immediately preceding his election, in order to be eligible to serve on the Employes' Council. Members of this council serve for a period of one year, and one member is elected each six months. For instance, each district having two representatives will elect one representative in January and one in July, each of whom will serve for one year. Foremen are not eligible to serve as members of this council.

Personnel of the Joint Council

Of the ten members of the Joint Council five are elected by members of the Employes' Council from among their own number, and five are appointed by the president of the company from the general staff of the firm, preference being given to employes in departments which are not generally classed as producing departments, the intention being to secure general representation of the employes by including members of the sales, purchasing, engineering, research, and advertising departments. Meetings of the councils are held each Thursday afternoon, at 2 P. M., in the following order: First Thursday each month, meeting of Employes' Council;

Form 505—5-6-19-5m

ABSENT REPORT

NAME..... CLOCK NO..... DATE.....

A—Absent with permission of foreman.
B—Absent, no reason known
C—Reported sick or disabled.
D—Reported sickness in the family.
E—Verified report of disability.
F—Injury received at plant.
G—Laid off. Slack work.
H—Laid off. Discipline.
V—Vacation.

SIGNED .....

NOTE : Please place a check or cross in front of the item in the above which covers reason of absentee. CHECK means all day. CROSS means half day.

Fig. 2. Form used by Foreman in reporting Absence of Employes and the Reason. These Data are recorded in the Office of the Director of Industrial Relations

second Thursday each month, meeting of Employes' Council; third Thursday each month, meeting of Joint Council; and fourth Thursday each month, meeting of both councils.

Meetings of the Employes' Council and of the Joint Council are presided over by chairmen elected by members of the respective councils, and the joint meeting of both councils is presided over by the president of the company, or, in his absence, by one of the vice-president. None but members of the Employes' Council or of the Joint Council are permitted to attend the meetings, except that either council is privileged to invite any executive or employe of the company to appear at its meetings and give any information desired by the council. Also, the president may invite employes of the company who are not members, to attend the combined meeting of both councils. Each council conducts its meetings in parliamentary form and keeps a record book in which the minutes are recorded. These record books are available for inspection by any employe of the company, and all employes are kept informed concerning the work done by the councils through reports on bulletin boards in the plant. The business considered by these councils consists of all matters pertaining to working conditions, including such features as safety, amusement, recreation, and measures designed to improve the efficiency and economy of the manufacturing operations.

No suggestion having a bearing upon conditions of employment in the plant or the relations existing between any employe and the company is ever barred from discussion. Any action adopted by the Employes' Council is put in the form of a "bill" which is then introduced for the consideration of the Joint Council. If favorable action is taken by the Joint Council, the bill is then passed to the president of the company, and if he signs the bill it will automatically become a part of the law of the plant. This employes' representation plan does not abridge or interfere with the established rights of any officer or employe of the company. Its purpose is to bring about closer relations between the employes and officers, and to insure uniform justice to every employe, as well as to improve the shop methods with a view to securing the maximum efficiency in production; and the application of the plan has proved it to be successful in accomplishing these results.

How Employes Become Stockholders in the Company

It has been stated that an effort is made to have all the company's employes feel that they are working with the management as partners, rather than for the management as employes. Numerous means have been employed to emphasize this, but the most obvious of these is a plan inaugurated in 1916 by which all employes are encouraged to become stockholders in the company. Each employe is permitted to buy stock, the amount of his annual subscriptions being up to 10 per cent of his yearly earnings. These subscriptions are made for what are known as "lots" of stock costing $150, each of which consists of one share of preferred stock of $100 par value, which pays a dividend of 7 per cent per annum, one share of common stock of $100 par value, and one employes' participating profit-sharing certificate of no par value, on which a dividend is paid at the minimum rate of $6 per annum, or at such higher rate as may be decided upon by the board of directors. In a period of exceptional prosperity, such as the years just past, this special distribution to holders of participating profit-sharing certificates has been very substantially in excess of the stipulated rate of $6.

Payments for these lots of stock purchased by employes are made in cash at the office of the company's treasurer, any amount from $1 up being acceptable. The usual partial payment plan for the purchase of securities is followed, and all dividends and other distributions accruing from the ownership of stock are credited to the amount of the purchaser until payment has been completed. The stock is then made out in the name of the purchaser and delivered to him. If an employe desires to cancel his subscription for stock after payments have been started, or if he leaves the company either voluntarily or for cause, the amount of money which he has paid on his partially completed subscription will be returned with interest at 5 per cent. No interest charge is deducted for that portion of the total obligation which remains unpaid.

If employes who have completed paying for one or more lots of stock leave the employ of the company they may or may not retain their stock, as desired, but those employes who elect to continue the ownership of stock will forfeit the income from their participating profit-sharing certificate, as this is a special distribution made to stockholders actually on the payroll at the time the distribution is made. Also, employes who remain in the company's service but dispose of their stock to an outside purchaser automatically cause their participating profit-sharing certificate to become void, as this part of the investment is not transferrable. In the event of the permanent disability or death of an employe who has completed payment for one or more lots of stock, the company agrees to redeem his participating profit-sharing certificates at the rate of $50 each; and in the case of employes who suffer a similar misfortune during the time that they are paying for one or more lots of stock, the participating profit-sharing certificates are redeemed at the rate of $15 each.

Results Obtained by Having Employes Become Stockholders

Two reasons led to the inauguration of this plan by which employes have been enabled to become stockholders in the

A—Absent with permission of foreman.
B—Absent, no reason known.
C—Reported sick or disabled.
D—Reported sickness in family.
E—Verified report of disability.
F—Injury received at plant.
G—Laid off. Slack work.
H—Laid off. Discipline
V—Vacation.

ATTENDANCE RECORD

Form 495-3-16-19-1500

NAME CLOCK NO.

WEEK ENDING	MON	TUES	WED.	THUR	FRI	SAT	TOTAL	V	WEEK ENDING	MON	TUES	WED.	THUR	FRI	SAT	TOTAL	V

Fig. 3. Form used by Director of Industrial Relations to maintain Card File Record of the Employes' Regularity of Attendance which determines their Eligibility for Vacations

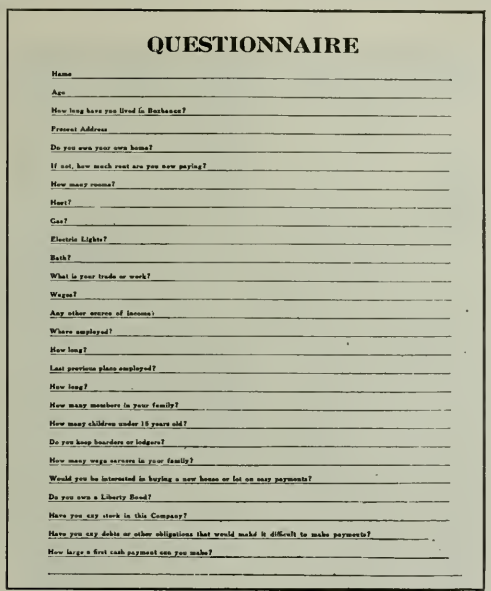
company—namely, to promote thrift among the men and to foster the idea of partnership between the management and the men in conducting an enterprise in which both have a common interest. The first of these reasons requires no comment, but it will be of interest to note several of the beneficial results which have been obtained by the spirit of partnership that has been created by stock ownership. When a new man is being "broken in" in many shops, it is not at all uncommon to see the experienced employes ridicule his somewhat clumsy efforts to master the details of a new kind of work; and while he is learning, the inexperienced employe is likely not only to do very little useful work but also to completely spoil many partially finished parts. Where the other employes are merely working "for" the management, the loss resulting from this lack of knowledge on the part of a new man does not seriously disturb them; but in a plant where the employes are also stockholders, the situation immediately assumes a very different aspect. Each man realizes that out of every dollar wasted through the spoilage of material, a certain part comes out of his own pocket, and he will do everything possible to stop such leaks. Thus at the Clark plant, where a new employe is having any trouble, he is almost certain to have one of the experienced stockholding employes in the same department give him a few words of advice or suggestions about handling the work, which soon enable him to master the difficulties encountered.

Safeguarding the Common Interests of the Firm

The same tendency is shown by employes who are stockholders to see that none of the tools and supplies used are stolen or mislaid. The following is an interesting case in point. Recently a contractor was employed to make certain changes in the plant and his men were at work at the time that the shop was running. When these men had finished their work and were packing up tools and other supplies belonging to the contractor, a stockholding employe of the Clark Equipment Co. saw one of them pick up a portable electric drill and put it into his tool bag. The Clark employe did not think anything of this matter at the time, but later it occurred to him that the electric drill belonged to his company instead of the contractor whose men were working in the plant. This incident was reported to the foreman of the department and an investigation resulted in the recovery of a tool worth possibly $50. Many other similar incidents could be cited to show the care with which those men who are stockholders in the company guard the common interest which they have in all matters pertaining to its welfare.

Stockholders' Meetings

As stockholders of the company, it is felt that all employes who have made an investment in stock should be kept informed as to the condition of the firm's business. With that idea in mind, at least four meetings are held each year, at which all stockholding employes are urged to be present. These meetings are presided over by the president of the company, or by one of the other higher officials. Statistics are given as to the condition of the firm's business and information regarding new orders which have been taken since the last meeting was held. At these meetings, the presiding official is prepared to answer all reasonable questions bearing upon the condition of the company's business. In this way all stockholding employes are able to acquire a knowledge of the affairs and business prospects of their company and thus assume the position of true partners in the enterprise.



QUESTIONNAIRE

Name

Age

How long have you lived in Bucheon?

Present Address

Do you own your own home?

If not, how much rent are you now paying?

How many rooms?

Heat?

Gas?

Electric Light?

Bath?

What is your trade or work?

Wages?

Any other source of income?

Where employed?

How long?

Last previous place employed?

How long?

How many members in your family?

How many children under 16 years old?

Do you keep boarders or lodgers?

How many wage earners in your family?

Would you be interested in buying a new house or lot on easy payments?

Do you own a Liberty Bond?

Have you any stock in this Company?

Have you any debts or other obligations that would make it difficult to make payments?

How large a first cash payment can you make?

Fig. 4. Form of Questionnaire used in determining the Financial Reliability of Prospective Purchasers of Homes

Hygienic Work-shops and Well Kept Grounds

From the title illustration, which shows a partial view of the factory and its grounds, it will be apparent that the buildings have a liberal amount of window space. All buildings are of the most modern type of construction, with steel-framed windows running practically the entire distance from the ground to the eaves, while windows in the monitor roofs furnish additional light. There are modern ventilating systems which assure the circulation of fresh air, and drinking fountains are well distributed throughout the plant.

As he comes to work in the morning, the employe is greeted by the sight of beautifully kept lawns decorated with flower beds and shrubs. To work efficiently that man must be in good health. In spending time and money upon the maintenance of attractive grounds surrounding its plant, the company's purpose has gone beyond the attainment of a decorative effect. It is thought that the natural reaction on the workmen who enter the shops, after crossing grounds decorated with lawns, shrubbery and flowers, will be to take to their work a desire to make it approach the perfection with which nature's handicraft is performed. In order that the ground surrounding the factory may be maintained in excellent condition, an experienced gardener is kept constantly on the company's payroll and a well equipped greenhouse is provided for his use in obtaining the great quantity of bulbs and plants that are required to produce the wonderful horticultural effects obtained.

Vacations for Men Employed in the Shops

Most of the workers in manufacturing plants are paid by the hour, that is to say, a deduction is made from their pay for any time that they are absent from the plant during working hours. Naturally this general system is followed at the Clark plant, but employes who fulfill certain requirements in the performance of their year's work are given a vacation with pay. The general plan is to give a vacation of one week to each man who has been on the payroll for one year or more, and three days to each man who has been in the company's service for at least six months; but in order to be eligible for this vacation there are certain other requirements which a man must fulfill. For each day of absence without an approved cause the employe loses 1 per cent of his vacation. Thus the vacation is made an incentive for regular attendance. Fig. 2 shows the absence report form which is made out by the foreman of the department and sent to the office of the supervisor of industrial relations, indicating the cause; absences coming under the heading B or H result in the penalty of a deduction from the man's

vacation. A permanent record of these reports is kept on cards of the form shown in Fig. 3, and at the end of the year this card record shows the amount of deduction, if any, which is to be made from the vacation of each man in the plant. The employes are given a Saturday afternoon holiday with pay each week. In order to obtain this benefit, however, they must not come late or leave the plant before the authorized quitting time. Any man failing to fulfill this requirement is not paid for Saturday afternoon.

Allowance Made for Transportation

Buchanan is a town of approximately 3000 inhabitants, and a large majority of the working people in this community are employed by the Clark Equipment Co. Owing to the rapid growth of business and the need of more workers, one of the problems that required attention was that of providing transportation for those who come from other towns, or houses to accommodate men who desire to bring their families to live in Buchanan. Taking these two questions in the order in which they have been named, it may be mentioned that there are 180 men who come from towns surrounding the plant over a radius of sixteen miles. Men who ride ten miles or less to reach the plant are given an allowance for transportation of 30 cents for the round trip, and such an allowance is also made in the case of those men who have their own motor cars. Men who have to ride further than ten miles get an allowance of 40 cents for the round trip. This plan tends to create an adequate supply of labor, because those who would be deterred from seeking employment with the company, owing to difficulty of reaching the factory, are induced to come.

How the Housing Problem has been Solved

An ambitious housing plan has been worked out for the benefit of those employes who wish to live in Buchanan but are unable to secure the type of living accommodations which they desire. The company bought a tract of land on high ground overlooking the plant and sub-divided it into building lots, this section of the town having been given the name of "Liberty Heights." To date, forty-three houses have been built for employes, the price of which ranged from $2500 to $4500. In every case, the purchase price of the house represents the actual cost of construction; the price of the lot is the cost of the ground to the company on an acreage basis, plus a profit of 100 per cent. At the end of five years, or sooner if all payments have been made on the transaction, this 100 per cent profit on the cost of the land is returned to the purchaser with interest at 5 per cent, the idea of returning this margin of profit being to create an additional incentive for those who purchase houses to complete their payments and become home owners. It may be mentioned, however, that this return of the profit on the land is only made in the case of buyers of homes who are still employes of the company.

The houses are sold to the workers on most liberal terms, the amount of the initial payment which is required and the rate at which the balance of the obligation must be paid off being far lower than is the case in dealing with real estate companies. Hence, the employes who purchase houses on these liberal terms of payment are greatly benefited, but the company is obtaining a partial return on its outlay of money through the fact that a man who buys a home is far less likely to leave the employ of the company and move to another town.



Fig. 5. Interior of Greenhouse where Plants and Bulbs are propagated to decorate the Grounds surrounding the Plant

Advantages of Organizing a Separate Land Company

It was considered best to handle these real estate transactions by avoiding any idea of paternalism on the part of the company; for that reason the Buchanan Land Co. was formed to handle all of this business. By having dealings with a separate company, it is also made easier for an employe to quit his job and still continue making payments on the house. The land company is presided over by the purchasing agent of the Clark Equipment Co., who acts in the capacity of general manager. To facilitate his work in dealing with those employes who desire to purchase homes, a standard questionnaire was prepared, and the first step taken by a man who is interested in becoming a householder is to apply for one of these blanks, which he fills out and returns to the manager of the Buchanan Land Co. The questionnaire is shown in Fig. 4. By looking over the man's answers to these questions a reasonably accurate idea can be secured as to his financial reliability and as to the probability of his fulfilling his obligations. It is important to note that the practice is to build exactly the type of house which is desired, rather than to sell a house which has already been built. A large variety of architects' plans are available for selection, or the purchaser may provide his own plans. The age and earning capacity of the prospective purchaser and other factors of a like nature are carefully considered, and he is not allowed to obligate himself for the purchase of a piece of property where the price is so high that there is little probability of his being able to complete making the required payments within a reasonable length of time.

Clark Hospital Association

No hospital facilities were available in Buchanan until a decision was reached by the Clark Equipment Co. to provide a fully equipped building with adequate facilities to render surgical and medical service to the company's employes and their families. In handling this project, as in the case of the land company, it was desired to avoid any evidence of paternalism, and for that reason the hospital was equipped and turned over to the employes of the company to manage. The plan finally adopted consisted of the formation of an organization, known as the Clark Hospital Association, the charter of which allows any resident of the town to become a member, upon payment of an annual fee of $2, regardless of whether or not he is an employe of the company. This institution has been in operation for nearly a year and has already rendered valuable service. A board of directors which is responsible for the management of the hospital consists of men elected by the members of the Hospital Association.

Aside from humanitarian aspects, it is felt that this hospital, providing means of caring for employes of the company and members of their families, is an excellent business proposition. It is probably safe to say that 75 per cent of all surgical operations are performed on women patients. In Buchanan, as in many similarly situated manufacturing towns, a man whose wife became ill formerly had to send her away if surgical treatment was required. This not only cost him a lot of money, but also necessitated paying visits that took him away from his work; and delays in reporting progress made by the patient on those days that the man was actually at his job caused him to be less efficient than usual. Where the patient is at the Clark Hospital, a man employed in the plant is able to pay as many visits as may be desirable, and he is kept constantly informed as to the progress made by the patient, so that his efficiency as a workman is reduced as little as possible under the circumstances. For this reason it is believed that money required to put the hospital in operation is a profitable investment for the company, in addition to being a great help to the men.

The Theater and Allied Activities

In order for a man to do his work efficiently and to live a happy normal existence, both his mind and body must have recreation. Recognizing the truth of this fact, a theater was built right in among the factory buildings, lawns, and flower beds, and here various forms of entertainment are given to afford enjoyable pastimes for the winter evenings. Accommodation is provided for seating 1000 people, and the building is equipped with the regulation stage and footlights, dressing rooms, property rooms, etc. A theatrical company known as the Clark Players, recruited from those employed in the shops and offices, has been trained under the direction of a vice-president of the company who formerly had some theatrical experience. Four plays are staged every season, each play being presented three times.

In addition to giving performances at the plant, the Clark Players have made a practice of going to nearby towns, upon request, where they have given their plays with very successful results, the proceeds of such outside performances being donated to the Theater Association. Last year this association donated $800 to the Red Cross, $800 to a specially equipped hospital to care for influenza patients, and $100 to the Clark Hospital Association, after paying all expenses such as royalties on plays, the cost of stage settings, etc. The theater was opened on March 26, 1918, with a minstrel show. During 1918 the attendance at the theater was 10,944 with an average attendance of 421 for each entertainment that was given. The price of admission was first fixed at 50 cents, but later this was reduced to 25 cents with a 3-cent war tax, in order to bring the cost of the evening's entertainment low enough so that all members of a workman's family could come together.

In addition to the theatrical performances, this theater is used for moving picture entertainments, lyceum lecture courses, basket ball games, dances, smokers, etc. Not only is the provision of such a meeting place almost an essential in a moderate sized town, where there is only one other theater in which moving pictures are the sole form of entertainment, but a little thought will make it apparent that the holding of general meetings of this kind among employes is of great value in fostering a spirit of fellowship which enables them to cooperate far more efficiently during the hours they spend at work in the plant.

At the front of the auditorium in the theater, the seats are removable, leaving a clear floor space which is adapted for use in playing basket ball and for dancing. These two forms of entertainment are mentioned together because a practice is made of giving a dance after the basket ball game has been finished. Music for these dances is furnished by an orchestra, the members of which are all Clark employes. There is also a Clark band organized along similar lines. Basket ball teams have been organized among both the men and women employes, and matches are arranged with teams from nearby communities.



Fig. 6. One of the Larger Sized Homes built for a Clark Employe on "Liberty Heights"



Fig. 7. A Comfortable Bungalow built to suit the Requirements of a Small Sized Family

Cooperative Store

The high cost of living has led numerous industrial establishments to organize stores in which their employes are able to buy groceries and certain other necessities of life at prices based upon actual cost. Most of these stores have been placed right in the factory, and although they have given excellent service, there have been justifiable criticisms of the results obtained, important among which is the fact that the men of the family have to do the marketing at the plant, which is likely to create a certain amount of interference with their work. To overcome these difficulties, the cooperative store which employes of the Clark Equipment Co. have organized is located in a building in the shopping district of the town. As in the case of managing the hospital, there is an association known as the Cooperative Store for Clark Employes, to which any employe of the company is eligible for membership upon the payment of a fee of $15. The company furnishes the building in which the store is maintained and pays such expenses as light, heat and delivery service; but all other expenses of management come out of the small profits made on the sale of goods.

In order that members of the association may have the benefit of the lowest possible prices, this store operates on the principle of cash dealing; and an additional saving is effected through only making one delivery a week and that limited to purchases amounting to $5 or over. In certain cases it is necessary to grant credit, but it is also desired to

protect members of the association against the possibility of bad faith or misfortune on the part of those who apply for such accommodation. With this idea in mind coupon books are issued, after the merits of each individual case has been passed upon by the cooperative store committee, and a deduction corresponding to the amount of this coupon book is made from the next pay received from the company in order to reimburse the cooperative store for the advances it has made. In no case is a longer credit than two weeks granted. Membership in the association allows all members of the immediate family to make purchases at the store, and by having the store in the town the women of the family are able to do the marketing.

Provisions of the Benefit Association

Any employe of the company working on a wage basis is eligible for membership in a mutual benefit association which provides relief in the case of sickness, death, or accidents occurring outside of the plant. No provision is made for recompensing employes for time which they may lose in the event of accidents occurring in the plant, because this risk is taken care of by the employer's liability. The premium paid by members of this association is 6 cents a month for a claim of $1 a day for any period up to a maximum of twelve weeks. Insurance may be effected on this basis for any amount up to a maximum claim of $21 per week; and in any case, the payment made in the event of the death of the insured is $100. This association is managed by a committee of employes and is entirely self-supporting, except that the company bears such overhead expenses as bookkeeping. The average amount of insurance carried per man is $13.16 a week, and on August 31 there were 417 employes of the company carrying insurance under this plan.

Safety, Sanitation, and Health Committee

In almost every case where successful results have been obtained in the elimination of working conditions which are likely to cause industrial accidents, a great point is made of the value of cooperation from men in the shop. Owing to the nature of the work which must be done in many plants, it is a hard matter to avoid the occurrence of accidents, and the nearest approach to absolute conditions of safety can only be obtained through the cooperation of the workers in the plant. In performing their daily tasks, the men will see the possibility of accidents occurring at points which have never been regarded as dangerous, and if they are interested in the work, their suggestions for the safeguarding of dangerous apparatus are most valuable. The same applies to the improvement of sanitary conditions and other matters that are likely to affect the health or general welfare of the workers.

To facilitate the work, there is a committee known as the Safety First Committee which meets once a week with the director of industrial relations and discusses with him the opportunities for improving any conditions in the plant which may appear to be unsatisfactory. There are eight members serving on this committee, whose duty is to not only make personal investigations of working conditions but also to gain the views of individual workmen as to the possibility of making improvements. The plant engineer is a permanent member of this committee, but other members of its personnel are changed every three months. The director of industrial relations is not a member of the committee but he is always present at its meetings. The committee selects its own successors, and a joint meeting is always held between the outgoing and incoming members. All meetings of the committee are held on the company's time.



Fig. 8. General View of the Auditorium in the Clark Theater which seats 1000 People

Conclusion

There are two general classes of labor to be considered in working out a plan of industrial relations for application in a manufacturing plant. One class consists of men of American birth who are thoroughly familiar with the institutions of our country; and the other comprises foreigners who have come to America to secure the benefit of more satisfactory living and working conditions than those existing in their native lands. American traditions require that men engaged in industrial pursuits should feel that they hold a position in the plants where they are employed that amounts to something more than a number on a time clock. It is with this idea in view that the Clark Equipment Co., and other firms who are solving their problems of industrial relations along similar lines, have worked out definite methods for the application of employes' representation, participation in profits, and the various forms of athletic and social activity, which have been described in this article. In order to judge the success of the plan, it is merely necessary for an experienced observer to go through the work-shops and observe the attitude of the men toward their work and the organization by which they are employed.

How Pattern Shop Practice Affects Core-Room and Foundry Methods

By JABEZ NALL

WHEN patterns are generally spoken of as applied to the production of castings, they are apt to be thought of as facsimiles of the part or casting to be produced. Whether or not this is true depends upon the simplicity or complexity of the design of the part. Sometimes the outlines of a pattern will be so changed by the addition of core-prints, etc., that the designer himself often fails to see in it the form of the casting that he desires to make. Then again castings may be made without any pattern, or anything considered as such. A core-box with a few change pieces added may be used to make a number of cores which when assembled will prove the most economical and best way, both in the pattern shop and the foundry, by which to attain the desired result.

Patterns should not be considered as completed articles in themselves, but should be regarded as tools, by the help of which the foundryman is enabled to produce satisfactory castings. As tools, they should be so designed and constructed that their maximum usefulness, strength, and ability to retain their shape may be attained, as well as their greatest general efficiency and lasting qualities under the work which they have to perform.

Cost Consideration in Making Patterns

The question of cost must also be considered, having the same ends in view. If a pattern is intended to be used but once, or only a few times, it would be unwise as well as a waste of time and money to finish the pattern highly or to add other unnecessary labor or material as a means of increasing its strength, beyond or above what is needed to attain the desired result. Indeed, sometimes it is true economy to save on the pattern, even if by so doing the cost in the foundry is increased, but this practice should not be carried too far because any repetition of the use of the pattern thereafter would tend to offset more and more the initial saving in the pattern shop. In machining castings, there are tools for common rough work and fine tools for precision work with special jigs to aid in quantity production, and in pattern work the same difference exists; this should be properly recognized and considered.

The cost for labor spent in trying to attain exactness of dimension, or an extra fine finish on a pattern that does not require it, is an absolute waste. However, there are cases which require this exactness and fine quality of workmanship. The cost of the patterns thus produced—when such care is necessary for obtaining quality and quantity production of castings—is good economy even though the initial cost may be high.

As fine tools are necessary in the production of precision work in the machine shop, so a fine set of exact, easily manipulated and well fitting patterns is necessary in the production of castings, the quality, appearance, and dimensions of which are required to be duplicates of each other. Fundamentally the patternmaker should be capable and willing to work in accordance with the use and requirements of the article which is ultimately to be produced. A poorly designed pattern or core-box will add largely to the cost of molding, and will probably result in the loss of castings. A few simple examples will illustrate the points made in the preceding paragraphs.

Example of Economy in Making a Simple Form of Core

In Fig. 1 at *A* is shown a core of half-round section of approximately 10 or 12 inches in diameter. It is a common practice at present (though not so much so as formerly) to make this simple type of core by the use of a skeleton or frame box, as shown at *B*. This practice is more frequently followed in cases where the diameter of the core is larger than in the present example. While this method effects a slight saving in pattern work and lumber over that of making a box such as shown at *C*, the saving is very small if proper use is made of the woodworking machinery and if all unnecessary hand work is avoided. Taking into consideration the fact that this saving occurs but once, the use

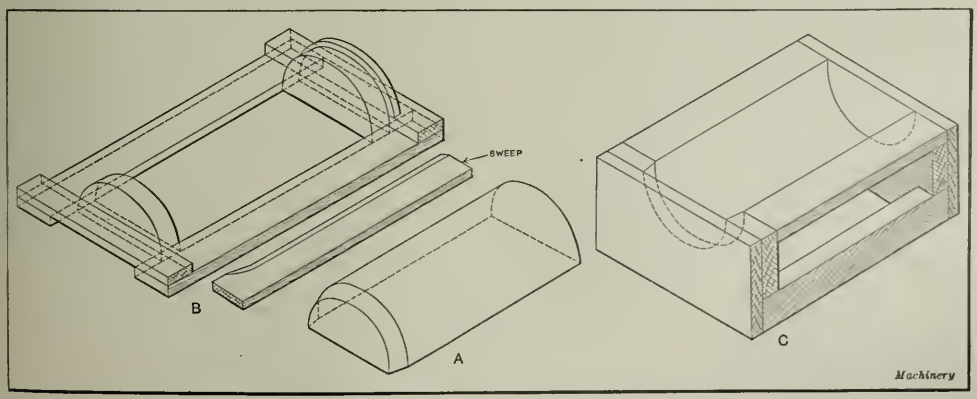


Fig. 1. Half-cylinder Core and Boxes in which it can be made

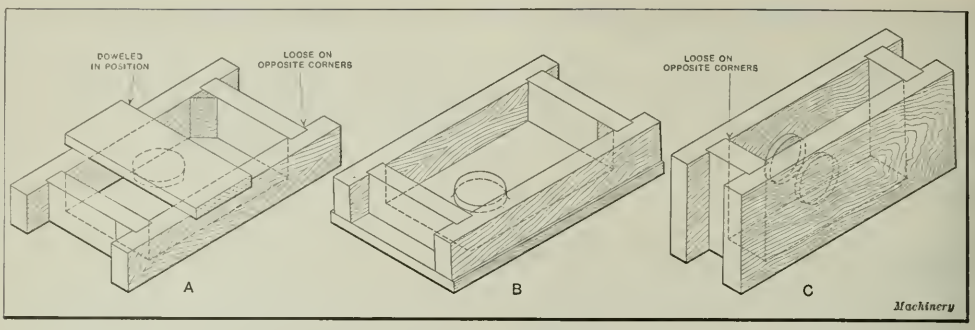


Fig. 2. (A) Poor Design of Common Core-box. (B) Improvement over Type of Core-box shown at the Left. (C) Design for Box having Bosses on Opposite Sides

of a skeleton is poor economy when it is considered that each time the box is used instead of the skeleton, a saving of from 300 to 400 per cent will be effected in the core-room, when the cores are made by hand. If a jarring machine is used, the difference will be still greater, for the cores will be more evenly rammed and more exact as to dimensions, if made in the box *C*.

There are other points in connection with the simple cylindrical core and its production that are not always given proper consideration by the patternmaker. Although there are various machines for producing cylindrical cores, it is often necessary to make cores of similar shape by hand, in which case it is quite common practice for patternmakers to provide a half-box. For cores of ordinary length (up to 16 or 18 inches and under about 6 inches in diameter) this is not good practice, when either accuracy or economy of production are considered.

To produce a cylindrical core from two pieces made in half-boxes, the coremaker must practically make two cores; he must also use two plates instead of one, thus using twice as much oven space; and there is also the consequent additional amount of handling. When the half-cores are dry and still warm they must be brought together, the joints must be cleaned off, and the cores must be fitted, calipered, and finally pasted and bound together. In the time thus consumed, a coremaker could have produced several seamless cores of accurate size and shape, if made in a cylindrical core-box and rammed from the end.

Efficiency in the Design of Common Core-boxes

A very common core-room tool is a box similar in design to the one shown at *A*, Fig. 2. This box is poorly designed for the work for which it is intended, and appears to be a misconception of the use of such a tool—the result of unfamiliarity with actual foundry practice. It does not save in pattern work, and is inconvenient to handle, requiring clamping together while being used. The boss must also be bedded in, the support of which prevents the quick striking off of the top of the box.

The solid or dump box shown at *B* in the same illustration is easier and more quickly made, requires no clamping, and being open at the face no tucking under is necessary, eliminating the possibility of the boss rising from its position unnoticed. This type of box insures a core of the right size, that can be made in the time that the coremaker would require to adjust the clamp on a box of the design shown at *A*. If a boss should be required on opposite sides of the casting, as is often the case, rather than add a bar with a boss attached to the core-box *B* (similar to the one on box *A*), better results will be had by changing the form of the box, so that the core is made on edge as shown at *C*. This box is loose on opposite corners and must be clamped together.

While these are but simple illustrations, they point to a fact that should be emphasized; namely, that patternmakers are often unfamiliar with actual foundry practice, or at least, do not give sufficient attention to details in the design of tools for the foundryman.

Cores for Molding a Self-oiling Bearing

An interesting molding job consists of casting a self-oiling pillow-block bearing, the pattern and cores of which are shown in Fig. 3. The pattern is shown at *A*, the main bearing core at *B*, while the core for the oil chamber is shown at *C*. The bearing itself is a steel casting, and presents a somewhat difficult problem in molding. Inasmuch as the oil-chamber cores, if made of the regular mixture of core sand, could

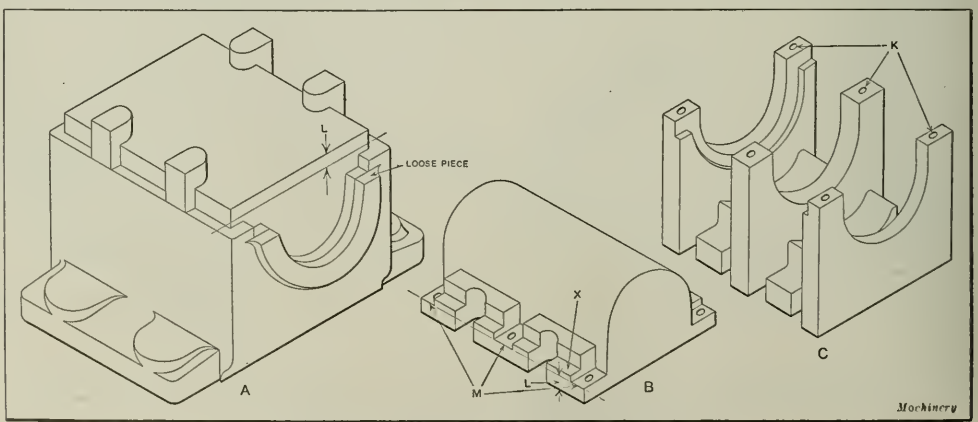


Fig. 3. Pattern and Core-boxes used in molding a Self-oiling Pillow-block Bearing

not be removed owing to the enclosed position, it was found necessary to form them of a very open, yet reasonably fine sand, with only a small proportion of loam, using oil only as a binder. This makes a core sufficiently strong to resist the pressure of the metal and the necessary handling, and one which, after being subjected to the heat of the casting, will pulverize under the shock of a hammer blow on the outside of the casting, or in the tumbling barrel. This mixture naturally generates a large quantity of gas, for the escape of which free and ample passages must be provided. If vents were not provided, the confined position of the core, which is almost surrounded by metal, would explode the mold.

To provide these air passages, wax vents ¼ inch in diameter are used, forming channels from the body of the core through each of the six passages as indicated at *K*, Fig. 3. When the cores are assembled as shown in Fig. 4, these vents

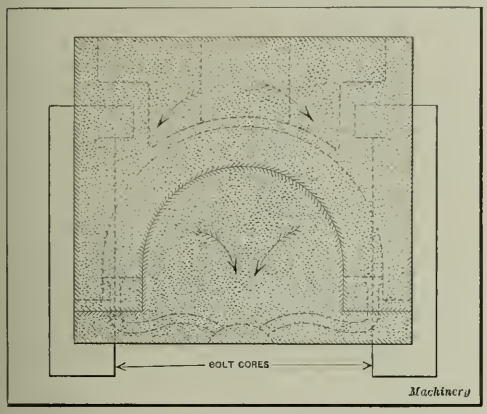


Fig. 4. Assembly of the Cores used in molding the Casting, the Pattern of which is illustrated in Fig. 3

from the oil-chamber core join other vents in the main bearing core, conducting these gases through the outside of the core-print and thence through the mold. The arrows in Fig. 4 indicate the general direction of the flow of the gases, which finally escape through a channel cut on the under side of the main bearing core.

As originally made, the prongs of the oil-chamber core rested on an even surface on the main bearing core, that is, on a surface in the plane of surface *X*, Fig. 3, but in casting, it seemed impossible to prevent a slight separation of the two cores under the pressure of the metal. This allowed the metal to flow into the vents, resulting in the loss of the casting, and creating a source of danger to the workmen. By adding about ¾ inch to the face of the core-print on the pattern, as at *L*, and raising the core-box of the main bearing core a corresponding amount, provision was made for forming recesses for the lengthened prongs of the oil-chamber core to rest in, as shown at *M*. This made it possible to seal these joints so that the metal could not run between them. Thus by this slight change in the design of the pattern, the danger to the molder was removed and no further trouble or loss experienced.

These illustrations show how essential it is that the patternmaker should have a thorough working knowledge of foundry conditions and practice. Owing to the fact that such a large proportion of the pattern work of today is done in job shops, sometimes far removed from the foundry, it is difficult for many patternmakers to obtain this knowledge first hand. For this reason, an attempt has been made in this article to set forth some important points relating to the effect on foundry practice of the methods employed in the pattern shop, and a careful consideration of these points should enable the patternmaker to produce patterns that will insure economical production in the foundry.

GEARS AND PINIONS FOR ELECTRIC RAILWAY SERVICE

At the meeting of the American Gear Manufacturers' Association in Boston in October certain rules covering the manufacture of gears and pinions for electric railway service were adopted as recommended practice by the members of the association. Railway gears have probably been standardized to a greater extent than gears used in any other field. This service can be divided generally into two classes—interurban and city service. The elevated and subway gearing can be grouped with the interurban. The standard pitch for interurban service has been set at not less than 2½, and for city service at not greater than 3. The standard face for interurban gears is 5 inches, and for city service 5 and 4½ inches.

The hub and bore dimensions for the gear are dependent to a great extent upon the American Electric Railway Association axle specifications. There are ten of these standard axles, E1 to E10, inclusive, covering all classes of service except trunk line electrification. The number of gear seat sizes have been reduced to six, 4, 4½, 5, 6, 7, and 8 inches. The length of gear hubs has been limited to two sizes, 4⅝ and 6⅛ inches. Two lengths of hub projections have been adopted which are 2⅛ inches on the motor side and 1 inch on the wheel side, also 1 inch on the wheel side and ⅛ inch on the motor side. The sizes of gear hubs have been reduced to five in number which are, 6½, 7, 8, 9½, and 10½ inches in diameter. The older designs of gears have several other sizes of hubs, and an attempt is being made to have customers bore out gear-cases to accommodate one of these standards. All solid gears are applied without a keyway with an allowance of 0.001 inch per inch diameter, this allowance being made in the bore of the gear. The pinion is applied with a taper bore tapering 1¼ inches per foot, which is now standard. The gear keyways have been standardized.

In conformity, as far as possible, with the American Electric Railway Association standards, the following limits for finish are recommended: The outside diameter over the teeth as machined must not vary from that specified by more than plus 0 inch or minus 1/32 inch. The face of the gears must not vary from the specified width by more than plus or minus 1/32 inch. The minimum thickness of the rim under the teeth shall be as follows, measured ⅛ inch in from the edge of the rim:

Pitch	Thickness of Rim
3	3/8 inch
2½	7/16 inch
2	1/2 inch

The web of all gears shall have four 3½-inch holes on a 7¼-inch radius spaced with a tolerance of ⅛ inch in the center of the webbed section, whenever the space will permit.

Dimensions of Bore and Hub

The diameter of finished bores shall not vary from that specified by more than plus 0.0015 inch or minus 0.001 inch. The diameter of the rough bore shall not vary by more than 1/16 inch over and ⅛ inch under that specified. The ends of finished bores shall be chamfered 1/16 inch on the motor side to avoid injury to the shaft when mounting. The diameter of the bores shall be measured with a pin gage or an inside micrometer.

The face of the hub shall have a smooth-bearing finish and run true with the bore. The variation from the specified dimensions of the hub and the hub extension shall not exceed the following: Length of hub over all, plus 0 inch to minus 0.02 inch; length of hub extension, plus 1/32 inch to minus 1/32 inch; diameter of hub extension, plus 0 inch to minus 0.03 inch.

The thickness of teeth at the pitch line must not be more than 0.01 inch under the size specified to allow for backlash. The teeth shall be of the Brown & Sharpe standard 14½-degree involute form unless otherwise specified.

All gears shall be tested for smooth running. The teeth must be equally spaced so that the gear will run smoothly

in both directions with a master pinion. Records of all chemical analyses and physical tests shall be kept by the manufacturer and shall be available to the purchaser for a period of one year. The purchaser reserves the right to reject any portion or all of the material which does not conform to the foregoing specifications in every particular.

Pinion Finish

The outside diameter of the pinion must not vary from that specified by more than plus 0 inch or minus 1/32 inch, measured at the center of the face. The face of the pinion must not vary from the specified width by more than plus or minus 1/32 inch. All bores must be finished after treatment. The diameter of the bore must be such that the standard plug gage will not project less than 1/32 or more than 1/16 inch, measured at the large end of the bore, and have bearing the full length of bore. All bores must be central with the pitch circle. All bores must have a reasonably smooth finish. The depth of the counterbore must not vary from that specified by more than plus 0 inch or minus 1/32 inch. The diameter of the counterbore must not vary from that specified by more than plus 1/32 inch or minus 0 inch.

The sides of the keyway must be cut parallel with the center line of the pinion. The width of the keyway must not vary from that specified by more than plus 0.003 inch or minus 0.0 inch. The depth of the keyway must not vary from that specified more than plus 1/64 inch or minus 0 inch. The fillet at the bottom of the keyway shall have 1/16 inch radius. Care must be taken to see that the pinion does not ride on the top or corners of the key. With this specification 1/32 inch clearance shall be provided for widths up to ⅞ inch, and 1/16 inch clearance for widths over ⅞ inch.

The thickness of teeth at the pitch line must not be more than minus 0.01 inch of the specified thickness. The teeth shall be of the Brown & Sharpe standard 14½-degree involute form unless otherwise specified.

Workmanship and Inspection

All pinions shall be tested for smooth running. The teeth must be equally spaced so that they will run smoothly in both directions with a master gear. All pinions shall be gaged with a standard taper plug gage, which shall be the same size as the nominal size of the bore at the large end. This plug gage must project not less than 0 or more than 1/32 inch, measured at the large end of the bore, and have bearing the full length of the bore.

All pinions shall be free from any seams, cracks, or other defects that would in any way affect their service. The purchaser reserves the right to reject any portion or all of the material which does not conform to the foregoing specifications in every particular.

Putting on Railway Motor Pinions

Many of the pinion failures on electric railway motors are caused by putting the pinions on incorrectly. It is generally believed that if a pinion is pushed on the shaft and the nut tightened, it will run satisfactorily without loosening. Experience has shown that in order to obtain satisfactory operation, pinions should drive their gears through the press fit or shrink fit on the shaft and not through the key. The key acts merely as a safety device should the pinion accidentally loosen. The desired fit for the pinion can be had by heating or by pressing.

Precautions Used when Putting Pinions on Shafts

The following points should be observed when putting pinions on railway motor shafts with a taper fit: The shaft should be clean and free from burrs or swellings; the pinion bore should be clean and free from burrs; the fit of the pinion bore should be in contact with at least three-quarters (75 per cent) of the surface of the taper fit on the shaft. This can be checked by rubbing Prussian blue, thin red lead and oil, or thin lampblack and oil on the pinion bore and fitting it on the shaft. After the above points have been taken care of the pinions should be put on the shaft cold to make sure that the keyway in the pinion is the proper size for the key mounted on the shaft, and that the pinion does not ride or bind on the top and sides of the key and will not ride the key when pressed further on.

The keyway on the pinion can be 0.002 inch larger, but not smaller than the key. There should be at least 1/64 inch clearance between the top of the key and the bottom of the keyway in the pinion. The corners of the key should be rounded to prevent their cutting into the fillet of the keyway.

Heating Pinions for Motors

Pinions up to three-inch bore should be heated in boiling water for thirty minutes, and those with three-inch or larger bore for sixty minutes. When the pinion has attained the temperature of the boiling water, namely, 100 degrees C. (212 degrees F.), it should be taken out of the water and the bore quickly wiped clean. Without allowing the pinion time to cool, it should be tapped on the shaft with a six or eight-pound sledge hammer, using a heavy piece of wood or copper between the pinion and the hammer. This sledging is not to obtain a driving fit, but to make sure that the pinion is home, and well seated. Three or four taps evenly distributed around the pinion end should be enough. The pinion nut with lock-washer can then be screwed home tight, with a wrench having a purchase or lever arm of three or four feet.

A suitable pinion heating arrangement can be easily made, the water being heated by an electric heater, a gas flame, or a steam coil. To prevent rusting and to insure a clean surface at the fit, washing soda should be added to the water in the proportion of one-quarter pound of soda to five gallons of water. By following these directions, it is possible to put pinions on armature shafts that will stay put and drive through their fit under the very hardest pulling from the motor.

* * *

HOTEL FOR EMPLOYES ERECTED BY THE NEW DEPARTURE MFG. CO.

Owing to the great difficulty of providing housing facilities for its unmarried employes, the New Departure Mfg. Co., of Bristol, Conn., has undertaken to build a hotel containing 300 rooms and intended to accommodate 600 men. The hotel is a five-story building, having bowling alleys, pool-room, and a barber shop in the basement; a large lobby with dining-room on the first floor; and sleeping rooms on the second, third, and fourth floors. The fifth floor will be fitted out as a club for the foremen, together with an assembly hall accommodating 300 persons. There will also be dining facilities on this floor, and a few guest rooms for guests of the company. The equipment throughout the hotel will be similar to that in the modern commercial hotel. In addition, the company has already built 100 houses, furnishing homes for 176 families, and is also interested in another real-estate enterprise which has constructed about 200 houses and is expected to erect as many more before the full building program is completed. The hotel and these houses are expected to take care of the present needs of the additional employes which the company expects to employ in the extensive additions made to its plant in Bristol.

* * *

The automobile industry is using a great amount of steel at the present time, and the requirements of automobile builders place a heavy demand upon the steel companies. The amount of steel consumed has greatly increased, since nearly all automobile bodies are made from sheet iron, and it is stated that the consumption of sheets of all kinds entering into the manufacture of automobiles is nearly 1,000,000 tons a year. The demand for steel in 1919 was from 20 to 25 per cent greater than during 1918, in spite of the fact that large quantities of steel were used in the latter year in building trucks for the Government.

Flush-pin Gages

By JOHN E. COLLINS



FLUSH-PIN gages are used for measuring the depth of holes, slots, counterbores, etc. This type of gage, in its simplest form, consists of a body *A*, Fig. 1, with a sliding pin *B*, which registers the depth of hole by means of a step on the top of the body. These gages are often mounted in holders of various designs and sizes, as illustrated in Fig. 2. The body should be made of machine steel, pack-hardened; the gage pins under ½ inch in diameter should be made of hardened tool steel, and those over ½ inch in diameter should be made of machine steel, pack-hardened.

In dimensioning flush-pin gages, care should be exercised in applying tolerances on the gages, and the standard type should be dimensioned as shown in Fig. 1. This type has no base attached, and therefore a minimum length of pin projecting beyond the body makes the opposite end of the pin come flush with the top of the step on the body. By giving the difference in tolerance allowed on the component to the bottom of the step, the maximum and minimum depths of the work may be readily gaged. This position is reversed on a mounted flush-pin gage; that is, the work rests on the gage bottom proper and is measured from the resting surface of the gage to the end of the pin, instead of from the lower end of the gage body to the end of the pin. The flush-pin gage shown at *C*, Fig. 1, is of correct design and is correctly dimensioned. Wherever possible, this type should be used, but if the pin should be too large to enter the work, a gage having the same size body but a smaller pin, as shown at *D*, is used. A variation of this type of flush-pin gage, as shown at *E*, meets the condition that arises in gaging a hole that is small in diameter and around which there is such a small area that the bodies shown at *C* and *D* would slide over the work instead of resting on its top surface. To take care of this condition, the body is counterbored, and a special pin with a slender end turned on it is used as shown in the illustration. Flush-pin gages are, in most cases, special, and for this reason usually require individual attention.

In Fig. 2 are shown two types of mounted flush-pin gages. The gage shown at the left has a movable spindle attachment. The type of work on which this gage is used is shown in section. The gage has a handle *A* which is used to lift the plunger *D* while the work is being placed in position for inspection. *B* is a pin mounted on a movable arm *J*, which may swing on the pivot *H* for convenience in loading cylindrical-shaped work. *C* is a stop-pin for limiting the swing of arm *J*. Blocks *E*, *F*, and *G* are held together by means of screws, and it is good practice to relieve block *F* about 1/32 inch on each side in order to obtain a perfect bearing surface between the blocks. Care should be taken to make block *E* high enough to provide a long bearing for pin *D*, so that there will be no danger of its wearing loose. The variation from the maximum and minimum limits is, of course, felt by the fingers on the top of pin *D*.

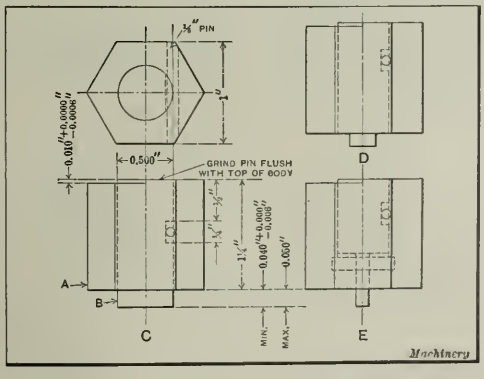


Fig. 1. Standard Types of Unmounted Flush-pin Gages

The type of gage shown at the right of Fig. 2 is used for measuring the distance from a counterbored surface to the bottom face of the work. *K* represents the outline of the work to be gaged. *L* is the base on which the work rests and to which the block *M* is attached. This block has two bearings for supporting the swinging bar *N*, on the end of which is a common flush-pin *O* that rests on the counterbored surface of the work. Rod *P* is the stop for bar *N* and supports it in the correct position. This rod should be hardened and ground on the end which bears against the bar. The dimension to be gaged is represented by *X*, and the manner of performing the gaging operation is so simple that no explanation is necessary. By making this dimension maximum it brings the pin to the top step of the body, and by giving the difference allowed in the manufacturing tolerance, the height of the step is found. Tolerances for the toolmaker which are allowed on the gage proper are applied in the opposite direction from those for the standard type of gage shown in Fig. 1. This mounted gage may be checked by the use of precision blocks or by making a special check, which in this case would be a hardened block made to the maximum dimension *X*.

Tolerances for Flush-pin Gages

Tolerances for flush-pin gages are taken from Table 4, published in the November number of MACHINERY, page 216, and are applied in the same manner as for plain gages. Referring to the dimensioned gage in Fig. 1, it will be noted that the general rule which can be applied to all limit gages having this system of tolerances is applicable in this case—that is, the minimum distance shows a maximum tolerance. Instead of giving the maximum distance a minimum tolerance, the tolerance is applied to the step on the top of the gage. This is done to give the toolmaker a tolerance on the last grinding operation, which will allow him a slight leeway, and at the same time enable him to produce a gage which is correct in gaging dimensions, as well as in direction of tolerance, so as to allow for wear of the gage in actual practice.

The method of final grind-

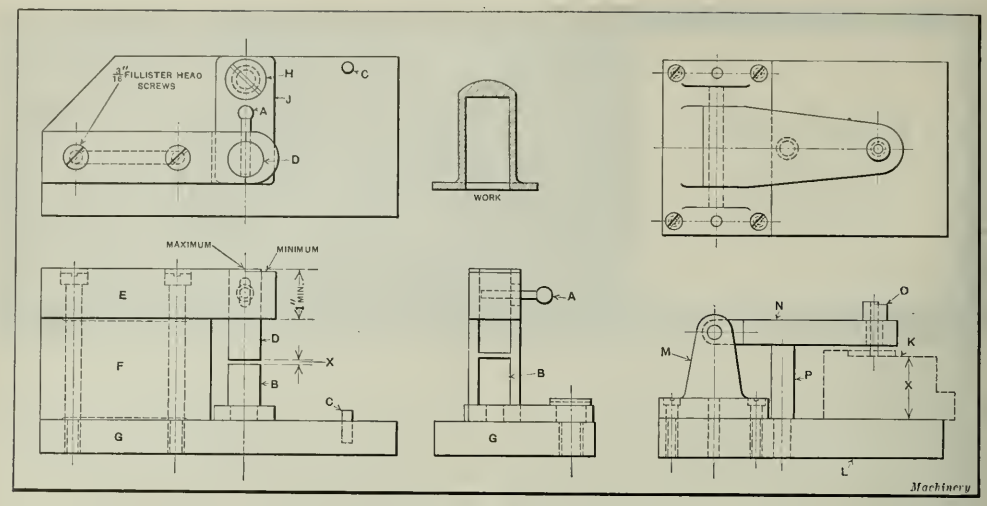


Fig. 2. Types of Standard Mounted Flush-pin Gages

ing and lapping for the step dimension (which is the last operation on the gage) is to set the body and pin in a suitable holder or vise on the grinding machine, with the minimum distance between the bottom of the gage body and the end of the gaging pin, correct to the dimension on the drawing. The tolerance for the minimum distance is taken advantage of and used to set the gage within the limits allowed. The tops of the body and of the gaging pin are then ground off together and lapped perfectly flat, as noted on the drawing. This gives one limit in the gage, and all that remains to be done is to allow the gaging pin to drop down out of the way, and grind the step proper to the minimum or "Not Go" tolerance as provided in the table previously referred to. This brings the gage within the prescribed limits.

Counterbore Depth Gages

Flush-pin gages of the type shown in Fig. 3 are used for gaging the depth of counterbored holes. The type shown at the left was developed for use on large holes, counterbored up to 5 inches in diameter, which have a close tolerance and must be measured from a shoulder on the outside of the work. The gage is bored to fit the diameter of this shoulder, with 1/64 inch clearance, and is then bored out for the pin gage body. The body is turned to fit the bore and pressed into the plate as shown in the illustration, after which the fitting surfaces are ground and the end of the gage body and the pins ground and lapped. This type of gage is inexpensive and will give accurate results to within 0.0015 inch.

The depth gage shown at the right in the illustration is for measuring the depth of counterbored holes from a flat surface. The shoulder *A* rests on the flat surface of the work and the foot *B* in the counterbore to be gaged. Any variation in the depth of the counterbored hole may be felt by placing the finger on the flush-pin and top of the gage.

* * *

I believe that the biggest problem industrial management faces today is the labor and production problem; it transcends in importance the sales and financial problems, and is worthy of the exclusive and direct attention of the chief executive.—*Charles Picz, President, Link-Belt Co., in an address before the Illinois Manufacturers' Association.*

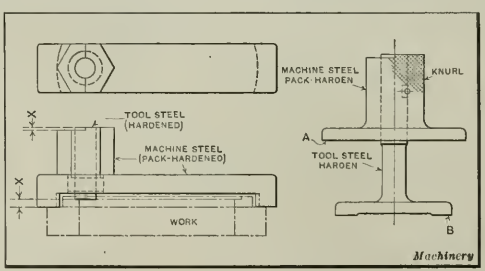


Fig. 3. Examples of Two Types of Counterbore Gages

NEW MOLYBDENUM HIGH-SPEED STEEL

A short time ago, Professor John Oliver Arnold, of Sheffield University, Sheffield, England, made some startling statements with regard to a new steel that he claimed had been developed in Sheffield and which was said to be superior to any high-speed steel hitherto made. He claimed for this new steel much greater hardness, longer life, and greater ability to remove a metal than any other steel. He stated that molybdenum was used instead of tungsten as a component of this steel, and the newspapers commented on the subject as if the use of molybdenum in steel was a new development. As a matter of fact, molybdenum was experimented with twenty years ago in steel making, and English steel makers, themselves, some eighteen years ago investigated the use of this metal as a substitute for tungsten, but for certain reasons the use of molybdenum was abandoned. One of the objections to molybdenum is stated to be the brittleness which it produces in the steel. Until further information about this new high-speed steel is received, therefore, there seems to be no reason to anticipate that any great discovery has been made, and it is generally believed among men familiar with the steel business in the United States that there is nothing new in the steel announced, but that it is merely a special form of molybdenum steel containing possibly also chromium and vanadium, which would tend to give it some qualities that would be valuable in a high-speed steel, but which, by no means, are new or unknown.

* * *

The Material Handling Machinery Manufacturers Association held its convention at the Waldorf-Astoria Hotel, New York City, January 29 and 30. At the meeting a business session was held in the morning of January 29, followed by a formal luncheon at the hotel. In the afternoon, there was a session at which short papers on mechanical handling were read, followed by open discussion and moving pictures. An executive session of the membership was held during the following day, and papers on mechanical handling were again read, followed by discussion and moving pictures.

LETTERS ON PRACTICAL SUBJECTS

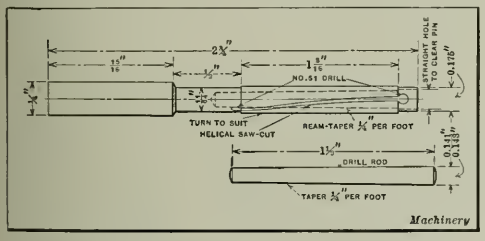
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INTERNAL LAP

The writer has learned by experience that an internal lap made according to the design shown in the accompanying illustration is especially suitable for use in lapping small holes which are long in proportion to their diameter. The following information should be of assistance in making laps of this type. It is the opinion of the writer that copper is the most suitable material to use in making the laps. It will be noted that the lap is necked between the handle and the body and that the end is turned down in a similar manner.

Two holes are drilled through these necks, as shown, being connected by a helical saw-cut—a feature which prevents the hole from being lapped out of round and also provides for removing unevenness caused by hardening. The end of the lap is drilled out to a depth equal to the length of the turned portion, so as to clear the large end of the tapered pin when the lap is expanded. The diameter of the tapered pin in relation to that of the body of the lap should be such as not to leave the metal surrounding the pin so heavy that it will not conform to the taper of the pin when the lap is expanded.

This lap has been used for lapping holes 0.185 inch in diameter, 1¼ inches long, and sufficient accuracy has been obtained to make it impossible to enter a 0.185-inch diameter plug either dry or by using ordinary oil, but with oil which had been used it was found possible to get the plug into



Internal Lap which is especially suited for lapping Small and proportionately Long Holes

the hole. As an experiment, a plug was made 0.0001 inch over size and this plug could not be pushed through, no matter what kind of oil was used. In lapping the hole, no extraordinary care was taken, a fact which clearly demonstrates the satisfactory results which can be obtained with a lap of this design. Previous to making this lap, a slit bushing was tried on a tapered arbor but without success, because it was found that the lap expanded much faster on the large end of the arbor than on the small end. Under these conditions, it was impossible to obtain a straight hole or to prevent bell-mouthing.

East Hampton, Conn. HOWARD HOUSE

INTERCHANGEABLE JIGS AND FIXTURES

The writer has often heard remarks pertaining to jig and fixture design, such as: "Don't try to use the same fixture for more than one operation if it is necessary to apply loose parts or reset the fixture"; or "You will not obtain accurate results, if you expect the operator to set up that tool." These remarks are perhaps justified, if the tools are intended for an established article or machine, and provided the expense involved in making them is not a deciding factor. But, if they are intended for a new machine, which may be altered or redesigned in a short time, it seems advisable to economize on tool expense, and build fixtures that can be used

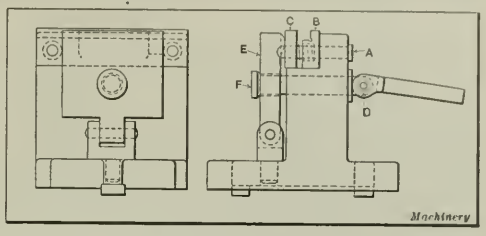


Fig. 1. Milling Fixture having Loose Jaw

for more than one part or operation. Of course, this practice should not be employed when production would be cut down to any great extent by tying up the fixture on one operation when it would be needed for some other operation.

Interchangeable jigs and fixtures should not be taken apart or changed by the operator, but should be returned to the tool-room after each operation, where they may be reset by an experienced mechanic. The fixture should be designed in such a way that when it is properly set, it cannot become easily changed either by accident or intention, except by the mechanic who is responsible for setting the fixture. The fixture should have dowel-pins or other fixed locating members so that the mechanic can reset it without using measuring instruments. Each fixture should be provided with an instruction sheet or diagrams showing the exact location of each loose part for the various operations for which the fixture is designed. The illustrations show several interchangeable jigs and fixtures which have proved useful in drilling and milling operations.

The most common type of interchangeable fixture is, perhaps, the ordinary milling vise that is provided with loose jaws and cam-clamping arrangement. This type of vise is satisfactory where extreme accuracy is not required, but the loose jaws do not always retain their accuracy of alignment or properly line up with the base if subjected to rough treatment. The fixture shown in Fig. 1 is a plain, inexpensive fixture with self-aligning jaws, which can be used instead of a milling vise on work requiring considerable accuracy. The two guide pins *A* are driven tightly into the base casting and the stationary jaw *B* fits snugly on these guide pins and is also fastened to the casting with screws. The loose jaw *C* is a sliding fit on the pins and

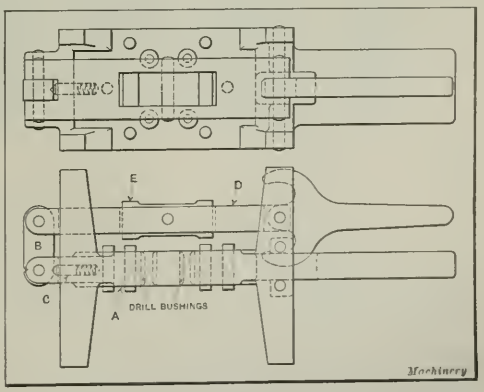


Fig. 2. Interchangeable Drill Jig

is held open by two springs when released by the cam. In order to change the jaws, the nut and pin at *D* must be removed, the bolt *F* withdrawn, and the clamp *E* opened, after which the jaws may be removed.

The drill jig shown in Fig. 2 is well adapted for drilling right- and left-hand pieces of similar shape which have the same size holes located in corresponding positions. Suitable locating pins should be provided on each side of the jig body, *A*, those on one side being used for locating the right-hand piece and those on the other side for locating the left-hand piece. The clamping leaf *D* which is equipped with an equalizer *E* is connected with the body by means of a link *B*. In this link are milled two notches which engage with the detent *C*. The detent is operated by a spring which holds the link and the clamping leaf in the desired position for drilling either the right-hand or the left-hand piece. If the jig is too large to make this spring detent arrangement effective, a more substantial screw-locking device may be substituted. This style of drill jig is especially valuable where it is essential that the holes in the right-hand piece line up perfectly with the holes in the left-hand piece.

In Fig. 3 at *W* is shown one of eight steel brackets that are drilled in the jig illustrated. All the brackets have similar profiles, the only difference being in the number of fingers *H* and the distance between the holes in the fingers. The work is located on the two steel blocks *A* and *B* by the two pins *G* in block *A*, and is then clamped in place by the bushing leaf *C*. Two bushing leaves *D* or as many as any one bracket has fingers, are mounted on a rod *F* which is of sufficient length to suit the widest bracket. These sliding leaves each carry two locating pins which straddle the work, thus bringing the leaves into the proper drilling position. The sliding leaves are clamped down by the cams *E*, which move freely on another rod and are backed up by the steel block *B*.

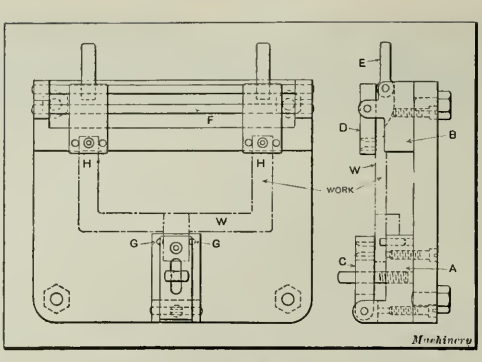


Fig. 3. Jig for drilling Eight Different Brackets

It was necessary to locate several arms in different positions on shafts of various lengths, drill and taper-ream the arm hubs, and drive in the dowel-pins. Building a separate drill jig for each shaft, was expensive, so it was decided to make one jig with adjustable parts. This drill jig is shown in Fig. 4 loaded with a shaft having three arms. The base is made long enough to adopt it for the longest shaft, and a sufficient number of blocks *A* are provided to handle the shaft having the greatest number of arms. Two set-up plates *B* and *C* are made for each shaft and provided with square notches for locating the blocks in correct relation to each other and to the stop *D*, which is doweled to the base. When drilling a shaft, the proper set-up plates are fastened to the sides of the base, and the blocks, which are numbered to correspond with the numbers on the plates, are put in place and screwed down tight, thus forming a rigid jig for the shaft. The arms are now slipped on the shaft and the jig is loaded. Each block *A* carries slots and stops for locating the arms, and the shaft rests in a vee and is clamped against the stop *D* by the wing-screw *H*. The clamps *E* are next pushed into position, and the work is clamped down. The bushing leaves *F* are tightened, so that they rest on the shaft. The holes are then drilled, the leaves opened up, the holes taper-reamed and the dowel-pins driven in, after which the finished shaft is ready to be removed from the jig.

Hartford, Conn. SVEND HELWEG

PRECISION DEPTH GAGE

In small-arm cartridges, such as the 0.30 and 0.45 caliber and the 110 grain precussion primer, it is essential that the primer cap does not project beyond the rim of the cartridge case. The depth gage here illustrated was designed for the purpose of expediting the inspection of these parts and also to insure accuracy. The gage is of interest-

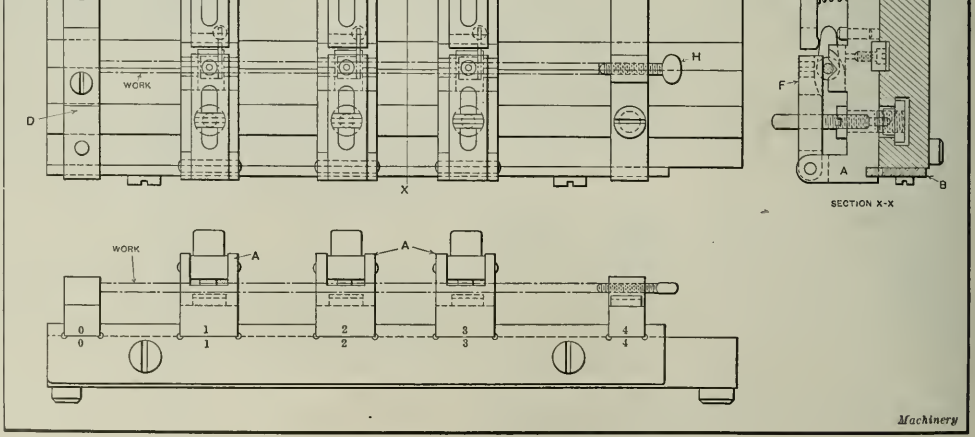
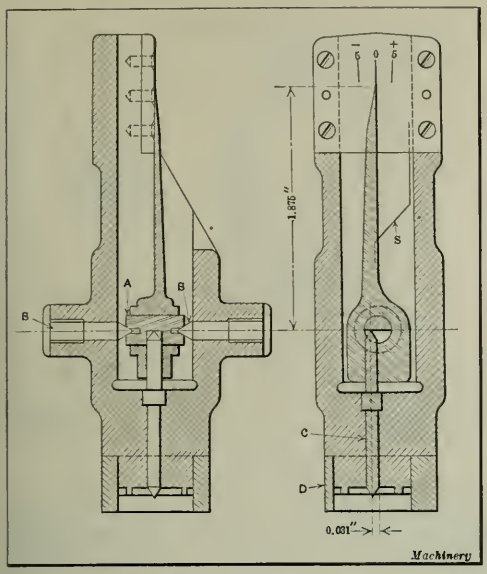


Fig. 4. Jig for locating and drilling Arms on Shafts of Similar Design



Precision Depth Gage with Graduations on a Scale of 60 to 1

ing design from the standpoint of the principle involved, and with modifications may be used for similar purposes.

The body is made from solid stock, turned, shaped, and bored as shown. The indicator arm is mounted upon a hardened steel arbor *A* in each end of which is a ground and lapped 60-degree female center. This arbor is ground on the outside and is a press fit in the hub of the indicator arm. The male centers which support the arbor are made of hardened tool steel and are ground and lapped, and provided with a threaded section for ease of assembling and adjustment. The arbor is also provided with a slot cut to a depth of one-half its diameter at right angles to its longitudinal center line. The bottom of this slot, which is the bearing surface for the plunger point, is accurately lapped. The center line of the plunger *C* is offset in relation to the center of the arbor an amount depending upon the degree of magnification desired. As will be seen, the offset in the gage illustrated is 0.031 inch, and the length of the arm, 1.875 inches, which gives a reading magnified more than sixty times. The reading is obtained on the graduated plate at the upper extremity of the indicator arm, the 0.005 inch graduations with this ratio being nearly 5/16 inch apart, and the 0.001 inch graduations being 1/32 inch apart. In the design shown, the graduations are so located that a plus or minus reading can be obtained. However, for this particular class of inspection, if the assembled primer cap projects beyond the rim of the case so that the gage registers on the plus side, or if the minus reading is below 0.005 inch, the cartridge would be rejected. The flat spring *S* shown at the right counteracts the tendency of the weighted end of the indicating hand to seek a vertical position, keeping it on the minus side when the gage is at rest and exerting sufficient pressure to force the plunger downward. The eccentric sleeve *D* at the bottom of the gage acts as a centering and retaining ring for the work to be gaged, and is pressed on the body. All movable parts of the gage can be readily replaced as required, and the bottom of the body proper can be finished down to compensate for the wear on the plunger, thus prolonging its usefulness.

The cartridges are inspected very rapidly and accurately with this gage. The instrument is held in one hand while the parts to be gaged are held in the other hand, and a variation of 0.001 or even 0.0005 inch can be readily detected.

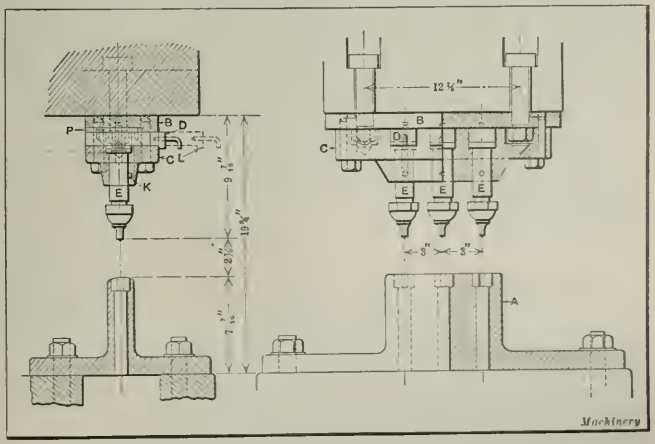
Plainfield, N. J. J. B. CONWAY

MULTIPLE PUNCH

One of the many varieties of multiple punches is shown in the accompanying illustration. Generally no provision is made in the design of multiple punches whereby any single punch in the gang may be rendered inoperative. This particular design, however, does contain this feature, and in consequence is especially suited for car-shop work, such as that requiring holes to be punched in channel iron in groups of two or more holes, where such holes are located at various intervals. The punch as illustrated is equipped for punching three holes ¾ inch in diameter. The stroke of the machine on which this punch was used is 3 inches.

The die-block *A* is bolted to the bed of the punch press and is made of cast steel. It is drilled through and counterbored, as shown, to the proper size for receiving the dies. The toolpost holder block *B* is made of open-hearth steel 1½ inches thick, 5¾ inches wide and 18¼ inches long and is secured to the ram of the machine as shown. The toolpost holder *C* is attached to this block by means of capscrews and dowel-pins. The punches *E* are prevented from rising when in operation by means of sliding keys *D*, one of which is provided for each punch. The keys have a lip *L* at one end and a pin *P* at the other end and these act as stops to prevent the keys from being entirely pulled out or from being pushed in beyond a predetermined position. Pins *P* operate in grooves in the blocks *B* when the key in which the pin is carried is moved. The keys *K* in the punches operate in keyways in the toolpost and permit the punches to be raised to an inoperative position when so desired; these keys also prevent the punches from turning when in operation. The construction of the punches proper should need no detailed description, as they follow the well-known standard type. As previously stated, it is possible to use as many of the punches in the gang as desired. To put a tool into an inoperative position, it is necessary only to move the key *D* to the position shown dotted in the illustration, which will allow the punch to be raised into the space formerly occupied by the key.

St. Louis, Mo. FRANK BRASCH

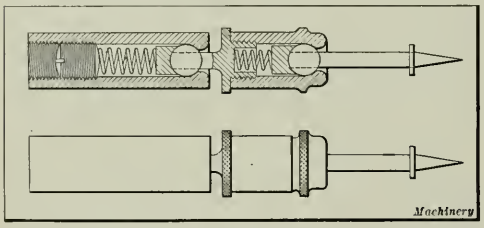


Gang Punch with Provision for independently placing the Punches into Operative Position. Equipment of this Design is used extensively in Car-shop Work

UNIVERSALLY JOINTED TOOL FOR LOCATING BORED HOLES

In the accompanying illustration is shown a device known as a "wiggler," which has recently become recognized as a necessity in certain classes of machine shop and tool-room work. The ease and accuracy with which bored holes can be located with the aid of this device is well known and appreciated. The tool shown in the accompanying illustration, however, is an improvement over the ordinary type. It consists of a double ball-jointed pointer which is of the usual design except that it has a collar pressed on at the indicating end and located about ⅜ inch from the extreme point. This collar or flange is ground to an outside diameter of exactly ¼ inch and, of course, must be exactly concentric with the axis of the pointer.

When the tool is used to locate a hole in relation to a finished surface, the shank is held in a chuck on the spindle of a milling machine. By means of the double-jointed arrangement the pointer can be readily adjusted to run true, after which the table on which the work is clamped is brought up carefully until the edge of the flange just skims the finished surface, care being taken not to disturb the adjustment of the pointer. In this position, the center of the machine spindle is exactly ⅛ inch from the locating surface in a perpendicular direction, and it is then only necessary to use the micrometer dials on the table to determine the location of the required point on the face of the work. By the substitution of a boring tool for the locating tool in



Tool used in the Spindle of a Milling Machine for locating Bored Holes

the machine spindle, the hole can then be bored and, if the milling machine is in good condition, a high degree of accuracy can be attained.

P. R. H.

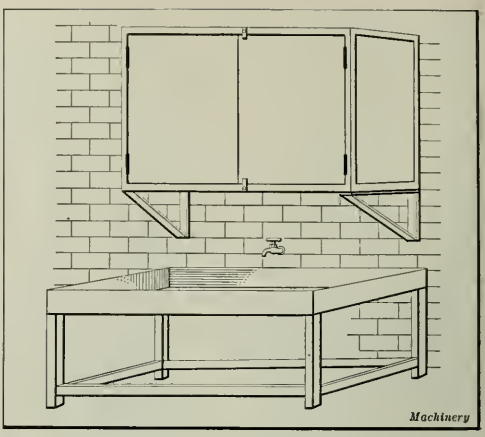
TRUCK FOR MOVING SHOP TOOLS

The use of rollers and skids for moving shop tools is fast being supplanted by the more convenient method of using trucks. This method is also much easier, cheaper, and quicker. A suitable truck for this purpose is one that is about 6 inches high, 4 feet wide, and 8 or 9 feet long, having four wheels 4 inches in diameter with a 4-inch tread. When a machine is to be moved, one end is simply jacked up and the truck slipped underneath. After the machine has been loaded, it is an easy matter to move the machine to its desired location, and this does not require the services of as many men as would be needed by the use of rollers and skids for the purpose.

Cicero, Ill. J. J. Borkenhagen

BLUEPRINT WASHING AND DRYING OUTFIT

A compact arrangement for washing and drying blueprints is shown in the accompanying illustration. It consists of a zinc tank which rests on a wooden framework, 2½ feet high, and a drying stove supported directly above the tank. The washing tank is 5 feet long, 3½ feet wide, and 6 inches deep, to which the water is supplied by a tap. A waste pipe is fitted at one end, the tank being slightly tilted to give



Blueprint Washing and Drying Outfit

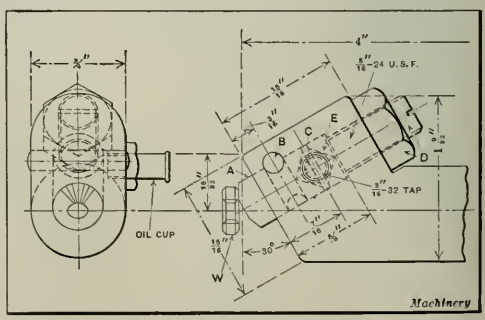
the necessary drainage. The stove is 5 feet long, 1½ feet wide, and 3½ feet high, and it has a timber frame which is lined with asbestos sheeting, the bottom sheet being perforated to allow the water to drip from the prints into the tank. The stove is rapidly heated by means of electric heaters, one being attached in each end. The prints are hung on laths which are fixed in racks at each end of the stove. This outfit has been in successful operation for over a year.

Toronto, Canada James B. Nelson

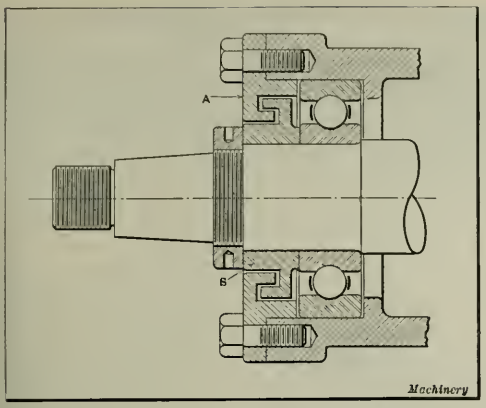
END-KNURLING TOOL

The end-knurling tool here illustrated was designed for use on an automatic screw machine and has given entirely satisfactory results. In this illustration, *W* represents the type of work on which this tool was used. The design is quite simple. The tool proper *A* is made of nickel steel and is provided with a circular groove in which the pin *B* engages to hold the tool in place and to permit it to revolve. The end thrust of the tool is taken by a steel ball *C* located in a conical recess in the end of the tool and held in place by a solid washer *E* having a similar recess. A set-screw *D* fitted with a lock-nut may be employed to compensate for wear of the ball and its points of contact in the two enclosing recesses. An oil-cup is provided as shown so that the ball may be readily lubricated, thus reducing to a considerable extent the amount of wear caused by friction. The shank of the tool-holder may, of course, be made to fit the turret of any screw machine, but the tool shown in the accompanying illustration was designed particularly for use on a Brown & Sharpe type of machine.

Buffalo, N. Y. H. Kurzweil



Automatic Screw Machine End Knurl



Ball and Roller Bearing Closure applied to Annular Ball Bearing

ENCLOSURE FOR BALL AND ROLLER BEARINGS

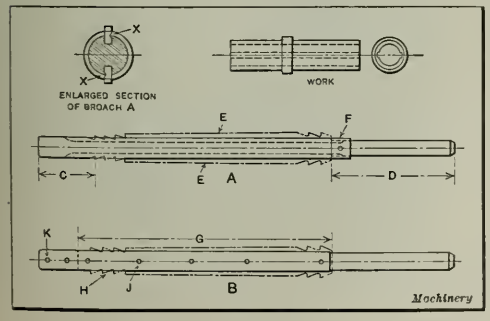
A device for the closure of ball and roller bearings for the purpose of protecting them from dirt and loss of lubricant is shown in section in the accompanying illustration. The application of the device to an annular ball bearing installation is clearly shown, as well as the rings which form the protection for the bearing. It will be noted that there are two of these rings, in both of which concentric grooves of rectangular section are turned. The groove in the face of the outer or stationary ring *A* receives the tongue of the inner or rotating ring *B*. The clearance between the sides of the tongue and grooves should be about 0.005 inch, and 1/16 inch space should be allowed for end play of the shaft. This space is clearly shown in the illustration. The protection afforded by this arrangement is remarkably good, even under the most adverse conditions, and is distinctly superior to the protection afforded by the use of felt washers, so commonly employed for this purpose. P. R. H.

KEYWAY BROACHES WITH INSERTED TEETH

The accompanying illustration shows two designs of inserted-tooth broaches which may be employed for broaching keyways in thin sleeves such as shown in the upper right-hand corner of the illustration. The broaches are of the push-through type; consequently the sleeves are held in a vertical position in a suitable fixture so as to allow the broaching tools to fall through the work after the keyways have been cut. The fixture is equipped with a hardened and ground steel bushing in which the body of the sleeve fits and against which its shoulder rests.

The tool shown at *A* in the illustration has two strips of cutting teeth *E* which are set in grooves milled in the shank and held in position by cutting a shallow groove *X* along one side of the strips and then peening the metal of the shank into these grooves as shown in the enlarged sectional view. A small collar *F* is pinned to the shank as a stop for these strips, the arrangement being entirely suitable for the small work for which broaches of this type are intended. One objectionable feature of the tool is that the strips of teeth cannot be removed without ruining the shank. The length *C* of the shank acts as a pilot in the bushing and the opposite end *D* is reduced in diameter so that it will readily fall through the work at the completion of the operation.

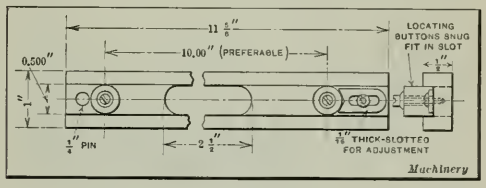
The broach shown at *B* contains but one set-in strip *H*, which fits into a slot cut through the shank and which is held in place by means of small pins *J*. This strip, as will be seen, has two sets of cutting teeth. The slot in which this strip fits is cut from the pilot end of the body to a depth suitable for the length *G* of the strip, the end of the slot *K* being closed with a filling strip, which is held in the slot by means of two small pins. This construction enables the cutting strip to be replaced when necessary by simply driving out the pins and substituting new strips of teeth. The latter construction is an economical method of making broaches of this type which, it should be mentioned, are intended to be used on an arbor press and for light work only. F. H. M.



Inserted-tooth Broaches for Light Work

ADJUSTABLE SINE BAR

The sine bar shown in the accompanying illustration possesses an adjustable feature which does not detract from its accuracy when employed to locate work and which greatly expedites the locating of the buttons. The design is not elaborate, and the only part that requires accurate machining is the ½-inch groove in which the buttons are located. The ground and lapped buttons must be a snug fit in this groove, the latter, of course, being parallel with the side of the bar. A ¼-inch pin is employed as a stop for the non-adjustable button and a 1/16 inch thick adjustable stop is provided for the adjustable button. This provision enables the toolmaker to remove and relocate the buttons when required and to reset them without difficulty. The fact that only longitudinal adjustment is needed greatly enhances the value of the tool. Of course, if so desired the adjustable stop may be eliminated and only the groove made use of, but the adjustable stop is the feature which should especially commend this sine bar. If an angle-plate having a vertical slot is used in connection with the sine bar, the 2½-inch slot in the bar will provide a ready means for bolting the sine bar in place after the work has been properly located by means of the buttons.



Sine Bar having Adjustable Feature for facilitating the Location of Buttons

Muskegon, Mich. GEORGE L. GARVIN

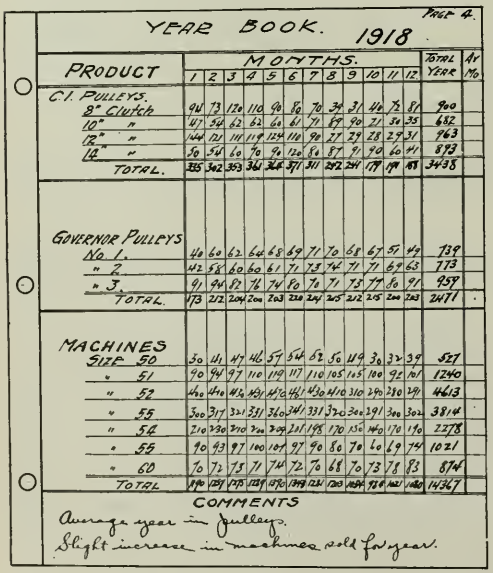
RECORD OF SALES

It is of great value to executives of manufacturing concerns to have reports available for constant reference, showing the amount of goods sold or the number of units disposed of within certain periods of time. The most common unit of time used in making these studies of sales is the month. Such reports will furnish the production manager or planning and routing engineer sufficient data upon which the schedules of production may be based. With the present high

cost of material, a minimum amount of work in progress and of stock on hand, compatible with good service and prompt delivery, is the best and most efficient method of doing business. An accurate report of the amount of goods sold is of great value to executives who are interested in watching the trend of sales, and is also useful to shop superintendents and foremen who are required to plan the production in sufficient quantities to supply the demand.

A large manufacturing company has evolved a simple plan for keeping executives and shop officials posted on sales requirements by making up what is termed a year book, a sample page of which is here illustrated. These pages consist of forms drawn on tracing cloth, on which the information is tabulated from month to month. Blueprints of these pages are bound and issued quarterly to the executives. Before issuing these quarterly statements, the folio already in the hands of the executives is recalled, the new quarterly statement is inserted, and the folio is returned intact. Thus, at the end of each year, the executives have a folio containing a complete synopsis of the year's business, which is easily accessible when rapid calculations and planning for future business demand such information. This report does not give prices, but simply states the quantity and kind of product sold.

Should information of this nature be desired at times other than the date of the quarterly statement, the executive has only to make his request to the proper clerk, and forthwith prints of the year book are made and sent to him. The data for the book are compiled from copies of customers' invoices, which are analyzed by filing in a box sub-divided in such a way as to give the desired information. Analysis is made and the information derived therefrom is tabulated



YEAR BOOK. 1918 Page 4.

PRODUCT	MONTHS. 1	2	3	4	5	6	7	8	9	10	11	12	TOTAL YEAR	AV /Mo
C.I. PULLEYS.														
8" Clutch	94	73	120	110	90	80	70	34	81	46	75	81	900	
10" "	47	56	62	62	60	61	71	67	90	71	56	35	682	
12" "	144	121	111	119	124	116	90	77	79	28	29	31	963	
14" "	50	54	60	70	94	120	86	87	9	90	60	41	873	
TOTAL.	335	342	353	361	368	377	317	262	249	175	191	188	3418	
GOVERNOR PULLEYS														
No. 1.	40	60	62	64	68	69	71	70	68	67	57	44	739	
" 2	42	58	60	60	61	71	73	74	71	71	69	63	773	
" 3	91	94	82	74	74	80	70	71	73	77	80	91	957	
TOTAL	173	212	204	200	203	220	214	215	212	215	206	198	2471	
MACHINES														
SIZE 50	30	41	47	46	57	54	52	50	49	36	32	39	527	
" 51	90	94	97	110	119	117	110	105	105	100	92	101	1240	
" 52	400	400	412	421	415	411	420	410	310	290	280	319	4613	
" 55	300	317	321	331	360	341	331	372	320	291	300	302	3814	
" 54	210	230	270	290	309	281	198	170	150	140	170	170	2278	
" 55	90	93	97	100	107	97	90	80	70	60	69	74	1021	
" 60	70	72	75	71	74	72	70	68	70	73	78	83	874	
TOTAL	1190	1257	1319	1369	1491	1373	1221	1255	1074	990	1021	1088	14367	

COMMENTS
Average year in pulleys.
Slight increase in machines sold for year.

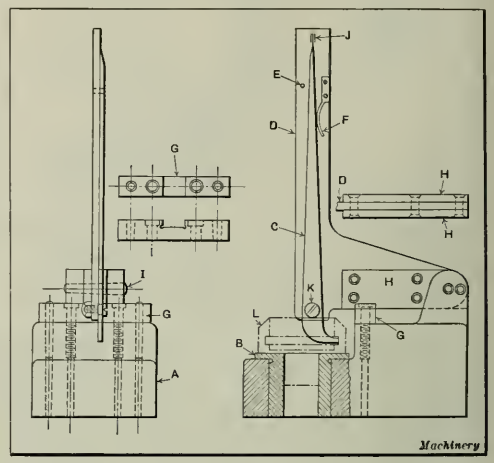
Year Book Page showing how Number of Sales is recorded

every month. A very short space of time is required for the process of analyzing the invoices, and the results of these analyses, as shown in the year book, amply repay any additional expense incurred by the clerical work. The year book also contains an index page as a means of enabling users to find the desired information readily. By making this information available to executives as well as to superintendents and foremen, everybody concerned is informed as to what is expected in the line of future production needs, and greater cooperation is obtained. It is the opportunity for intelligent cooperation that is too often lacking.

Bellows Falls, Vt. S. P. KEATOR

INDICATOR GAGE FOR INTERNAL GROOVES

Gages equipped with micrometer heads which have been employed on quantity production work have been described recently in the columns of MACHINERY, but it is the opinion of the writer that the use of micrometer heads on gages employed on this class of work should be generally avoided.



Indicator Gage which may be used to test Concentricity as well as Depth of Internal Grooves

Mistakes are likely to occur in reading the micrometer, and a great deal more time is consumed in measuring a part with such a gage than would be required if an indicator gage were used. The internal-groove gage shown in the accompanying illustration can be employed, not only for measuring the depth of the groove, but also for testing its concentricity, by merely observing the fluctuations of the indicator as the work is revolved in the locating bushing. The cost of this gage will surely not exceed that of a micrometer-head gage. Repairs will not be required frequently, as there are practically no parts subject to wear except the contact point of the indicator.

The cast-iron base *A* of this gage has two finished parallel surfaces, to one of which the steel bushing *B* is fastened and to the other, the locating block *G*. The bushing *B* is made of machine steel, casehardened and ground, and is a drive fit in base *A*. The shank of the work *L* fits into the hole of this bushing, and its base rests on the head of the bushing. The pieces *D* and *H* are made from ground flat stock (a commercial product) such as used by toolmakers in making gages, test tools, and jigs; this reduces the amount of machining required, as the pieces are simply riveted together after being cut to the required shape and size. The three assembled parts are hinged into a milled slot in the body by means of the tapered pin *I*. Indicator *C* is also made of ground tool steel of a standard thickness and the contact or gaging end only is hardened. The indicator hinges on part *D* by means of screw *K* and may be adjusted by means of a nut. The force exerted by the flat spring *F* when the gage is in use keeps the gaging end of the indicator in contact with the bottom of the internal groove. A stop-pin *E* is provided against which the indicator is forced by the spring when the gage is not in use. Three graduation lines at *J* indicate, respectively, the maximum and minimum limits on the work and the neutral position of the indicator, that is, the zero mark. Block *G*, which is fastened to the body with two screws and two tapered dowel-pins, is employed to hold the device to which the indicator is hinged in a fixed position. To check the accuracy of the gage, a test-piece should be made with a groove similar to that in the work.

Bridgeport, Conn. MAX SLUTZKY

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW AMERICAN METAL-WORKING MACHINERY

The New Tool descriptions in MACHINERY are restricted to the special field the journal covers—machine tools and accessories and other machine shop equipment. The editorial policy is to describe the machine or accessory so as to give the technical reader a definite idea of the design, construction, and function of the machine, of the mechanical principles involved, and of its application.

Taylor & Fenn Two-spindle Spline Milling Machine. Taylor & Fenn Co., Hartford, Conn. 563
Cincinnati Boring Mills. Cincinnati Planer Co., Oakley, Cincinnati, Ohio. 564
Pearson Precision Spacing and Boring Machine. Modern Machinery Exchange, 25 Church St., New York City. 565
Edwin Harrington Crankshaft Drill. Edwin Harrington, Son & Co., Inc., 17th and Callowhill Sts., Philadelphia, Pa. 566
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Morris Radial Drilling Machines. Morris Machine Tool Co., Court and Harriet St., Cincinnati, Ohio. 576
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Rose Diamond Holders. S. Rose Co., Inc., 1133 Broadway, New York City. 578
"Fulflo" Portable Coolant Circulating Unit. Fulflo Pump Co., Blanchester, Ohio 579
Jones Relieving Attachment. William D. Jones, 1010 Wilder Bldg., Rochester, N. Y. 579
High-speed "Red-E" Lathe and Grinder Center. Ready Tool Co., 650 Railroad Ave., Bridgeport, Conn. 582
Barton Drill Chuck. H. E. Barton Tool Co., 106 S. Jefferson St., Chicago, Ill. 582
Detroit Twist Drill. Detroit Twist Drill Co., Detroit, Mich. 582
Martin Tool-holder. Martin Tool Holder Co., Jackson, Tenn. 582

Taylor & Fenn Two-Spindle Spline Milling Machine

THE two-spindle spline milling machine here illustrated and described has recently been placed on the market by the Taylor & Fenn Co., Hartford, Conn. It is built from designs developed by the well-known machine tool designer B. M. W. Hanson, and is automatic in operation, being designed to simultaneously machine two spline grooves up to 6 inches in length on opposite sides of the same piece, single splines of the same or different dimensions simultaneously on two pieces, or through slots such as drift pin slots or cutter slots in boring-bars and similar work. Rapidity of action, ease of manipulation, facility of adjustment and large capacity permit this machine to handle a wide range of machine parts. Once set to cut a certain depth and length of slot, it will continue to do so until readjusted. Two cutters operating simultaneously reduce the

This machine is equipped with two spindles which operate simultaneously for cutting two spline grooves in the same piece, or in separate pieces of work. Its capacity is for splines up to 6 inches in length plus the diameter of the cutters, and the grooves may be cut to any specified depth, or they may be made to meet at the center of the work to form a slot such as the drift slot in a drilling machine spindle. Sufficient capacity is provided for holding work of any diameter up to 5 inches, and of any length.

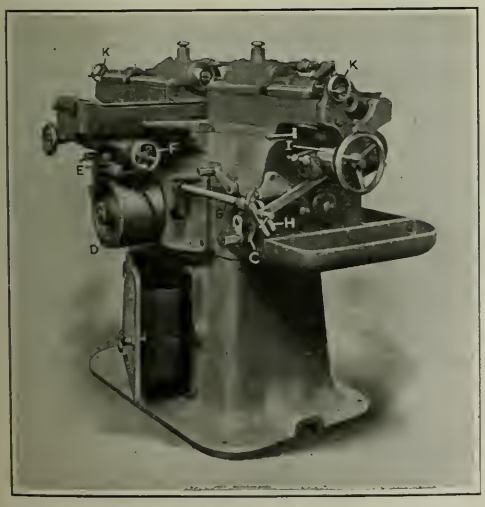


Fig. 1. Feed Control and Table Feed Mechanism of the Taylor & Fenn Duplex Spline Milling Machine

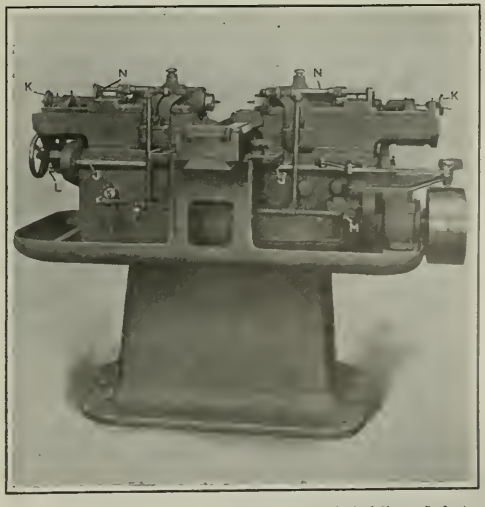


Fig. 2. Arrangement of the Pump and Piping which delivers Coolant to the Work through the Spindles and Cutters

machining time 50 per cent on work where two spline grooves are cut simultaneously in the same piece or in two separate pieces; and work of any diameter up to 5 inches, and of any length may be splined. A V-shaped vise affords a positive clamp for the work beyond the cutter traverse at one end, while the other end of short work, if centered, is supported on a male center and if uncentered is supported in a female cone. Long work is free to project beyond the confines of the machine at both the front and back. The maximum table travel is 6 inches, so that the maximum length of spline which may be cut at a single setting is 6 inches plus the diameter of the cutter. There are six changes of spindle speed ranging from 302 to 1885 revolutions per minute and ten changes of table feed so that an ample range is provided for handling splining operations in various metals and under any manufacturing conditions.

Mechanical Features of the Machine

Efficiency in this type of machine is dependent on the coordination of three functions: The cutters must rotate at correct speeds; the traverses of the table between its extremes must be accurate and at the correct rate, and the feeding of the cutters to depth must be properly timed and

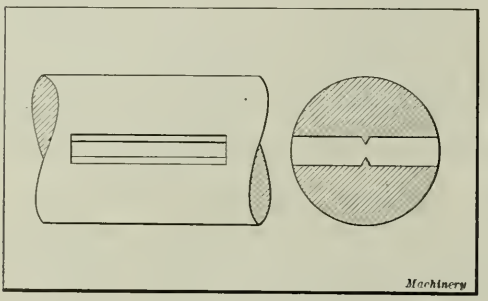


Fig. 3. Diagram showing need of providing Means of removing Fins from the Top and Bottom of Slots which are milled All of the Way through the Work

accomplished by uniform increments. All of these essentials have been incorporated in this machine, with the result that splines of duplicate length and uniform finish and accuracy are produced in a period of time, the duration of which depends upon the length, width, and depth of the spline and the cutting resistance of the metal that is being machined. No countershaft is necessary, as the drive is direct from a pulley on the lineshaft to a tight and loose pulley at the left of the machine at the rear. The shifter rod extends through to the front where all other control levers and wheels are located. A speed-box, within the column and to the left affords the six rates of spindle speed, the controls for these speeds being located within easy reach of the operator while standing at the front of the machine. It is necessary for the machine to be stopped while speeds are being changed, thus affording protection against damaged gearing. The speed gears are made of hardened alloy steel and run in an oil bath. Provision is made for obtaining the ten rates of feed for the table from a gear-box containing a cone of five gears and a two-speed clutch, controlled from the front of the machine. Each one of the ten rates of table feeds is available with each of the six spindle speeds. The work-table obtains its motion through a lever from a cam mounted at the front of the machine under the work-slide. This cam is driven by shafts and gears from the feed-box, and a simple, easily adjusted mechanism is provided, whereby the table movement may be varied from zero to the maximum of six inches. The feed movements to the spindle housings are transmitted through a crank and link mechanism from a cam mounted behind the table reciprocating cam which has just been mentioned, and provides for feeding the cutter into the work.

How the Cutters are Fed into the Work

At each end of the machine there is a small handwheel geared to a feed-nut in such a manner that turning this wheel moves a screw back into the nut. During this process the nut remains in fixed longitudinal position but rotates, while the screw is pressed by a compression spring back into contact with the nut. Turning of the handwheel is continued until a pointer, moving over a graduated scale, assumes a position corresponding to the depth to which it is desired to sink the cutter into the work, and this sets the depth of cut. When the machine is started, the feed mechanism causes the two feed-nuts to rotate, but as they are held against lengthwise movement, the screws push the two opposed cutter-heads inward against the pressure of the compression springs. Feeding of the cutter-heads continues until the predetermined depth is reached at which point the screws run out of the nuts and the feeding of the cutters is stopped. In cases where the slot is milled through, as for instance the drift slot in a drilling machine spindle, it becomes necessary to avoid leaving a small fin in the center of the work. This is accomplished by withdrawing one cutter just before it reaches the center of the work and causing the other cutter to continue its feed movement beyond the center. After the center of the work has been passed by this cutter, the head which carries it recedes. Of course, this synchronized movement of the cutter-heads is performed automatically by power.

Provision for Lubricating the Cutters

In the performance of spline milling operations it is of the greatest importance to provide for the efficient cooling of the cutters and work. Bearing this fact in mind, the cutter lubrication system on this machine has been developed along lines which afford exceptionally efficient results. A reservoir is secured to the door in the column and when this door is opened, the reservoir swings out with it and the supply of cutter lubricant can be readily replenished or the reservoir cleaned. The pump is driven at constant speed from the main driving pulley, thus making the supply of coolant uniform at all times and independent of the speed at which the cutters are driven. From the pump the coolant is carried by a system of telescopic tubes to the hollow cutter-spindles through which it passes to grooves in the shanks of the cutters, from which the fluid is projected under considerable pressure directly on the lips of the cutters, cooling them and at the same time ejecting any chips immediately they are formed.

CINCINNATI BORING MILLS

There are many boring mill jobs which could be handled on a machine of moderate size, were it not for the fact that the nature of the operation to be performed makes it desirable to take exceptionally heavy cuts under high speeds and coarse feeds. Such severe conditions of operation often require jobs to be put on large boring mills, which could otherwise be handled on smaller equipments. Recognizing this fact the Cincinnati Planer Co., Oakley, Cincinnati, Ohio, has recently added to its line of heavy-duty boring mills two machines built in 42- and 48-inch sizes. Aside from their more restricted capacities, these are in every sense heavy-duty boring mills; they are designed along the same general lines as larger machines of this company's manufacture and are especially suited for the more severe boring mill operations which have to be performed on pieces of moderate size. Certain modifications of design have been made in order to increase the convenience of operating these small machines and to reduce the amount of manual labor that is involved.

These 42- and 48-inch Cincinnati boring mills are of unusually heavy construction, and to adapt them for severe conditions of service they possess such features as the use of steel for making all of the driving and feed gears, with

an automatic lubrication system supplying oil to all gears and bearings. In this connection it is important to note that the speed and feed gears do not run in a bath of lubricant. Oil is pumped from a reservoir located between the housings at the back of the machine, and allowed to descend by gravity through tubes leading to each of the gears, bearings, etc., which require oil to assure its efficient operation. This system of oiling is also employed for the table spindle bearings and track. It will be noted from the illustrations that the housings extend right down to the floor and they are bolted, doweled and tongued to the sides of the bed.

The table is driven by a bevel pinion from which the driving shaft extends backward in a horizontal plane. This shaft is carried right through to the back of the machine, so that it may be supported by liberally proportioned bearings. The machine bed and speed-box are cast integral, the gears being located in a compartment at the top of the bed, which also forms a reservoir for oil that is used in the lubricating system; but as has been previously mentioned, the gears do not dip into this oil. For lubricating the gears, oil is allowed to drop on top of them, and after giving the required service it drains back into the reservoir. At the base of the bed, ribs are provided to stiffen the construction. Speed shifting levers and clutch and brake levers are provided in duplicate at opposite sides of the machine, and the links from these levers run through cored openings in the housings. Four geared changes of speed are provided, and with a three-step cone pulley this gives a total of twelve rates of speed covering a range from 2.45 to 59.20 revolutions per minute.

Each of the heads is furnished with independent feed, the gear-boxes for transmitting these movements to the heads being located at opposite sides of the machine. Eight changes of feed are available, covering a range from 1/40 to ½ inch per revolution. The feed mechanisms are of the tumbler type with the reversing gears in the feed-boxes. The back of the rail is clear of all mechanism. Large friction clutches are furnished for the rapid traverse boxes, and attention is called to the fact that the hand movements, power feeds, and rapid traverse movements are interlocked so that it is impossible for two conflicting mechanisms to be engaged simultaneously. Safety devices, such as automatic trips and shear pins, are provided to protect the mechanism; and micrometer collars are furnished on all the feed-rods. Ratchet handles provide for obtaining fine horizontal and vertical movements of the heads by hand. A self-centering conical bearing supports the table, and all journal bearings in the machine are furnished with bronze bushings. Graduated segments provide for conveniently swiveling the heads to any desired angles up to 45 degrees on either side of the horizontal. If so desired, a turret head can be furnished on these boring mills. The guides on the rail are of the long narrow type and the rail is clamped on both the inside and outside of the housing faces. Danger of damaging the pinions is avoided by cutting the feed racks for the full length of the rams; and a slip friction safety device in the elevating mechanism overcomes the possibility of breakage, in case this mechanism is engaged while the rail is still clamped. Boring mills of this type can be equipped with countershaft drive and a belt shifter. They can also be furnished with a constant-speed motor on the arch in place of the tight and loose pulleys or with a variable-speed motor and single pulley instead of a cone. Of course it will be apparent that in the latter case, the table speeds will be governed by the range of the motor.

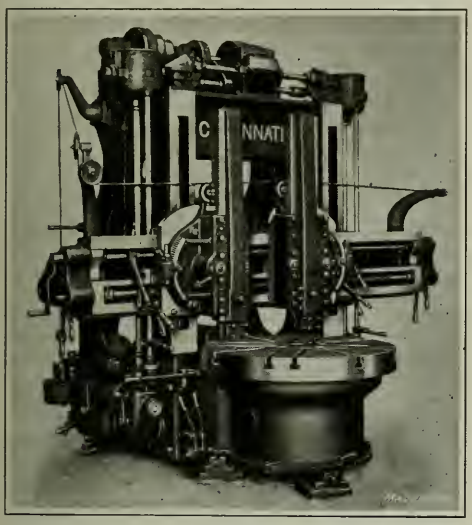


Fig. 1. Boring Mill built in 42- and 48-inch Sizes by the Cincinnati Planer Co.

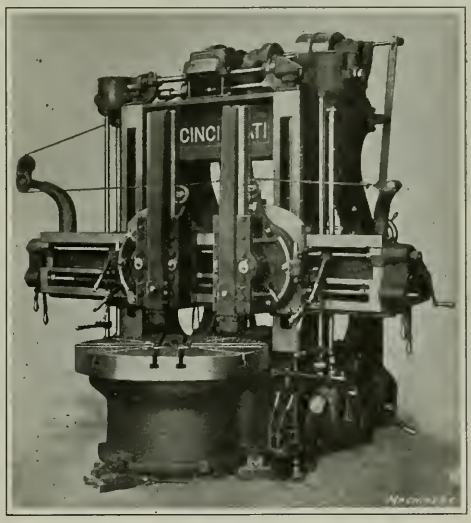
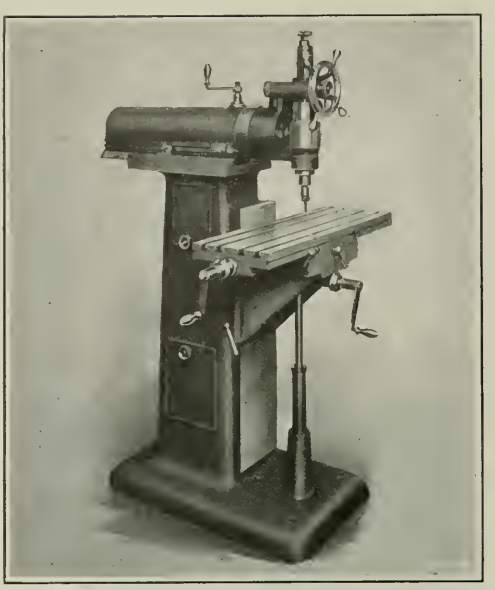


Fig. 2. Opposite Side of the Cincinnati Planer Co.'s Boring Mill shown in Fig. 1

PEARSON PRECISION SPACING AND BORING MACHINE

For use in the performance of accurate jig boring operations and similar work where it is required to have a number of holes accurately bored and spaced in a piece of work, the Modern Machinery Exchange, 25 Church St., New York City, is now building the Pearson precision spacing and boring machine which is here illustrated and described. Reference to the accompanying illustrations will make it apparent that in general appearance this machine has features similar to those found on the knee type of milling machine and on the crank shaper. Located at the right-hand side, there is a cone pulley which provides for obtaining changes of speed, and from this pulley power is transmitted through shafts and gearing to the drilling spindle that is carried by the horizontal ram.

It will be apparent that transverse adjustment of the drilling spindle is accomplished by changing the position of the ram, and longitudinal movement of the work under the spindle by a suitable movement of the table; the vertical movement of the table to bring the work into contact with the



Pearson Precision Spacing and Boring Machine built by the Modern Machinery Exchange

tool is made possible through raising or lowering the knee. In starting to locate for boring a series of holes where an accurate relationship is required between adjacent holes, the method of procedure is as follows: The work is accurately located under the spindle for the first hole and this hole is then bored. At the front of the table and at the left-hand side of the ram it will be seen that there is a fixed stop mounted on the frame of the machine and a micrometer head carried by the movable member. Standard end gages are used in connection with each of these micrometer heads and after one hole has been bored, substitution of suitable end gages in place of those formerly employed enables the cross-movement of the ram and the longitudinal movement of the table to provide for re-engaging the micrometer heads with different lengths of end stops that have been substituted for the ones formerly employed. With an arrangement of this kind the user has absolute assurance that he will secure work possessing the required degree of accuracy; and the rapidity with which holes can be accurately located and bored is the means of effecting a substantial reduction in the cost of performing such toolmaking operations.

EDWIN HARRINGTON CRANKSHAFT DRILLING MACHINE

This machine was designed and built by Edwin Harrington, Son & Co., Inc., 17th and Callowhill Sts., Philadelphia, Pa., to meet the requirements of a motor manufacturer who has several sizes of crankshafts in which oil-holes have to be drilled, requiring flexibility of spindle location and sufficient drilling power to insure high production. Fig. 1 shows the entire machine, and Fig. 2 a single head on the mounting plate. The work holding jig and the crankshaft were loaned by the motor manufacturer. Four individual spindle heads are used, each with its own driving motor and feed control. They are mounted in pairs on plates, which permits of variation of distance between spindle centers, variation of distance between the spindle nose and the work, and change of angle. The length of the spindle feed is sufficient to drill all the way through the average crankshaft, but as two holes usually intersect at the center bearing, and as long drills are objectionable, it is better to divide the cut by drilling successively from two sides. After the holes have been drilled half way from one side, the crankshaft is reversed end for end, which brings it into the proper position to have the holes completed from the other side, meeting those first drilled in the center of the cranks.

The spindle heads are made only for motor drive, to avoid any difficulty of providing for belt drive in various positions. Belted connection is made from the motor to the spindle pulley to allow a flexible drive with the tension taken by ball bearings on the pulley hubs to relieve the spindle from any strain. As only a single-spindle speed is required, the motor can be of the constant speed type for either direct or alternating current, and permanent changes of speed can be made by changing the size of the motor pulley. The spindle runs in a long sleeve, having a bearing for its full length, which is advanced out of the head by its steel rack and pinion for accomplishing the spindle feed. A ball race at the forward end takes the drilling thrust, and a flange attached to the end of the sleeve carries the trip rod. Drilled for the entire length of the spindle there is a 5/16 inch diameter hole to provide for the use of oil-feed drills, if desired.

The feed is driven from the spindle pulley by spur gears, so arranged that the driven gear may be changed to get different rates of feed. Two pairs of triple threaded steel worms and bronze gears, each with a ball thrust mounting, drives the rack pinion. A clutch is provided between the spur gear and the first worm to disengage the power feed, either manually or automatically at any predetermined point; also, a lever on the upper end of the rack pinion operates a clutch for making connection with the worm-gear and provides means for moving the spindle at one handling. The plates upon which the heads are mounted are provided with T-slots to allow movement of the heads to change the distance between centers, and they are located on the table by a central stud with hold-down bolts in slots at the ends. Provision is made for locating a tapered dowel-pin in a separate hole for each size of crankshaft. The location of the plate on the table and the shape of the table are subject to change to suit the job under consideration.

The table is made in a convenient shape to allow easy loading of the work and it has sufficient space to receive a jig of nearly any size. The top has a flat surface with a trough all the way around, and ample ribs are provided to afford the necessary strength. The jig is easily located on the table by an inserted key with hold-down bolts and dowels for endwise location. A tank and two pumps for cutting lubricant make a separate motor-driven unit to be placed on the floor beneath the machine. The end pump (hidden by

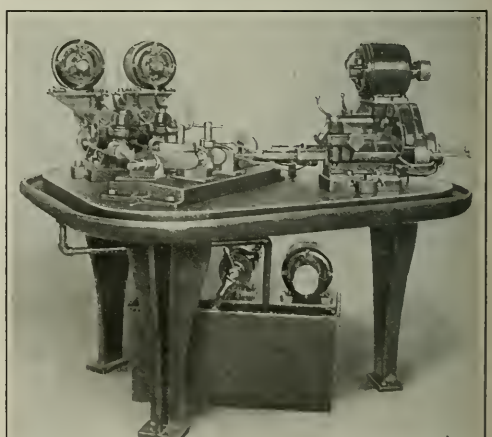


Fig. 1. Machine built by Edwin Harrington, Son & Co., Inc., for Use in drilling Oil-holes in Crankshafts

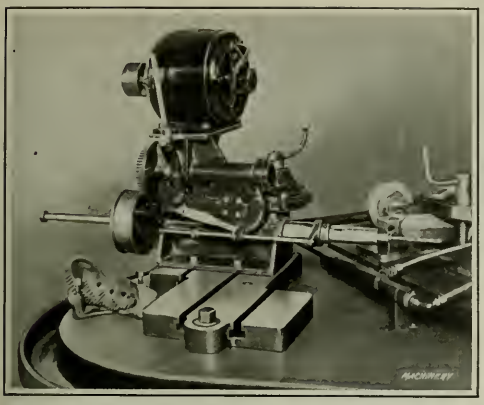
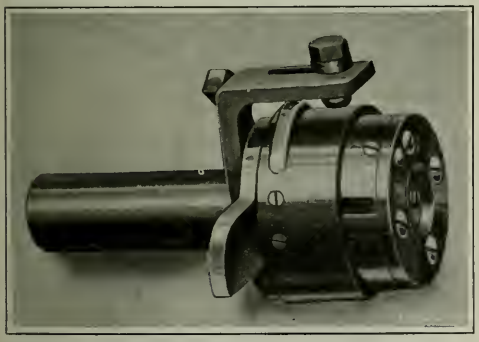


Fig. 2. A Single Head of Machine shown in Fig. 1, illustrating Mounting Plate and Jig

the front leg) delivers oil at the point where the drills enter the bushings, and the pump in the center is provided for a supply through flexible tubes to a fitting on the outer end of each spindle when oil-feed drills are used.

EASTERN MACHINE SCREW CORPORATION'S SELF-OPENING DIE-HEAD

The Eastern Machine Screw Corporation, 23-43 Barclay St., New Haven, Conn., has brought out a new self-opening die-head intended for use on Brown & Sharpe automatic screw machines Nos. 00, 0, and 2. It is very small and can be concealed in the hand. This head is installed by fitting the floating shank into a hole in the turret. An adjustable button on the tripping arm which extends along the die-head automatically depresses the tripping device when the thread is



Style D Self-opening Die-head made by Eastern Machine Screw Corporation

cut to the desired length, instantly opening the die-head. Closing is accomplished by a dog which engages the closing handle as the die-head comes up out of the pocket when the turret revolves, setting the chasers ready for the next cut. This new die-head, because it is self-opening, eliminates the time used to reverse and withdraw the ordinary head; does away with the wear on the chasers while backing off; reduces the number of spoiled threads to a minimum; eliminates left-hand tooling; permits the use of a reverse belt in the forward position, providing two forward speeds, one for forming and the other for threading; and also permits the use of higher spindle speeds and dies to match, thus increasing the output and decreasing the need of attention. All parts of the die-head are hardened and ground. A single micrometer screw adjusts the depth of cut, and by changing the chasers, a wide range of threads may be cut with the same head. The ¼ inch size, for example, will cut from ¼—20 to 1/56 or finer. The chasers are hobbed from high-speed tool steel and ample clearance is provided at all points. They are inflexible, being operated by cams, which is said to eliminate tapered threads. This method of holding and operating the chasers is embodied in all H & G die-heads made by the Eastern Machine Screw Corporation, and this new head makes the line quite complete, including as it does, both rotating and stationary types adaptable for use on all kinds of threading machines.

TAFT-PEIRCE V-BLOCKS AND ANGLE-IRON

Among the new tools and gages recently placed on the market by the Taft-Peirce Mfg. Co., Woonsocket, R. I., is a line of V-blocks for use in the machine shop. They are made in two styles: the solid type made in a 4-inch size, and the skeleton type made in 6- and 8-inch sizes. These blocks are furnished in pairs, and in each case the vee is central with the sides. The 4-inch size of block is made of tool steel, hardened and ground on all external surfaces, with its sides under-cut in such a way as to permit the use of clamps for holding the blocks in place. The 6- and 8-inch sizes are pro-

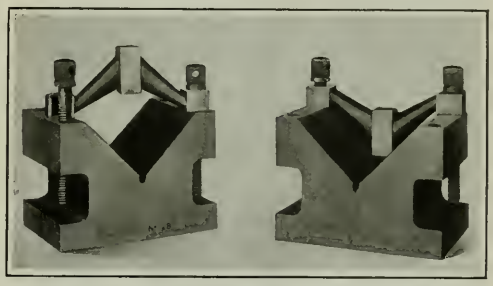


Fig. 1. Solid Type of 4-inch V-block made by Taft-Peirce Mfg. Co.

vided with a slot in one end and in the base, as well as one bolt hole in the base and one in the end, for the purpose of clamping the blocks in place.

Both types of blocks are equipped with clamps of novel design. From the illustrations it may be seen that one end of the clamp is open toward the outside; while the other end is open toward the side, which permits the clamp to be swung out from under the screw on one end, and then pulled away from the screw on the other end without turning the screw more than a few turns. The clamps are so designed that they may be used either side up, thus giving a wider range to the size of work that can be held in the block, as well as decreasing the amount of adjustment necessary with the clamping screws. All blocks are equipped with four clamping screws and two clamps. The 6- and 8-inch blocks are made of cast

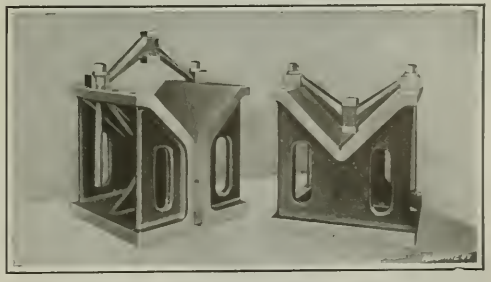


Fig. 2. Skeleton Type of 6- and 8-inch V-block made by the Taft Peirce Mfg. Co.

iron and so designed as to give maximum strength with minimum weight, as well as to promote convenience in handling.

The angle-iron is one of the most useful tools for setting up certain kinds of work, and it is ordinarily a homemade contrivance. Sometimes holes are provided for bolts, but usually the work is clamped to the legs of the angle with some form of jaw clamp. The Taft-Peirce Mfg. Co. has studied this simple tool and standardized a given design in seven sizes. These slotted angle-irons are specially designed for use on milling machines, planers, boring mills and drilling machines; and a combination of dimensions has been selected to meet as wide a range of conditions as possible, with a minimum number of sizes. Slots are provided clear through both faces—the slots being located at right angles to one another. The webs are cast well back from the edge, and therefore do not interfere with the use of clamps, while the faces are accurately finished so as to be square with each other. In the small sizes, the angles are ground and in the large sizes they are planed.

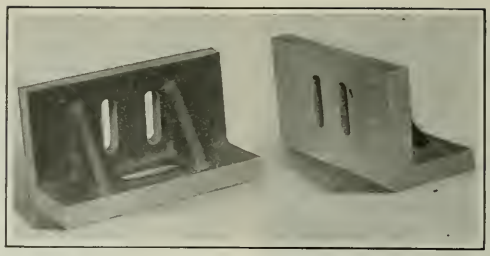


Fig. 3. Angle-iron made by the Taft-Peirce Mfg. Co.

WORCESTER QUICK-CHANGE LATHE

The quick-change feed mechanism on a lathe which has recently been added to the line of machines built by the Worcester Lathe Co., 100 Beacon St., Worcester, Mass., is simple in design and capable of meeting all usual needs, being substantially constructed and of neat appearance and convenient to operate. It provides for obtaining twenty-four changes of threads and feeds without changing gears, the threads being: 4, 4½, 5, 5½, 6, 6½, 7, 7½, 8, 9, 10, 11, 12, 13, 14, 15, 16, 18, 20, 22, 24, 26, 28, and 30 per inch. Four change-gears are provided, however, namely, a 64-tooth gear for cutting 32, 36, 40, 44, 48, 52, 56, and 60 threads per inch; a 24-tooth gear for cutting 3 threads per inch; a 46-tooth gear for 11½ threads per inch, and a 54-tooth gear for 27 threads per inch.

Changes of gears can be made in one minute or less, as on all Worcester lathes. Gears for cutting other threads, such as: 2, 17, 19, 25, 29, 31, 33, 35, 37, 39, 50, 64, 75, per inch, and other unusual threads, can be furnished on order. Translating gears for cutting the following metric pitches can be furnished: ¾, 1, 1½, 2, 3, 4, 6, and 8 millimeters. Also translating gears for cutting usual threads per centimeter can be supplied. All gears in the quick-change feed-box are of steel, those most subject to wear being heat-treated.

GARVIN CAM OR FORM MILLING MACHINE

The distinguishing feature of this machine over one previously built by the Garvin Machine Co., Spring and Varick Sts., New York City, for use in cutting flat or cylindrical cams is the change from a vertical to a horizontal spindle, in addition to certain other modifications. Fig. 1 shows this machine arranged for flat cam work, and it will be noted that the work is mounted on the end of the work-arbor, toward the spindle, with the former at the outer end of the arbor. A worm and worm-wheel drive the work-arbor from a universal power-feed shaft which can be seen at the front of the machine. Power is transmitted through spur gearing, giving three changes of feed for the flat cam cutting fixture only. The arm carrying the work-arbor pivots on its forward end, and is guided at the rear end by guides, all mounted on the same table. The arm has in addition to its own weight that of detachable weights to keep the former pin against the former, offsetting the stress of the cutter. These weights can be added to either end of the arm and are made so as to release the pressure on the former when cutting steep angle cams.

Fig. 2 shows the machine arranged for cutting cylindrical cams. In changing the flat cam fixture to the cylindrical fixture, the entire slide shown bolted to the saddle of the machine, can be taken off and laid aside. The power feed universal jointed shaft readily detaches for this purpose and attaches to the cylindrical fixture. In operation the feed

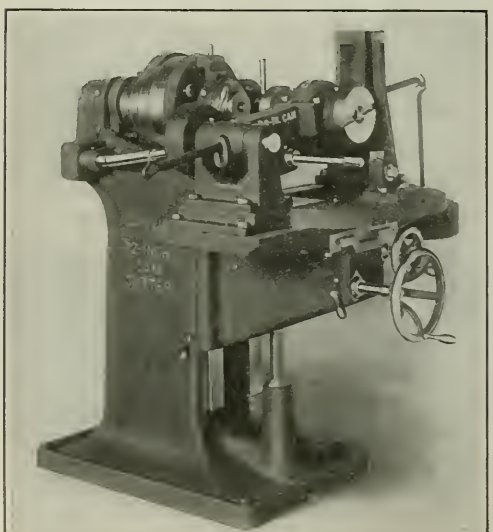


Fig. 1. Garvin Cam Milling Machine equipped for Flat Cam Work

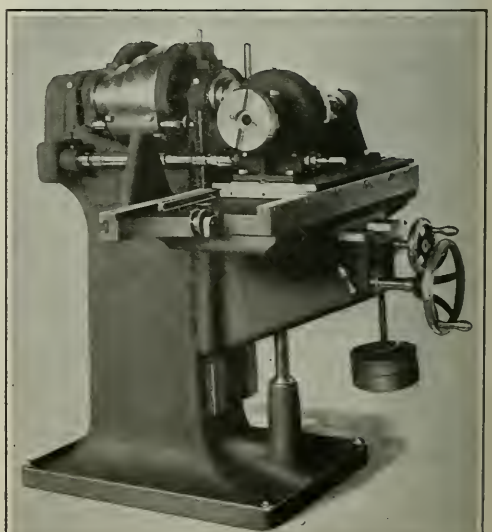


Fig. 2. Garvin Cam Milling Machine equipped for cutting Cylindrical Cams

rotates the work on the arbor, the work being mounted on the far side of the fixture and the former on the other end of the work-arbor. The former pin, shown at the front of the machine is kept against the former by weights. Movement of the cylindrical fixture is very sensitive as it works on large balls in a V-shaped tool steel track. The feed of both attachments can be disconnected by a clutch, giving hand feed control by a wrench. This will be found very handy in setting up for cams that are cored and also for helping over steep angles. The feed of both attachments can be disconnected by a clutch feed control by a crank wrench. On the worm-shaft there is provided a square end to receive a crank. The spindle of this machine is of the Garvin standard milling machine construction, and all gearing is

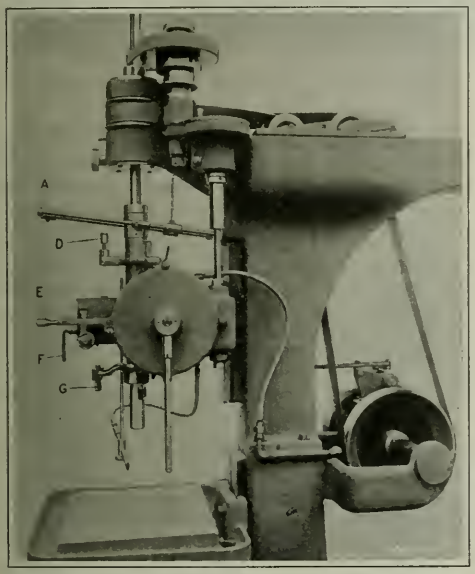


Fig. 1. "Avey" Automatic Drilling Machine built by the Cincinnati Pulley Machinery Co.

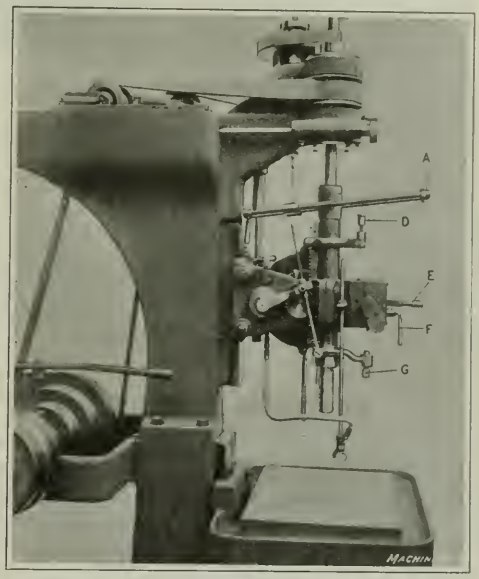


Fig. 2. Opposite Side of the "Avey" Automatic Drilling Machine illustrated in Fig. 1

housed, protecting it from damage or injury to the operator. There are two changes of feed provided on the machine when using the fixture for cutting cylindrical cams.

"AVEY" AUTOMATIC DRILLING MACHINE

Readers of MACHINERY who visited the exhibition of the Master Car Builder's Association at Atlantic City, in June of last year, or the meeting of the National Foundrymen's Association at Philadelphia, in October, will recall seeing the machine which is the subject of this article. It is the "Avey" automatic drilling machine manufactured by the Cincinnati Pulley Machinery Co., of Cincinnati, Ohio. The original conception of this machine and the one kept in mind through all the development period was to evolve a mechanism which would reduce manual labor to a minimum. Another point which had always to be kept in view was to produce a standard machine which would be adaptable to a large number of variations in products, thus eliminating to a very great extent the necessity of manufacturers of parts which are drilled in great quantities, having to have special machinery for the operation.

This machine can be used automatically, semi-automatically or as a plain hand feed drill, with equally satisfactory results. No time is required to change from one style to another, as the movement of one member accomplishes this in each instance. When used automatically, both the approach and return of the spindle are automatic, the spindle going through a continuous number of cycles of operations without the necessity of engaging or disengaging the feed by the operator. The strokes can be varied in length from a maximum of 5 inches to a minimum of $\frac{3}{4}$ inch, and the greatest number of strokes per minute is 30. Four rates of feeds and four spindle speeds are available, with a maximum capacity for drilling $\frac{3}{4}$-inch holes in cast iron and $\frac{5}{8}$-inch holes in steel, the maximum spindle speed being 3500 revolutions per minute, which will permit of quite a range in the smaller work.

Provision is made for advancing the spindle by hand ahead of the power feed, without disengaging the latter; and no time is lost when doing this, as the clutches pick up the power feed instantly and automatically, wherever the hand feed drops it. A simple and direct method of securing this result is provided, as extension weight bar *A* directly in front of the operator is used for this purpose. The design and operation of the clutch makes it possible to drill blind holes and to maintain a uniform depth of hole within a limit of variation of 0.001 or 0.002 inch.

A lever for controlling the feed is always within easy reach of the operator. It can be disengaged at any point by means of lever *F*, or, as previously explained, it may be advanced or jumped at will. The amount of over-weight to the spindle can be regulated to accommodate different weights of tools, and all shock of the returning spindle is taken up by means of an adjustable spring plunger. The difference between automatic and semi-automatic feeding is that in the former case, the spindle goes through a continuous number of cycles of operations automatically, as previously explained; while in the latter case it completes one cycle and then stops, one cycle consisting of engaging the feed by means of the clutch lever *E* by hand, the spindle feeding down to depth as determined by the graduated depth stop *D*, tripping automatically, returning to the starting position and stopping. A change from full to semi-automatic feeding is obtained by giving adjustable pin *G* a quarter turn so that the power feed is engaged or not when the spindle returns, as desired. The hand feed lever, used only when the power feed is disengaged, has a ratchet arrangement whereby it can be set

at any position in relation to the spindle or can be disengaged and hangs without revolving when automatic feeding is utilized.

All revolving members in the head, as well as the idlers, spindle and countershaft, are mounted on annular ball bearings, making the operation of this machine practically noiseless, very sensitive and avoiding all possibility of sticking through lack of lubrication. The machine lends itself remarkably well to the employment of automatic or semi-automatic fixtures which, in many cases, can be connected to the machine and which function with the spindle movements.

Several useful attachments can be added to this machine to enable it to meet special requirements in drilling. Among these are two which are especially interesting; one is an automatic cut-off valve for the lubricant, whereby the fluid flows only while the drill is cutting, thus avoiding the unpleasant splashing of the lubricant on the operator when loading the fixtures or changing the work. The other attachment to which reference is made is a stroke limiting device which automatically controls the number of strokes that the spindle will make before stopping. The advantage of this will be seen in connection with automatic fixtures when operating on pieces with more than one hole of the same diameter. These machines are made with any number of spindles, from one to six.

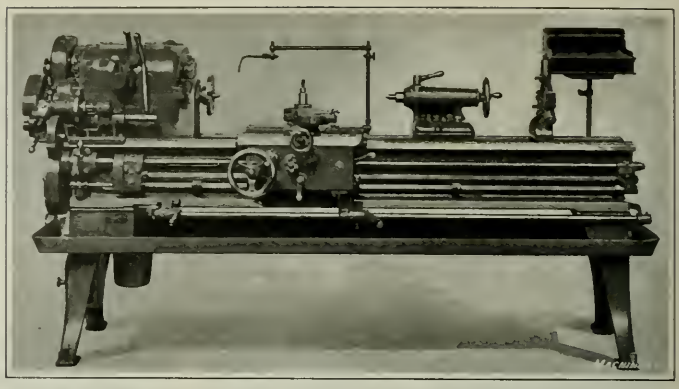


Fig. 1. 14-inch by 8-foot Geared-head Lathe built by the Springfield Machine Tool Co.

SPRINGFIELD LATHES

In the accompanying illustrations there are shown three engine lathes which have recently been added to the line of machines built by the Springfield Machine Tool Co., 631 Southern Ave., Springfield, Ohio. Fig. 1 shows the front view of a 14-inch by 8-foot engine lathe equipped with an all-geared head, motor drive, rapid change-gears, relieving attachment, oil-pan and pump, taper attachment, and a cabinet for carrying small tools. Attention is called to the head, which is of the selective geared type, having twelve mechanical changes of speed in the head. It is equipped with ball bearings throughout, with the exception of the spindle journals which are adjustable and oiled by means of sight-feed oilers. The oil passing through these journals is arranged to return to the interior of the head and thus keep up the oil supply of the interior.

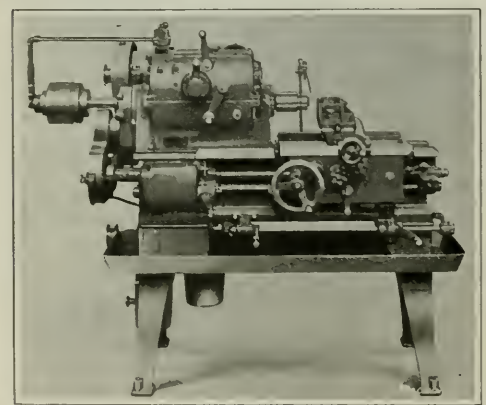


Fig. 2. 14-inch by 4-foot Geared-head Lathe built by the Springfield Machine Tool Co.

All the gears in the headstock are of steel; they run at low speeds and are designed to give a very smooth turning effect to the work. The head shown in Fig. 1 is arranged with two frictions; first, the friction which engages through the back-gear trains and the direct drive gears is operated by the long handle shown in the front of the headstock. It is of the type used in all of Springfield tool-room lathes, and is suitable for all tool-room work, especially in the chasing of threads wherein the operator may perform his operation in the back-gear, and on the returning cut, without disengaging the half-nuts, he can come back at the ratio of about 10 to 1; that is, the returning movement of the carriage is about ten times as fast as the forward cutting movement. The second friction is at the driving pulley of the lathe, in cases where belt drive is used, and in the driving sprocket in the case of motor drives. This sprocket is contained under a guard at the extreme high and left portion of the headstock. The friction is controlled from two positions in the front of the lathe, one traveling with the carriage and the other one at the headstock end of the machine. These levers can be seen extending forward on the lower lateral rod shown on the machine. By means of this friction, the lathe can be instantly started and stopped at any time without stopping the motor. The friction is also provided with a drag so that the work may be quickly brought to a standstill. The headstock is provided with twelve mechanical changes of speed arranged in geometrical progression.

The relieving attachment will cut from two to twenty-six flutes per revolution of the spindle; and it will relieve right- or left-hand threads, both external and internal. The relieving cam is provided with a cone friction in order that the operator may exactly adjust the position of his relief. The rapid change-gear system is capable of cutting forty different threads and furnishing forty different rates of feeds. The upper screw is the lead-screw and is used only for thread chasing. The second rod is the feed-rod, and it is used only for turning; while the third rod is the automatic stop and reverse rod, which controls both the feed and the lead-screw motions. Automatic stop-collars which are adjustable are provided on this lathe. The lever which points directly forward on the right-hand side of the carriage is for the purpose of controlling the right- and left-hand rotation of both lead-screw and feed-rod. This illustration also shows the heavy tailstock which is of recent design; and also the method of bringing the cutting lubricant over the work.

Fig. 2 shows a 14-inch by 4-foot all-geared-head engine lathe of the Springfield "Standard" type. The headstock is of exactly the same design as the one previously described, except that the friction which is interposed in the tool-room lathes between the back-gear and direct gear trains, is now a positive clutch, and is operated by the lever which extends downward on the front of the headstock. The other fric-

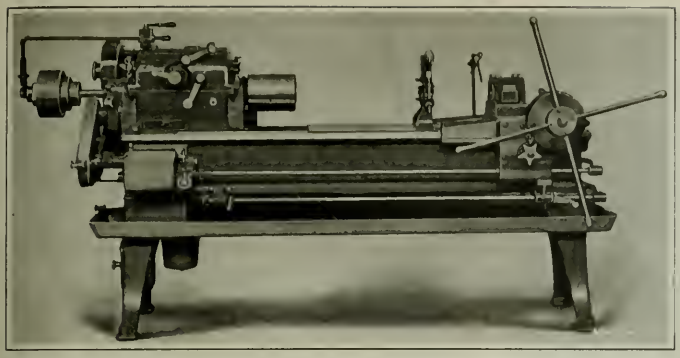


Fig. 3. 14-inch Geared-head Lathe of Simplified Design built by the Springfield Machine Tool Co.

tion, which is the driving friction in the pulley position, is the same in all Springfield geared-head lathes, and it is operated from the front of the bed by the same method as previously described. This machine is equipped with the Springfield standard gear system, which has a simpler method of gearing, in so far that in the production lathes, the change of threads is not important and very seldom used; but an instantaneous feed-box is furnished which gives a wide range of feeds. This lathe is equipped with an air chuck. The particular chuck shown is manufactured by the Logansport Machine Co., Logansport, Ind. The tool-rest on this machine is special and may consist of an adjustable rest which carries a circular threading tool and a small stellite turning tool. The turning tool is adjusted for the diameter of the work and is independent of the threading tool; the function of this particular tool is to turn and thread from the rough, threaded collars by passing over them once.

Fig. 3 shows a 14-inch machine of the geared-head type with the standard Springfield gear system. The lead-screw has been omitted, but the lathe is equipped with the clutch controls as previously described, and an air chuck, this particular chuck being of the collapsible collet type instead of the expanding type. The outstanding features of this machine are the adaptation of the well-known spindle and axle boring carriage to this size of lathe, and the special steadyrest. It consists of a counterbalanced quick-acting, locking mechanism, requiring merely a push of the hand to open it and a pull to close it. These machines are intended purely for use in the boring and reaming of tools at high speed.

AJAX UPSETTING FORGING MACHINE

With the steady increase in the use of alloy and high-carbon steels in the forging industry, a demand has developed for forging machines which will stand up under the increased strain of working these materials and still do their work rapidly and economically. With a view to supplying this demand, the Ajax Mfg. Co., Cleveland, Ohio, has recently offered to the trade an upsetting forging machine embodying features that are new to machinery of this class. This machine has the steel bed reinforced with tie-rods; and it is equipped with sleeve type, phosphor-bronze bushed, crankshaft bearings in the continuous housings of the bed, and steel gears and pinions with teeth cut from the solid blanks. A positive die grip is insured, and protection is afforded against damaging the mechanism by the breaker bolt in the safety knuckle. Operation is by means of the Ajax patented lock device which stops the dies in the wide open position, and the header slide at the back of its stroke. All of these features are well known to those familiar with this company's machines.

The new machine is approximately 40 per cent heavier than the older models, the new 4-inch size weighing 120,000 pounds, the 5-inch, 155,000 pounds, and other sizes in the same proportion. This increase in weight has been utilized to strengthen and increase the size of all parts. Some idea of the capacity of these machines may be had from a test recently conducted at the Ajax plant. A 4-inch machine, in a single blow, forged a disk 9½ inches in diameter and 1¼ inches thick on the end of a 3½-inch bar of 0.60 per cent carbon steel at a cherry red heat. In performing this operation the machine gathered 8 inches of stock and flattened it out with no tendency toward stalling.

The slides are of considerably increased length and they are of the suspended type, operating on overhung bronze-faced bearings, which construction places the sliding surfaces in such a position that they receive proper lubrication and are not exposed to undue wear by the accumulation of scale and other abrasive substances. The header slide carries a triple high tool-holder, so constructed as to permit its adjustment to any desirable location of the grooves in the gripping dies. The die-slide carries the moving die in a box-shaped recess, which gives the die the backing of the entire side face of the die-slide against the backing plate during the heading operation. This eliminates local wear in the backing plate and any resulting rocking tendency of the die-slide.

In order to transmit the power necessary for the making of large forgings, a twin gear drive from the pinion-shaft to the crankshaft is employed on all machines of the larger sizes. This gives equal torque to both ends of the crank-pin, greatly decreasing the strain in this part. In addition, the crankshafts have been nearly doubled in weight. The self-adjusting safety pitman is an entirely new feature in machinery of this class. Its construction is apparent from Fig. 2. The middle center is slightly raised above the line of the other two, so that a pressure on the ends results in a buckling tendency. This buckling is resisted up to a predetermined pressure by the latch held in place by a heavy coiled spring. When this pressure is reached the latch jumps up, giving complete relief without requiring the building up of additional pressure. On the return stroke, the pitman straightens out, the latch drops into place, and the

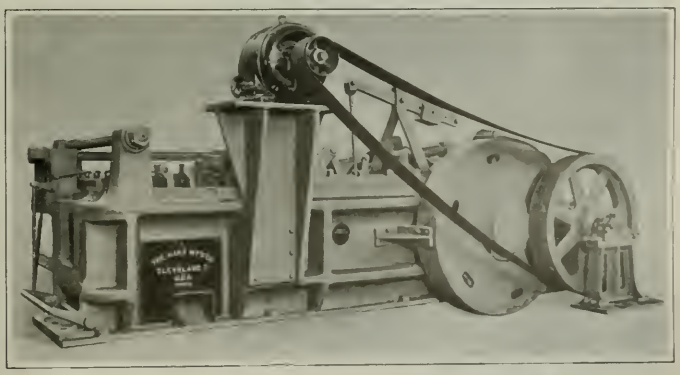


Fig. 1. Improved Type of Upsetting Forging Machine built by the Ajax Mfg. Co.

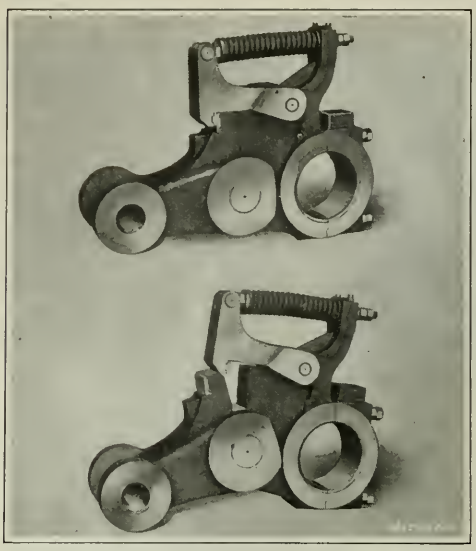


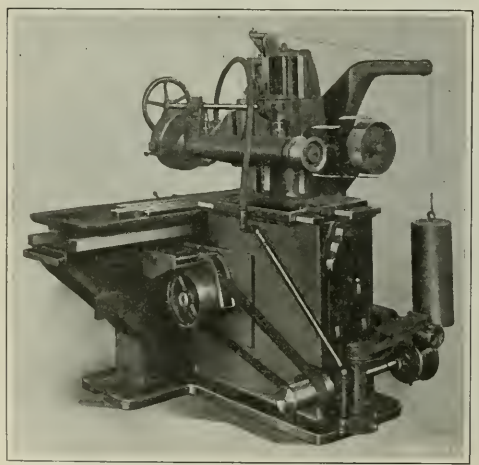
Fig. 2. Self-adjusting Type of Safety Pitman used on the Ajax Forging Machine

machine is then ready to go on with the performance of its work without delay.

By tightening or loosening the spring, a nicety of adjustment can be obtained which permits the working of the machine to its full capacity with assurance that the limit of its strength will not be exceeded. In order to increase the capacity to correspond to the increased power and strength and to fully utilize this additional capacity, the stock gather, die opening and die height have been greatly increased. This makes possible the production of larger forgings in fewer operations than previously, and gives space for the placing of more grooves in a single face of the die, thus reducing the number of die changes that are necessary.

DIAMOND SURFACE GRINDING MACHINE

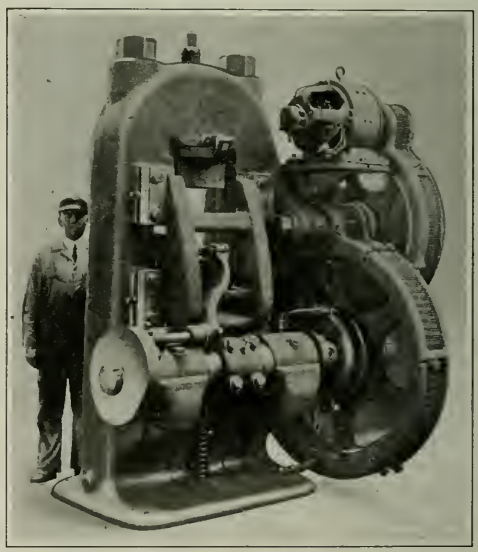
The Diamond Machine Co., Providence, R. I., has recently made some noteworthy improvements in the design of its surface grinding machine. One of these consists of the elimination of one of the electric motors formerly used to supply power to this type of grinder. On the older style of machine, one motor was used to drive the spindle and a second motor to drive the table. In the improved design, which is here illustrated, one motor serves both purposes. It is a 3-horsepower unit and transmits motion to the spindle through a chain and belt drive, and to the table driving mechanism through a chain, worm-gear and belt transmission. The second improvement mentioned is in the method of hanging the saddle counterweight. By using an arm to carry a pulley, the wire cable supporting the counterweight is kept free from contact with any part of the machine which would cause the cable to wear or which would tend to prevent its free movement.



Improved Surface Grinding Machine built by the Diamond Machine Co.

FERRACUTE EMBOSSING PRESS

The toggle action embossing press shown in the accompanying illustration, has been recently built by the Ferracute Machine Co., Bridgeton, N. J. The frame consists of a one-piece casting, with the columns set close together to minimize all possible spring. Each column is 13 inches square and is made solid with the exception of a vertical 5½-inch cored hole containing a 5-inch steel bar, the combined tensile strength of columns and bars allowing for a large safety factor over the 450 tons pressure for which the machine has been designed. The toggles are set in the lower portion of the press and are straightened out by an eccentric shaft at the back. This shaft obtains its motion from the large gear on its outer end, connection being made by a clutch. Pressure on the treadle causes the press to start and make a stroke, automatically stopping when a complete stroke has been accomplished. If continuous action is desired, the treadle may be locked down.



450-ton Embossing Press built by the Ferracute Machine Co.

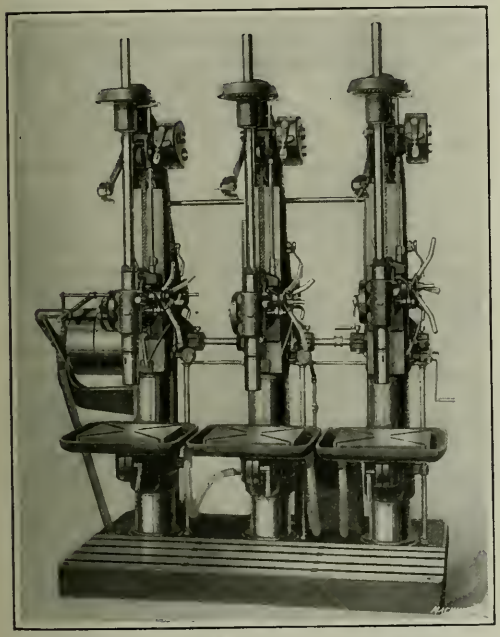
Power is supplied by an electric motor containing a rawhide pinion that gears into teeth cut in the rim of the flywheel. The ram has a stroke of 2 inches, and the distance from head to ram, when the latter is in its lowest position, is 20 inches. A sliding die-chuck is given an intermittent horizontal motion of 10 inches by a series of levers connected to the main shaft by means of a cam. This device enables the chuck, when making its stroke, to dwell while the embossing or coining dies come together. The flywheel, motor pinion, main gear and its pinion are thoroughly guarded,

and wire mesh is cast between the arms of flywheel and gear as an additional safety precaution.

The head is vertically adjusted by means of a horizontally moving wedge, enabling the pressure to be transmitted through solid metal. The weight of the head is taken by a helical spring at the top of the press. Thorough lubrication of the toggles, so essential in presses of this nature, is insured by numerous oil-cups. The press makes thirty-strokes per minute, and the total weight of this machine is about 18,500 pounds.

BARNES SLIDING-HEAD GANG DRILLING MACHINE

In the March, 1919 number of MACHINERY, a description was published of a 26-inch sliding-head drilling machine which had been developed at that time by the Barnes Drill Co., 814 Chestnut St., Rockford, Ill. The accompanying illustration shows a drilling machine of somewhat similar design, which is a recent product of the same firm. This is also a



Sliding-head Gang Drilling Machine built by the Barnes Drill Co.

26-inch machine and has the sliding-head feature; but it will be seen that this machine has independent columns. Eight changes of geared speed and of geared feed are provided for each spindle, all of which are independent of each other, and all under instant control of the operator from the front of the machine. With the driving pulley running at 325 revolutions per minute, the spindle speeds are 230, 183, 146, 93, 57, 46, 36, and 23 revolutions per minute. The available rates of feed are 0.005, 0.008, 0.012, 0.017, 0.022, 0.030, 0.043, and 0.075 inch per revolution.

KELLER THREE-SPINDLE DIE-SINKING MACHINE

In the September, 1915, number of MACHINERY, the article entitled "Mechanical Production of Drop-forging Dies," illustrated and described the use of an automatic profiling machine built by the Keller Mechanical Engraving Co., 74 Washington St., Brooklyn, N. Y., for use in this class of die-sinking. Readers of this publication and other experienced mechanics know that the Keller machine, with which the



Fig. 1. Three-spindle Automatic Profiling and Die-sinking Machine built by the Keller Mechanical Engraving Co.

trade has grown familiar, has been built with one milling spindle and one spindle for rotating a tracer point, with means for guiding it over the surface of a model, in order that the contour of the model may be accurately reproduced in the die-block on which the milling cutter is working. The use of machines of this type has been the means of effecting substantial savings in the cost of a great many different kinds of dies, and during the period of intense industrial activity of the past five years, the possibility of having machines do work which formerly required the services of highly skilled mechanics—of which there was an insufficient supply to meet the demand for their services—was a highly important factor.

Recently the Keller Mechanical Engraving Co., has made a further development in this type of die-sinking machine, which consists of an equipment built with one spindle for guiding a tracer point over the surface of the model, and two

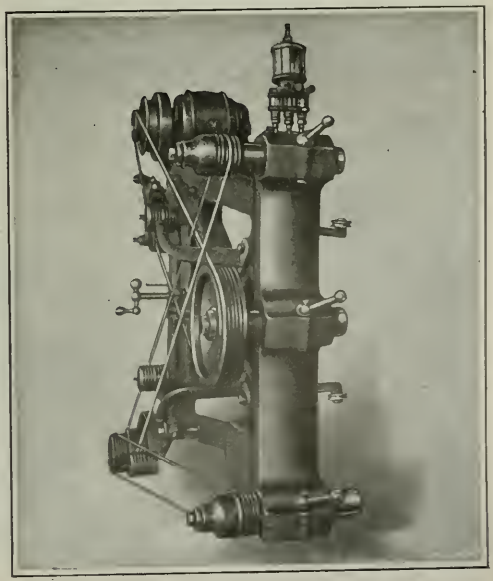


Fig. 2. Three-spindle Arm used on the New Keller Machine

spindles in which suitable milling cutters are mounted to provide for simultaneously sinking two dies which are exact duplicates of the model. A machine of this type is able to effect important savings in production costs in those plants where a sufficient number of duplicate dies are required so that it is a desirable proposition to use a machine for producing them two at a time. On the machine equipped with three spindles, the die-block and model-holding fixture is of essentially the same design and construction as that used on the two-spindle machine, except for the fact that additional means are provided for holding the model between the upper fixed bracket and the lower adjustable bracket. The jacks, clamping bolts, straps and spacers for use in connection with the double-spindle fixtures are also used with the triple outfit. Sufficient capacity is provided for mounting two die-blocks and one model, each 10¼ inches wide by 12 inches deep, and of various lengths from 20 to 28½ inches, according to the conditions of operation. Provision may also be made for mounting four die-blocks and two models, as shown in Fig. 1, and where this practice is followed the capacity is for dies up to 9⅛ inches wide by 12 inches deep, and from 9½ to 12½ inches long, according to the conditions of operation. Of course, it will be apparent that the tracer point is only in contact with one model at a time, and only two dies are being cut simultaneously.

REED-PRENTICE GEARED-HEAD LATHE

The 14-inch geared-head lathe which is here illustrated and described is a recent product of the Reed-Prentice Co., Worcester, Mass. A view of the gearing in the headstock is illustrated in Fig. 2. It is of the selective type, permitting the operator to instantly obtain any one of eight speeds; and changes can be made without slowing down the machine or without removing the cutting tool from the work. It is stated that the point where a change is made from one speed to another cannot be detected on the work, should changes be made while the tool is under cut. The speeds are obtained through spur gears and internal expanding friction clutches, with provision for guarding against the engagement of conflicting ratios of gears, as it is absolutely necessary for the three levers to be in the operative position in order to start the spindle. Consequently, when either lever is brought into neutral position it stops the spindle.

The back-gears are placed in a plane with the spindle and pulley shaft, which makes them readily accessible and permits the bottom of the head to be cast solid, enabling the gears to run in a bath of oil. The intermediate bevel gear in the reversing attachment has also been brought up to a plane with the pulley shaft, thereby making it accessible for adjusting the friction fingers. A locking mechanism has been provided in the form of a plunger that engages a hardened steel notched ring keyed to the spindle, to facilitate

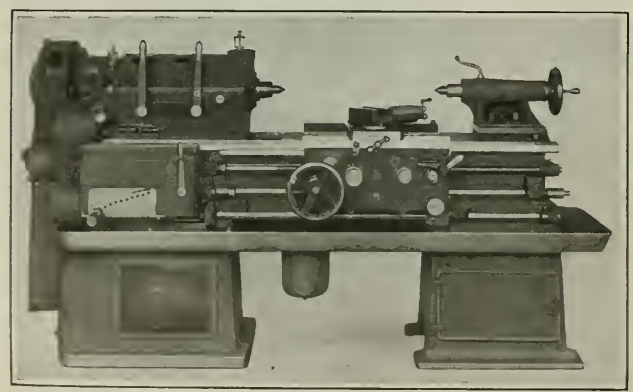


Fig. 1. 14-inch Geared-head Lathe built by the Reed-Prentice Co.

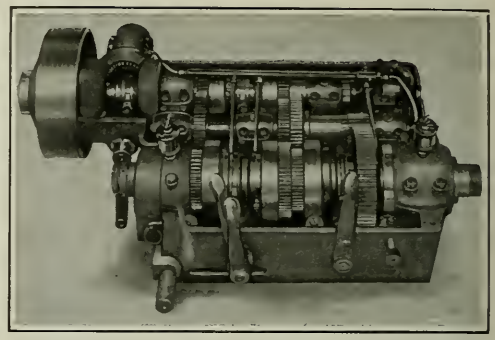


Fig. 2. Gearing in the Head of the Reed-Prentice Lathe shown in Fig. 1

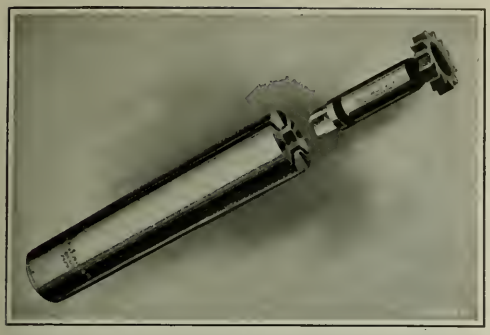
removal of the faceplate. An interlocking mechanism makes it impossible to engage the spindle clutch until this plunger has been released from the spindle, thus safeguarding against accidents. A geared pump in the headstock supplies lubricant for all bearings with the exception of the two main spindle bearings which are supplied from sight-feed oilers. Gurney ball bearings are used in the driving pulley. The rocker carrying the tumbler gears at the end of the head is of new design, consisting of a pull plunger with locating holes in the side of the head. End thrust of the spindle is taken by ball bearings.

A new type of apron has been developed for use on this lathe. It is of the double-plate type, with provision for gaining access to any part of the mechanism without removing the apron from the bed. All shafts and studs are supported at both ends by bronze bearings, and the rear plate is made in box form and securely bolted to the carriage. The front plate is bolted and doweled to the rear plate and may readily be taken off by removing six cap-screws, thereby exposing the gears and other mechanism of the apron. The open and shut nut is planed into the guide cast integral with the rear plate, and a new locking mechanism of very simple and rigid construction has been incorporated to prevent engagement of the longitudinal feed when the open and shut nut is engaged or vice versa. A pull gear engaging the rack has been slightly modified to prevent slipping from the operator's greasy hand. It is disengaged from the rack when screw cutting to prevent the handwheel from rotating during this operation. Both longitudinal and cross feeds are operated by friction clutches. An oil reservoir delivers lubricant to bearings in the rear plate of the apron and the front bearings are lubricated by oilers at each bearing.

A liberal area is furnished for the sliding surfaces of the carriage on the ways. Although the general lines of the tailstock have not been changed from previous designs of the Reed-Prentice Co., the tailstock has been strengthened and additional rigidity provided by giving it a better support on the inside vees or ways of the bed. Two vees support the tailstock. The bed is liberally proportioned with its top made of the drop vee type. All parts of the lathe are interchangeable so that it is a simple matter to order repair parts, should it become necessary to do so after the lathe has been placed in service.

SCULLY-JONES KEYWAY CUTTER AND CHUCK

Scully-Jones & Co., 647 Railway Exchange Bldg., Chicago, Ill., have added to their line the "Wear-ever" Woodruff keyway cutter and chuck which forms the subject of the follow-



"Wear-ever" Woodruff Keyway Cutter and Chuck made by Scully-Jones & Co.

ing description. Attention is called to the fact that this chuck has a positive drive and that it is self-centering, thereby preventing all slipping of the cutter and insuring a true center. This chuck fits all makes of milling machines and it will be seen that the only provision needed to use a standard Woodruff keyway cutter is to square the end of the shank. The use of this equipment is claimed to give the two important advantages of a positive drive and a self-centering cutter. The chuck fits all makes of milling machines and is said to reduce the breakage of cutters in addition to giving a high degree of accuracy to the work. In cases where it is necessary to have a considerable distance between the face of the milling machine and the center of the cutter, an extension is provided with the tool to take care of such jobs.

MILWAUKEE HORIZONTAL DRILLING MACHINE

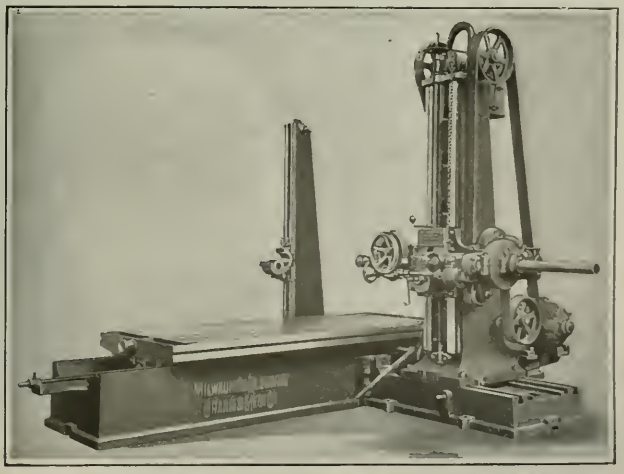
A No. 25 horizontal drilling machine has recently been developed by the Milwaukee Electric Crane & Mfg. Co., Inc., Milwaukee, Wis., which is adapted for performing a wide range of drilling and boring and is especially suited for operating, at one setting, on pieces too long or bulky for the usual type of machine. Double setting of the work not only wastes time but frequently causes errors when boring holes for shafts or bearings which are required to be exactly parallel, as in the case of gear housings for spur or helical gears, the teeth of which must bear evenly along the entire length of face. While originally a homemade tool supplied with a rolling or rail table, in which form it is still made for the rougher kind of work, its range of usefulness was felt to justify a new and modern design and refinement of details to secure greater durability and accuracy in operation, as well as the more rapid change in speed and manipulation made possible by the use of direct-connected variable-speed reversible motors. The ideal drive would be obtained if it were possible, by belting the motor to the spindle with only a single gear reduction, but as this is not feasible, the scheme adopted comes as near to it as possible in the matter of simplicity and directness. This makes for high durability and efficiency by eliminating useless gearing and getting the power of the motor to the spindle by the shortest cut.

The spindle is geared for standard speeds of 20 to 400 revolutions per minute, which may be increased or reduced when special service is to be met. With a 4 to 1 motor speed range and a sixteen-point controller, thirty-two different speeds are obtainable with a single back-gear ratio of about 5 to 1. All gears are of steel, with wide faces and carefully cut teeth; they run in oil and are supported on both sides by large bronze bearings arranged for ample and continuous lubrication. Power is transmitted through a maximum of only four reductions of spur gears to secure minimum boring speed and maximum torque, thus permitting most of the motor power to reach the cutting tool without being reduced to a great extent by friction losses.

The standard spindle feeds provided for this machine are: 0.009, 0.014, 0.020, 0.030, 0.050, and 0.070 inch per revolution. The feed is cut in or out by means of a trip lever and quick return or advance secured by means of the handwheel on the quill-pinion shaft. Gears for obtaining changes of feed are of steel and phosphor-bronze with wide face and heavy pitch, and they run in an oil-tight case for constant lubrication. The quill-drive worm-wheel is made of bronze, and is entirely covered; the worm is made of hard steel, running in oil.

The carriage elevating and lowering mechanism is operated by power or hand, and the driving gear is provided with a limiting torque clutch to secure safety to the mechanism in case the carriage is clamped too hard to the column, when the power drive is thrown into gear. The hand adjustment is used only to secure final setting of the carriage. A steel scale on the face of the column indicates the distance from the top of the table to the center of the spindle, and a corresponding scale is carried by the outboard column. The drill column is mounted on a side extension of the bed and is movable to or from the table to suit the size of the work and reduce the overhang of the spindle. This is an important advantage in many cases where end milling and facing is necessary and secures more accurate spotting of the drill than is possible with a long overhang.

The standard table furnished with this machine is 4 feet wide and 9 feet long and slides on a heavy, planed, cast-iron bed 15 feet long. The table is operated by a screw driven by power and capable of easy and accurate adjustment by hand from both sides of the work. Suitable T-slots are provided for clamping the work or fixtures and the front edge of the table is T-slotted for bolting on special indexing plates or fixtures for accurately locating shaft bearings or other holes in duplicate work. Tables longer or shorter than the standard length can be furnished to meet special requirements. The drill is operated by a 3½ to 5 horsepower, 4 to 1 variable-speed motor, with the starting, stopping and reversing lever placed on the spindle carriage within convenient reach of the operator. This machine occupies a maximum floor space of 14 feet 6 inches by 17 feet 10 inches.



No. 25 Horizontal Drilling Machine built by the Milwaukee Electric Crane & Mfg. Co., Inc.

"RADBORE" SQUARE-HOLE DRILL

For use in drilling a square hole out of any solid material in one operation, without previous preparation and without subsequent finishing, Lawson & Co., Inc., 416 W. 33rd St., New York City, are now making a tool known as the "Radbore Head," for which the Fairbanks Co., Broome and Lafayette Sts., New York City, has the exclusive sales agency. It is a square-hole drilling attachment which can be easily and rapidly attached to any milling or drilling machine. Reference to Fig. 1 will explain just how it is done; and Fig. 2 shows a cross-section of the shank of a drill which is rotated inside of a square guide as shown by the outside lines. If cutting edges are ground on the end of the drill, as indicated at the left-hand side of the illustration and shown in the enlarged view of the drill point at the right, they will sweep across the surface of a square with rounded corners. Hence, if the drill is fed into the material, it will cut out a square hole with filleted corners. To make a hole with sharp corners, one cutting edge is made longer than the rest, and this goes into the corners to square them. In Fig. 2 a Type A drill is shown in the view at the right-hand side and a Type B drill in the view at the left.

Development has made this tool combine the features of simplicity, positive action, and minimum wear. The drills

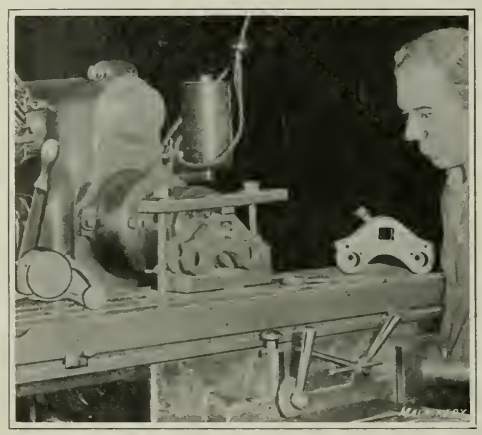


Fig. 1. Application of the "Radbore" Square-hole Drill on a Milling Machine

have a positive drive from the spindle of the machine, and the cutting lips follow a path determined by the adjustable jaws of the head, so that no preliminary round hole is necessary. The cutters are so designed that there is no material in the bottom of the hole, which is not removed by the cutting edges; therefore, blind square holes can be obtained in one operation and without any subsequent finishing.

One of the most important features of this tool is the design of the drills. They are manufactured in two different styles—Types A and B. Type A generates a hole with filleted or rounded corners, this fillet being $\frac{1}{8}$ of the drill size; and the radius or the amount of stock that is left in each of the four corners of the square hole, is absolutely equal. This assures uniform distribution of power where a square hole is used, either in a driving gear or in a driving shaft. Furthermore, as a radius is left in the four corners, there is no possibility of the power being applied except on the four sides of the square, owing to the fact that the driving shaft is always milled flat on the edges and hence will not touch in the corners of the square. The measurement across the corners of any square hole drilled by a Type A drill, can be quickly determined by multiplying the drill size by the constant 1.311. The Type B drill is designed for die work, the squaring of the ends of keyways, etc., and the

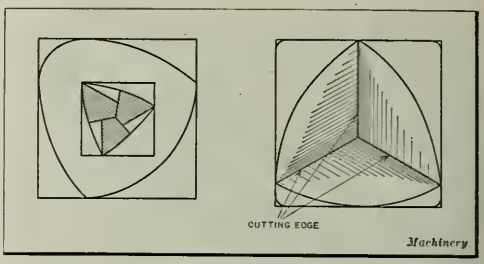


Fig. 2. Types A and B "Radbore" Square-hole Drills

deriving of square holes with sharp corners. In other words, the Type B drill is found useful in the tool-room for the quick and accurate completion of sundry jobs, while the Type A drill finds application out in the factory, where it is used on production work.

"Radbore" heads or chucks are manufactured in four sizes and two different styles—the range of drills from $\frac{1}{8}$ inch to 2 inches, being as nearly equally divided between the four chucks as possible. Type A drills are manufactured in sizes ranging from $\frac{1}{8}$ inch to 2 inches by intervals of 1/16 inch, and the Type B drills are made in sizes from $\frac{1}{8}$ inch to $1\frac{1}{4}$ inches by intervals of 1/16 inch.

MORRIS RADIAL DRILLING MACHINES

In the January, 1917 number of MACHINERY, a description was published of 2½-, 3-, and 3½-foot radial drilling machines built by the Morris Machine Tool Co., Court and Harriet Sts., Cincinnati, Ohio. Recently this firm has introduced a machine which is here illustrated and described, radial drilling machines of this type being built in the three sizes that have just been mentioned. Their design is similar to that of the machines previously announced in MACHINERY, except for improvements which have been made in various details of the design. The head is heavily constructed and it is accurately balanced on the arm, permitting it to travel freely, movement of the head being accomplished by a rack and pinion, reduction gears and a handwheel. Helical spindle gears are employed which have a sufficient angle to assure

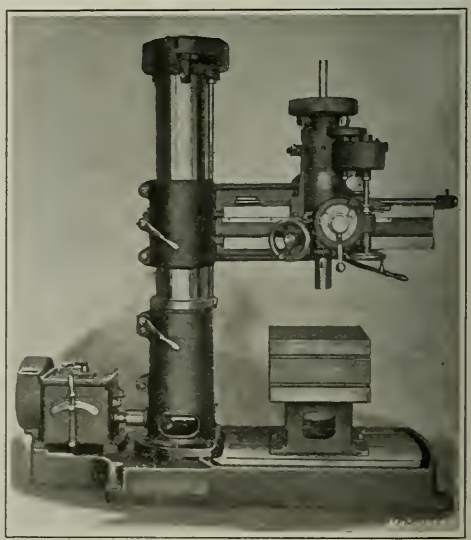


Fig. 1. Radial Drilling Machine built in 2½-, 3- and 3½-foot Sizes by the Morris Machine Tool Co.

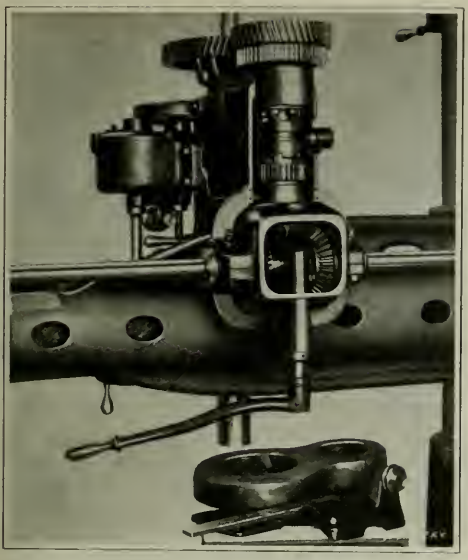
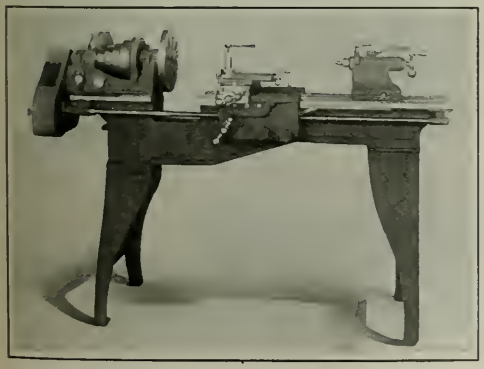


Fig. 2. Rear View of Head on Morris Radial Drilling Machine showing Arrangement of Helical Spindle Gears, Etc.

keeping more than one tooth in mesh at a time, and to avoid end thrust. The column is made of semi-steel and finished to size by grinding. It is supported by both a large ball bearing and roller bearing in the stump, where it is rigidly clamped, this construction permitting the arm to swing with exceptional ease.

SENECA FALLS GAP LATHES

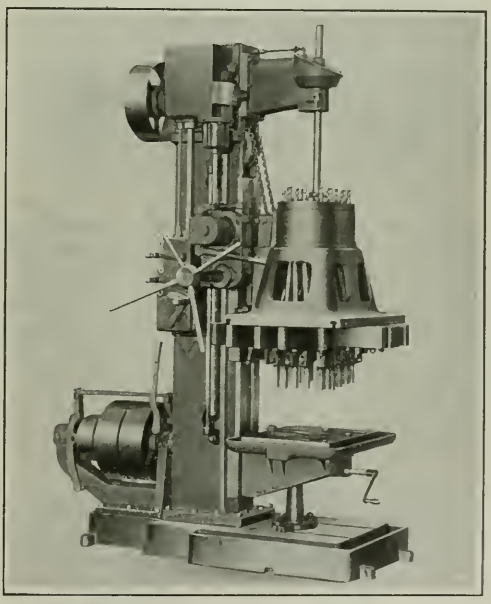
The Seneca Falls Mfg. Co., Inc., 331 Fall St., Seneca Falls, N. Y., has recently developed two sizes of gap lathes which are built to swing 11 and 13 inches, respectively, over the ways and 18 and 21 inches in the gap. In working out the design of these machines the increased swing of the gap type of lathe has been added to the features of this company's "Star" screw-cutting lathes. The bed is made of box section and braced by cross-webs, ample metal being furnished around the gap section. A bridge piece is furnished to close the gap when the extra swing is not required. These lathes are built with beds 5, 6, 7, 8, and 10 feet in length. It will be noticed that the carriage has the cross-slide placed at the left-hand side and the cross-feed screw is furnished with the usual micrometer collar graduated to 0.001 inch. A safety device is provided in the apron so that the longitudinal feed and split nut cannot be engaged at the same time. All standard threads from 3 to 72 per inch, including the 11½ and 27 pipe threads, can be cut on these machines; and either transposing gears or a metric pitch lead-screw can be furnished to provide for cutting metric threads. Attachments which are available for use in these lathes include a raising block, quick-change gears, taper attachment, individual motor drive, draw-in-chuck, milling and gear-cutting attachments, turret, relieving attachment, etc.



"Star" Gap Lathe built by the Seneca Falls Mfg. Co., Inc.

FOX MULTIPLE-SPINDLE DRILLING MACHINE

In the accompanying illustration there is shown a Style D-22 multiple-spindle drilling machine which is a recent product of the Fox Machine Co., Jackson, Mich. This machine is the third in size of a new series which have been developed by this firm. Constant-speed drive is employed, and a disk clutch carried on Hyatt roller bearings transmits power to the head of the machine. The control lever is within easy reach of the operator, and the driven pulley which transmits power to the gear-box also runs on a Hyatt roller bearing, being carried on a sleeve with no overhang and no bending strain on the change-gear shaft. The gear-box is mounted at the top of the column and contains two shafts which run on Hyatt bearings, and carry the sliding cone change-gears. The upper shaft, extending into the bevel gear-box, carries the bevel pinion, and the crown gear driving the vertical shaft is carried on a steel sleeve running in a bronze bearing, and the thrust is taken by ball bearings. The sliding cone gears give three changes of speed, these changes being obtained by manipulating the lower lever at the side of the column.



No. D-22 Multiple-spindle Drilling Machine built by the Fox Machine Co.

Secured to the side of the speed-box, there is a box carrying the feed gearing. Power is taken from the variable-speed shaft, and transmitted through two sets of cone gears, then through the worm and gear mounted on the vertical shaft. All gears are enclosed and thoroughly lubricated and the control levers are at the side of the column. All thrusts are taken on ball bearings and the head carries the feed-worm

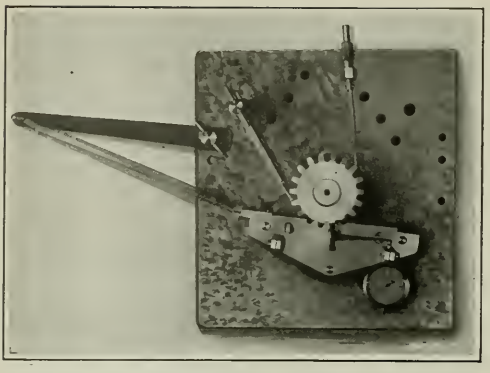


Fig. 1. Kavle Correct Involute Contour Indicator made by the Manufacturers' Consulting Engineers

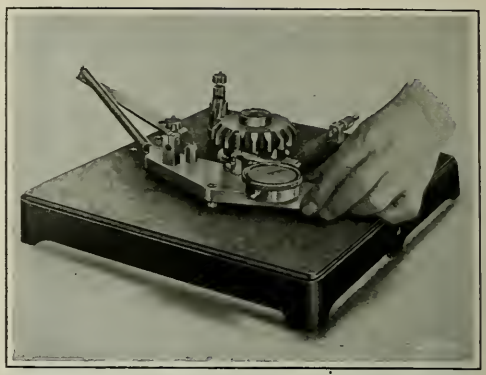


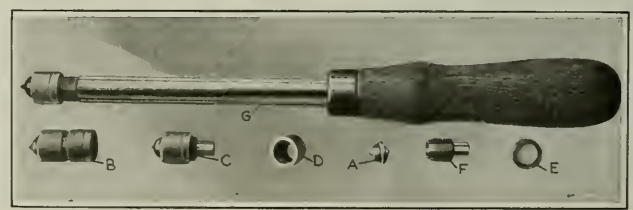
Fig. 2. Using the Kavle Correct Involute Contour Indicator for testing a Gear

and gear which run in oil and are always in mesh. A quick-acting clutch is controlled by a lever at the front of the head and is automatically disengaged by an adjustable stop on the column. On all of the new Fox multiple-spindle drilling machines, the rack is made of extra width and cut from solid steel to mesh with a pinion of special stub tooth design, with a small number of large teeth cut into a solid straight shaft.

The spindles of all Fox drilling machines are turned "over size," for instance, ¾-inch spindles are actually ⅞ inch outside diameter, 1-inch spindles 1⅛ inches outside diameters, etc. All spindles ½ inch and over are carried in cast-iron bearings with bronze bushings. The bearings are securely held to the adjusting arm by two bolts which lock them in place. There are two spindle gears to provide different speeds for each spindle, which make it possible to use different sizes of twist drills and drive each at the correct cutting speed. Some users of multiple drilling machines prefer the single speed drive to the spindles, and for such users, the Fox Machine Co. builds machines with a single-speed drive.

KAVLE CORRECT INVOLUTE CONTOUR INDICATOR

The Kavle correct involute contour indicator has been developed by the Manufacturers' Consulting Engineers, McCarthy Bldg., Syracuse, N. Y., for use in testing the accuracy of the form of gear teeth. Its operation is based on the same principle as that used in laying out a true involute tooth form. The indicator consists of a baseplate, a plug of the same diameter as the base circle of the gear to be indicated, a plug or bushing to locate the gear, and a straightedge which is held in contact with the base circle plug by means of a steel ribbon, 0.002 inch in thickness, and a spring. On the straightedge there is mounted a 5 to 1 lever, the short arm of which is in contact with the tooth form to be indicated, while the long arm is in contact with the plunger of an Ames indicator. This 5 to 1 lever multiplies the reading, so that one mark on the indicator gives you a reading of 0.0002 inch. As the straightedge is rolled about the base circle plug, the short arm follows the tooth form while the long arm remains in contact with the indicator plunger. If the tooth is of true form the pointer will not move; but if the tooth is not of true form, the indicator will show any deviation from true form to 0.0002 inch. The indexing of the teeth may be indicated to the same degree of accuracy by means of the spring stop together with the Ames indicator reading.



Diamond Holders made by the S. Rose Co., Inc., for Use in the Wheel Truing Device on Norton or Landis Grinders, or for Operation by Hand

ROSE DIAMOND HOLDERS

In the accompanying illustration there is shown an adjustable diamond holder which is sold by the S. Rose Co., Inc., 1133 Broadway, New York City. The stones are set in metal by a cold process, and under high pressure the metal solidifies and is then completely steel jacketed. The metal used for this purpose has a melting point of 1217 degrees F., so that the rubbing of the wheel against the diamond cannot create enough heat by friction to injure the matrix in which the stone is held. This method surrounds the diamond with a metal matrix that closely embraces the stone and supports it at all points except the actual edge that is to be used. It is claimed that the cold process of setting eliminates danger of checking the stone and that there is no danger of the heat causing loss of weight or impairing the hardness of the diamond.

Reference to the accompanying illustration will make it apparent that the diamond set in its metal mounting is carried in a holder which is secured to the threaded end of a shank. At *A* there is shown the diamond set in its metal mounting and *B* illustrates the diamond mounted in a holder to fit the wheel truing device on a Norton grinder, while the mounting to fit the wheel truing device on a Landis grinder is shown at *C*. At *A* it will be seen that the diamond point is located at the left, and a conical seat at the right of the mounting fits into a concave conical seat machined in the end of the shank. Behind the cap *D* there is a collar or washer *E* that is screwed up behind the threaded cap to serve as a lock-nut to prevent the collar from turning on its thread. At the top of the illustration there is shown a diamond holder with a long shank that has a wooden handle to adapt it for use by hand.

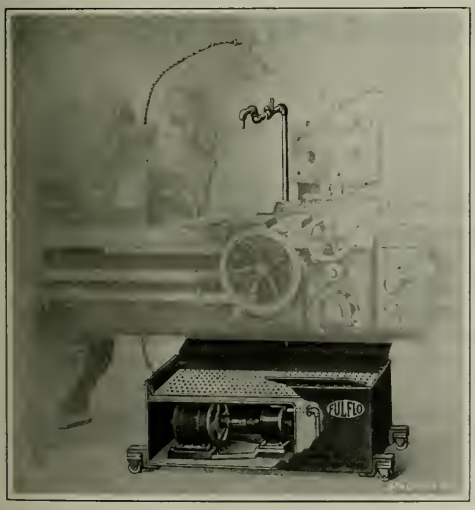
All of these holders can be used for any size stone from ¼ to 2½ carats. In setting a diamond in the holder it is placed in position in the inner collar with the point projecting through the hole, and the metal is then forced into the space between the diamond and the collar, thus affording the uniform support on all sides of the diamond to

which reference has been made. Mounted in this way, and clamped by the method previously described, it is claimed by the manufacturer of this tool that the final result is just as solid as if the tool were made in a single piece.

"FULFLO" PORTABLE COOLANT CIRCULATING UNIT

The accompanying illustration shows the general design and one of the applications of a portable motor-drive pump unit, made by the Fulflo Pump Co., Blanchester, Ohio, for delivering coolant to the cutting tools and work on all sizes and kinds of machine tools. This portable unit was designed to provide a compact and inexpensive cutting tool lubrication system that could be quickly wheeled up to any machine tool in the shop, and immediately start supplying the coolant to the cutting tool. A great many machines in the shop are not equipped with a pan and pump because they are used mostly for working on gray iron; but occasionally such machines are used on malleable iron, steel or some other hard materials where coolant is vitally necessary to attain the best results. It is for such occasions that this portable unit is needed, for while it is possible to work such materials dry after a fashion, it is certainly not economical to try to do so, since much more work and better work can be done with coolant.

There are other cases where it has become necessary to use machines, not equipped with a pan or pump, most or all of the time on materials requiring coolant. It is difficult and expensive to try to improvise a coolant system for such machines, and the "Fulflo" portable unit is a satisfactory as well as an inexpensive solution as a permanent system for such machines. On machines having individual coolant systems, but for some reason the pumps or other parts of the system are out of commission, the portable unit affords an emergency outfit to prevent delaying production.

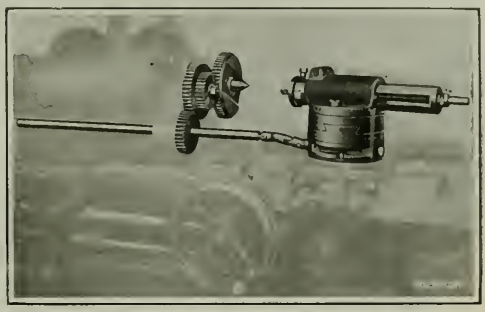


Portable Unit made by the Fulflo Pump Co., for circulating Coolant to Cutting Tools

It is a complete, self-contained system, requiring nothing but the attaching of the motor cord to a lamp socket. The total height from the floor is only 14 inches which permits of its being rolled under almost any lathe. Provision is made for attaching additional splash boards when required. The pump and motor are completely covered, affording them ample protection from both liquid and dust. This outfit can be used on grinding machines, as well as on lathes, drilling, gear-cutting, and milling machines, etc., as the pump is not affected by emery dust or grit and chips. The same pump, motor, and base may be installed on a machine as a permanent installation, where the portable outfit is not required, since the machine is provided with its own drainage and pan system.

JONES RELIEVING ATTACHMENT

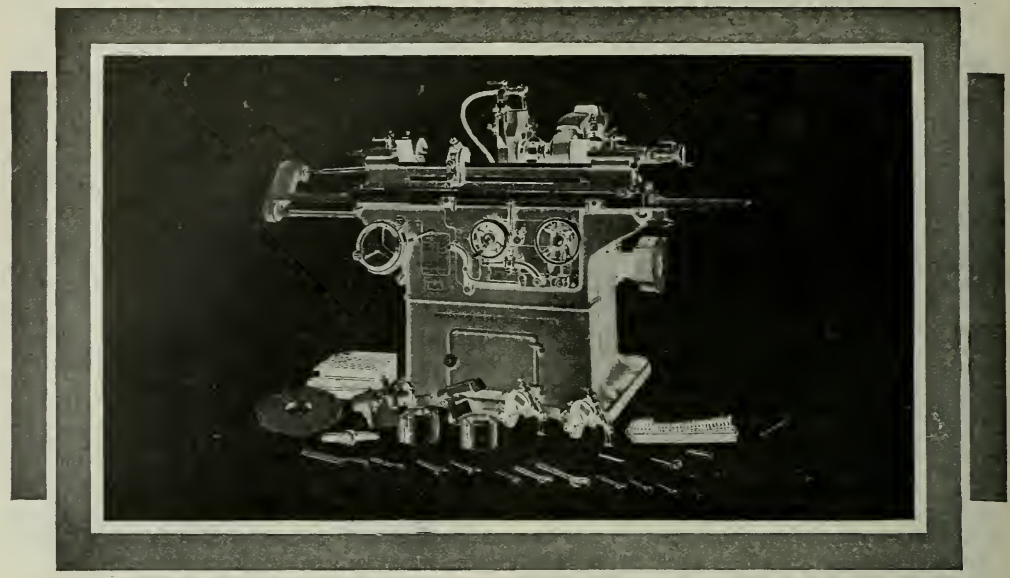
In the accompanying illustration is shown a device known as a full-swing relieving attachment which was designed by Harold R. Cleveland, and is manufactured by William D. Jones, 1010 Wilder Bldg., Rochester, N. Y. This tool is adapted for heavy work, and it has been designed to provide for the performance of all relieving operations including any angle, side, face or irregular spaced flutings or taper cutting. It is



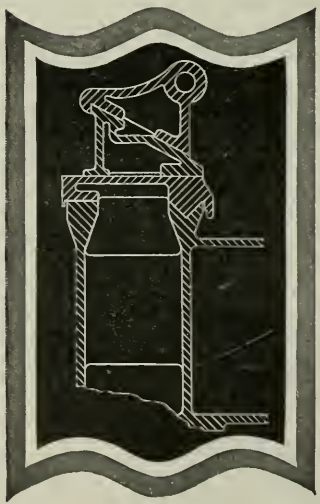
Full-swing Relieving Attachment made by William D. Jones

made in three horizontal sections, two of which remain stationary after they have been brought into alignment. Graduations provide for setting to any required angle, and the tool-holder can be moved for any axis of movement without reference to the tool. This relieving attachment can be used on any type of lathe which has a compound rest and it is usually made for 13-, 16-, and 18-inch lathes, while special attachments may be furnished for use on 24- and 30-inch lathes. The relieving head is mounted on a swivel base in place of the compound rest, and is driven from the nose of the headstock by a gear, from which power is transmitted through a train of change-gears to provide for relieving various numbers of flutings. A gear rack for the change-gears is mounted on the bed of the lathe immediately beneath the driving gear. A universal joint between the splined shaft and relieving head provides for movement of the cross-slide, and attention is called to the fact that the entire mechanism is direct geared or stationary with the exception of the reciprocating tool-holder.

A hand cross-feed movement of 3 inches is provided on the tool-holder for cross-relieving either straight or on an angle; and provision is made for vertical adjustment of the tool bit over a range of $\frac{3}{8}$ inch. The tool-holder is designed for bits up to $\frac{5}{8}$ inch square. This attachment may be used in connection with the taper attachment of a lathe to provide for relieving conical shaped cutters, pipe reamers, etc. It will also relieve form contour cutters when used in connection with a form and weight to guide the carriage. The standard relief is 0.1 inch, but special cams can be provided to produce a greater or lesser relief than the standard amount. A set of four cams with one, two, three and four steps is furnished with each attachment to provide for operating on cutters with various flutings, it being necessary to use a suitable cam in connection with the proper change-gears. It is possible to relieve cutters with from 2 to 28 flutes, with the exception of those numbers that are not used such as eleven, thirteen, seventeen and twenty-three. Spiral driving gears are employed, and the cams are made of heat-treated nickel steel. All operating surfaces are ground and scraped, and provision has been made for adequate lubrication.



Let Brown & Sharpe Maintain Your



These machines embody features that are facts and not possibilities.

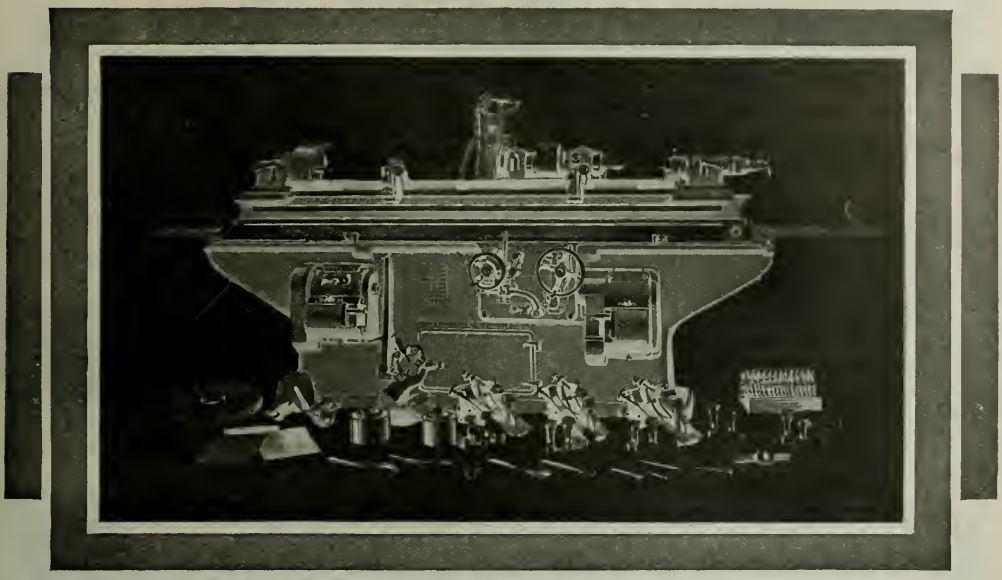
The swivel table is of special design with its face at an angle with the face of sliding table, as is clearly shown by section drawing.

By this construction the thrust, resulting from the wheel pushing against the stock and the downward pull due to rotation of wheel, is resisted by the headstock and footstock in a manner which reduces sliding and twisting tendencies to a minimum.

This construction also brings the centres over a solid wall of metal extending directly to the floor.

The low and compact designs of headstock and footstock are of prime importance where permanent accuracy for continuous operation is a requirement.

Brown & Sharpe Mfg. Co.



Plain Grinding Machines
Standards of Accuracy

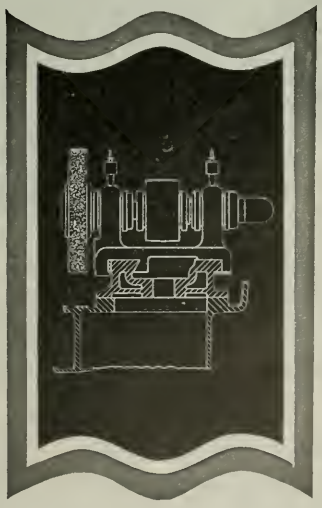
The rigid wheel spindle support with solid walls of base extending to floor, insures absence of vibration which would impair accuracy.

The location of wheel on end of spindle, facilitates the removing and changing—a great asset in production where the same machine must be used for varied set-ups.

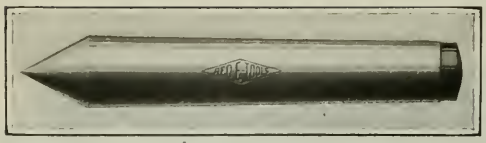
The spindle pulleys are easily and quickly changed—one nut being the only adjustment necessary.

These and other features are vital factors to the manufacturer who must maintain a high degree of accuracy.

An industry whose grinding is the product of Brown & Sharpe Grinding Machines is assured of prestige—and in the shop, production and efficiency.



Providence, R. I., U. S. A.



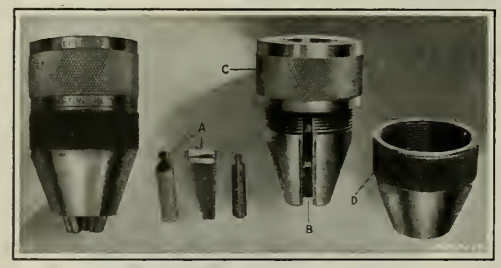
High-speed Lathe and Grinder Center made by the Ready Tool Co.

HIGH-SPEED "RED-E" LATHE AND GRINDER CENTER

For use on lathes and grinding machines the Ready Tool Co., 650 Railroad Ave., Bridgeport, Conn., has developed the "Red-E" high-speed center which is here illustrated and described. It is claimed that this center not only lasts longer, but that its use makes possible the running of machines at their maximum speeds, without danger of burning the centers or having them freeze to the work. Another important claim made for this device is that it eliminates losses resulting from having machines standing idle while centers are being reground or replaced. These "Red-E" centers are made with Nos. 2, 3, 4 and 5 Morse taper, Nos. 7, 9, 10 and 11 B. & S. taper, and Nos. 5 to 12, inclusive, Jarno tapers.

BARTON DRILL CHUCK

A clear idea of the design and construction of a new hand-operated drill chuck recently developed by the H. E. Barton Tool Co., 106 S. Jefferson St., Chicago, Ill., will be obtained by referring to the accompanying illustration which shows one complete chuck and another partially disassembled. Referring to this illustration, it will be seen that the three jaws *A* are furnished with cylindrical shaped heads that fit into grooves *B*. These grooves are cut in the head of the operating screw



Drill Chuck made by the H. E. Barton Tool Co.

which is threaded into the body of the chuck in such a manner that turning knurled sleeve *C* causes the operating screw to push down or pull up the screw head in which grooves *B* are cut. This causes the jaws to slide in their respective grooves in the chuck body and it will, of course, be apparent that on their outer edges these jaws are tapered and curved so that they conform to the conical surface of the chuck body. Knurled cap *D* is screwed to the chuck body over the jaws to provide for retaining them in place. This is a self-contained, keyless chuck and is adapted for use on high-speed drilling machines or portable electric drills.

DETROIT TWIST DRILL

The Detroit Twist Drill Co., Detroit, Mich., has developed a hot-rolled drill known as the Detroit Double-D. It is made of a tungsten-chrome high-speed steel. The flutes are of unusual width to afford ample chip clearance, and a 32-degree helix angle at the point especially adapts these tools for drilling tough, hard materials. Another feature that adapts these drills for severe service is the graduated thickness of the web which affords ample torsional strength. Drills of this type are furnished in sizes from ½ inch to 1½ inches in diameter.

MARTIN TOOL-HOLDER

A tool-holder has recently been developed by the Martin Tool Holder Co., of Jackson, Tenn., which provides for utilizing pieces of broken high-speed steel drills, reamers, etc., in making cutter bits for use in the tool-holders. This practice eliminates the waste of expensive high-speed steel scrap which is usually considered valueless except for remelting. In Fig. 1 there is shown a bit made from a broken drill, which clearly illustrates the method of grinding. It is merely necessary to grind a clearance below the cutting edge and



Fig. 1. Martin Tool-holder for Round Bits, in which Broken Twist Drills, etc., can be utilized

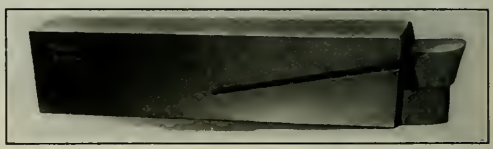


Fig. 2. Martin Tool-holder in which the Tool Bit is made from Square Bar Stock

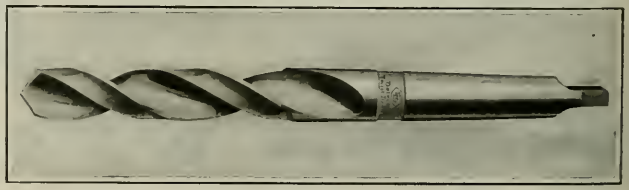
to produce the necessary rake as shown. It is claimed that this is the means of making a perfectly efficient cutter. Martin tool-holders are made in various standard types such as straight, right- and left-hand, cutting off, necking, forming, turning, etc. They are made of tool steel to afford ample strength and durability; and in addition to the holders for round tool bits, as shown in Fig. 1, these holders are made to carry square bits, as illustrated in Fig. 2.

NEW MACHINERY AND TOOLS NOTES

Slip Joint: Fox Machine Co., Jackson, Mich. A universal slip joint which derives its name from the fact that it can be pushed or slipped into position where the joint locates itself firmly, being driven by a key. The joint can also be taken off a shaft without having to remove a taper pin.

Shop Truck: William H. Haskell Mfg. Co., Pawtucket, R. I. A shop truck for general use, with a body 21 inches wide, 31 inches long and 13 inches deep, which is supported on two 20-inch side wheels and a 7-inch front wheel. The body is made of ⅛-inch stock, riveted to angle-irons at the corners

Carburizing and Annealing Box: Quigley Furnace Specialty Co., 26 Cortlandt St., New York City. A line of steel boxes adapted for use in the performance of carburizing and annealing operations. They are made from a special steel which is said to give maximum resistance to oxidation with a minimum cost per heat-hour of service.



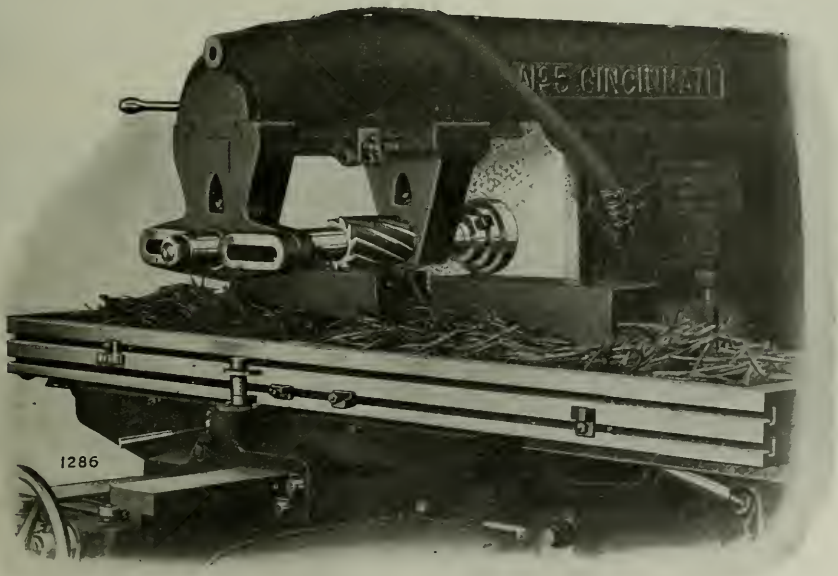
Double-D Drill made by the Detroit Twist Drill Co. for drilling Forgings, Cored Steel Castings, etc.

24 Cubic Inches of Steel Removed Without Braces

THE CINCINNATI RECTANGULAR OVERARM

(PATENTED)

enables the new No. 5 machine to take cuts up to its normal rated capacity without the use of braces.



Material, machinery steel, cutter, 4½-in. diameter Cincinnati design spiral mill, 2 in. arbor

Cut, ¼-in. deep, 5-in. wide. Feed, 19 in. per minute

Removing 23¾ cubic inches of steel per minute—without the use of braces.

THE CINCINNATI MILLING MACHINE CO.

CINCINNATI OHIO, U. S. A.

Elevating Truck: Lakewood Engineering Co., Cleveland, Ohio. An industrial truck adapted for carrying work and elevating it to the proper height for loading on storage racks or freight cars or for placing on machines.

Ball Bearing Jack: Duff Mfg. Co., Pittsburg, Pa. A 75-ton high-speed ball bearing screw jack adapted for use in handling locomotives and other heavy equipment. In designing this tool, the operating mechanism has been located at the base, bringing the bulk of its weight near the bottom.

Industrial Crane Truck: Elwell-Parker Electric Co., Cleveland, Ohio. A motor-driven truck which receives power from an electric storage battery. This truck is of the elevating type and is furnished with a revolving jib crane which has a capacity for loads up to 1000 pounds at a fixed outreach of 48 inches.

Siren: Inter State Machine Products Co., Inc., Rochester, N. Y. A siren with a weather-proof housing for use as an emergency signal for factories, steel mills, coal mines, etc. This siren may be used either in a vertical or horizontal position. The actuating motor operates on 110-volt direct current or alternating current of any frequency.

Heat-treating Furnace: W. S. Rockwell Co., 50 Church St., New York City. A side-opening furnace which is adapted for handling work that varies considerably in size and shape. This furnace is 36 feet wide and approximately 5 feet long, being divided into seven compartments with provision for combining two or more of the compartments as required.

Radius and Angle Grinding Wheel Dresser: S. L. & M. Sales Co., 408 Moffat Bldg., Detroit, Mich. A tool for use in dressing abrasive wheels that have a curved or angular face. Sufficient capacity is provided for dressing a 12-inch wheel to a radius of from 0 to 1¼ inches, either convex or concave, and flat-faced wheels can be dressed to any desired angle.

Combination Torch and Furnace: North American Mfg. Co., 5902 Carnegie Ave., Cleveland, Ohio. A blow torch combined with a specially built furnace The flame is adjustable from 3 to 24 inches and affords a maximum temperature of 2500 degrees F. The furnace is made of cast iron and lined with firebrick, asbestos being used as an insulating material.

Counterbore: Cost-Cut Counterbore Co., 74-78 Fort St. East, Detroit, Mich. A built-up, renewable counterbore which is made of five pieces, namely, a holder, cutter, pilot pin, pilot bushing, and set-screw. It is claimed that the only parts of this tool that will wear out are the cutter and pilot bushing, and the cutter can be resharpened repeatedly until it is worn out.

Airplane Propeller Forming Machine: Keller Mechanical Engraving Co., 74 Washington St., Brooklyn, N. Y. A machine for this purpose which has cut fifty propellers from the rough in a period of 8½ hours. Two propellers are formed simultaneously but only one blade of each propeller is worked on at a time. A machine of this type can also be utilized for the forming of other wooden products.

Facing and Boring Machine: W. W. Ayre, 303 Fifth Ave., New York City. A tool which is adapted for use on either boring, milling, or drilling machines or turret lathes. Feeding of the tool is accomplished by a star-wheel, and the screw is provided with a micrometer collar, divided in intervals of 0.001 inch. Hence the term micrometer facing and boring machine, which has been given to this tool.

Combination Drill-holder and Size Gage: Russell & Burr, 716 Land Title Bldg., Philadelphia, Pa. A device designed to facilitate the storage of drills according to size, when they are returned to the tool-room. It consists of a cast-iron base, and a hardened steel V-gage with ground edges. Two rows of holes are drilled parallel to the V-gage to accommodate full sets of drills, for instance, No. 1 to No. 60 B. & S. gages.

Industrial Trailer Truck: Warren & Irrgang Co., Springfield, Mass. A Type WJ10 trailer truck which is 36 by 72 inches in size and has a height of 16 inches. This truck is of all-steel construction with the chassis constructed of four 3-inch, 4-pound channels running lengthwise, two for each side, these channels being tied together with ¾- and ⅞-inch truss rods and framed with 2- by 2- by 3/16-inch angle-irons.

Power Hammers: Kaukauna Machine Works, Kaukauna, Wis. This concern has redesigned the Mayer power hammers of its manufacture, which are built with heavy gray cast-iron frames made in a single piece for the smaller hammers and in two parts for the larger sizes. A steel ram operates in V-guides cast integral with the frame. Hammers of this type are built in five sizes with capacities of 25, 50, 100, 250, and 500 pounds.

Crankshaft Lathe: Wickes Bros., Saginaw, Mich. A production machine for use in turning crankshafts, regardless of whether they have one or more throws. In addition, this machine can be readily adapted for facing off the cheeks of the webs. It is built in two standard types, one of which is known as a duplex machine for turning two pieces simultaneously, while the other is styled a universal machine and is suitable for turning one piece at a time.

Micrometer Caliper: Lindquist Engineering Works, Portland, Conn. A micrometer caliper which provides for making direct measurements of 0.0001 inch. It is similar in general design to an ordinary micrometer, although certain modifications were necessary to provide for attaining a greater degree of accuracy in measuring. Micrometers of this type are made in all sizes required for measuring work from ¼ inch to 6 inches in diameter, the total range of each tool being only ¼ inch.

Drilling and Tapping Machine: Landau Machine & Drill Press Co., Inc., 19 W. 44th St., New York City. A drilling machine equipped with the selective turret head that characterizes the tools of this company's manufacture. On the present machine, provision has been made for reversing the direction of rotation to enable tapping operations to be performed. There are four spindles in which different tools may be mounted, any of which may be brought into the operating position.

Camshaft Lathe: Charles Gordon, Inc., Milwaukee, Wis. A machine on which several departures have been made from established practice in designing tools of this general type. For instance, the work travels past the tools to obtain the feed, and the tools are located at the rear of the work which rotates in a direction opposite to that customarily employed. The camshaft forging is supported on centers, and adjustment of the tailstock provides for handling different lengths of shafts up to 60 inches.

Center Drill and Countersink Holder: Lindquist Engineering Works, Portland, Conn. A tool for drilling centers on a lathe, which is designed to overcome the necessity of taking out the tail center and substituting a chuck. This tool is made of a single piece of steel, with a recess to fit over the tail center. The outside of the tool is knurled to enable the operator to hold it between his thumb and finger while performing the centering operation. These tools are made in four sizes for Nos. 13, 30, 46, and 52 drills, respectively.

Plain Cylindrical Grinding Machine: Fitchburg Grinding Machine Co., Fitchburg, Mass. A line of machines of this type, on which the wheel-spindle is made of tool steel and runs in bronze bearings with adjustment for wear. The automatic cross-feed is operated at each reversal of the table and may be set in such a manner that it is self-releasing when the work has been ground to the required size. The table swivels on a central stud and can be set for taper grinding operations. Fine adjustment is furnished for the work-rest to accurately maintain the desired dimensions.

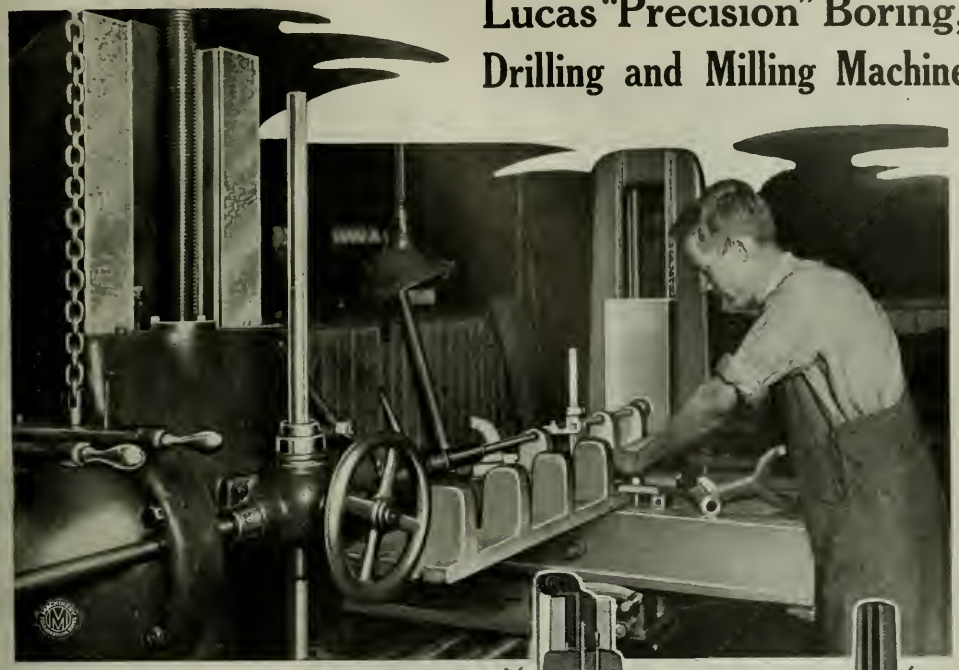
Duplex Thread Grinding Attachment: Precision & Thread Grinder Mfg. Co., 1932 Arch St., Philadelphia, Pa. A duplex attachment that provides for using two wheels to grind a thread, operating at opposite sides of the work. The wheels are beveled so that they grind on opposite sides of the thread; and on production work where a large number of duplicate pieces are to be ground, these wheels are set to the thread of the first part. The threads on following pieces of work are set to the wheels, provision being made for accomplishing this result by means of an adjustable dog.

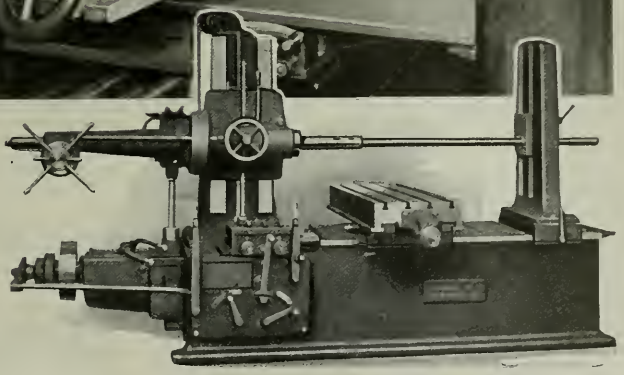
Gun-boring Lathe: William K. Stamets, Pittsburg, Pa. This machine has a bed made in two I-sections with flat ways affording a liberal bearing surface. These two members are connected by inverted U-shape cross members placed at intervals of 24 inches. The headstock totally encloses all working parts and acts as a reservoir for lubricating oil. Submerged in the oil is a gear-driven pump that supplies lubricant to a second reservoir at the top of the head, from which it is conducted through pipes and distributed to all bearings that depend upon this system for lubrication.

Bolt and Nut Machinery: William H. Haskell Mfg. Co., Pawtucket, R. I. A line of machinery adapted for performing hot-forging operations on bolts and cold-punching operations on nuts. To adapt these machines for severe service their design has been carefully worked out to afford ample durability. For instance, all bearings that carry heavy loads are bushed with either babbitt, bronze, steel, or cast iron This line includes a hot-forging machine for stock up to ¾ inch in diameter, a No. 2 upright shear for cutting round bolt stock of the same size, a long stroke press for trimming the flash from bolt heads, and a two-spindle horizontal bolt milling machine.

Adjustable Milling Cutters: Moback Tool & Machine Mfg. Co., 330 Atlantic Ave., Boston, Mass. Milling cutters made according to a principle of construction which involves the use of clamping wedges to hold the blades in place. Each wedge has three tapers placed to produce a full bearing pressure on the blade which is adjustable to two cutting positions, each blade being provided with two cross-slots for that purpose. After the blades are worn to the end, the clamping wedges are removed and the blades shifted to the second slots, thus doubling their life. When they are worn out the blades can be replaced without discarding the balance of the tool. Cutters of this type are made as end, face and side milling cutters.

Lucas "Precision" Boring, Drilling and Milling Machine





Two in the Kempsmith Toolroom--One Three Years Old, One Six Months—

'Nough said

The Kempsmith Manufacturing Company of Milwaukee, Wis., fully appreciates the advantage of highly accurate jigs and fixtures to assure complete interchangeability and eliminate fitting in assembling. Kempsmith tool-room equipment includes only the most accurate machines, among them two Lucas "Precision" Boring, Drilling and Milling Machines—the performances of the first having sold the second during the past year.

The No. 31 machine is here shown boring a swivel jig used in milling triple gear forks for the Kempsmith Maximiller—a small, but important factor in assuring efficiency to this high class production machine. A Lucas Boring Machine gives prestige to any tool-room and insures work that is accurate within very close limits. Let us tell you more about it.

LUCAS MACHINE TOOL CO. NOW AND ALWAYS OF **CLEVELAND, OHIO, U.S.A.**

FOREIGN AGENTS: Alfred Herbert, Ltd., Coventry. Societe Anonyme, Alfred Herbert, Paris. Societe Anonyme Belge, Alfred Herbert, Brussels. Allied Machinery Co., Turin, Barcelona, Zurich. Benson Bros., Sydney, Melbourne. V. Lowener, Copenhagen, Christiania, Stockholm. R. S. Stokvis & Zonen, Rotterdam. Andrews & George Co., Tokyo.

PERSONALS

HUGH L. SIEGEL, formerly general sales manager for the Ford Roofing Products Co., is now associated with the Walter A. Zelnicker Supply Co., St. Louis, Mo., as assistant to the president.

ALFRED SPANGENBERG, formerly superintendent of the Ordnance Department of the Mead-Morrison Mfg. Co., East Boston, Mass., is now superintendent of the Reading Valve & Fittings Co., Reading, Pa.

ROBERT P. LEOPOLD, formerly chief master gage inspector at Frankford Arsenal, Philadelphia, Pa., is now mechanical engineer with the C. Walker Jones Co., Philadelphia, Pa., manufacturer of knitting needles.

H. C. BARNES has joined the Allegheny Gear Works, Pittsburg, Pa., as superintendent of laboratory and metallurgical work. Mr. Barnes is a technical graduate with more than ten years practical experience.

IRVING H. JONES has become associated with the machinery department of Joseph T. Ryerson & Son, Chicago, Ill., and will specialize in sales engineering work on the Ryerson line of machine tool equipment.

E. W. BERNHARD, for a number of years connected with the Hess Bright Mfg. Co. of Philadelphia, Pa. as planning manager, has been made assistant to the general factory manager. H. W. JACKSON has been promoted to the position of factory manager.

L. R. MEISENHELTER has been appointed special representative of the Houston, Stanwood & Gamble Co., Cincinnati, Ohio, manufacturer of large lathes, and will devote his entire time to the sale of this company's line of lathes. Mr. Meisenhelter has disposed of his interest in the L. R. Meisenhelter Machinery Co.

J. GEORGE LEYNER has resigned as president of the J. George Leyner Engineering Works Co., Littleton, Col., and is now devoting all his time to the Leyner Tractor & Mfg. Co., 212 Tramway Bldg., Denver, Col., organized for the manufacture and sale of the Linapede tractor, the design of which has recently been improved by Mr. Leyner.

J. T. MACMURRAY, formerly works manager of the Mead-Morrison Mfg. Co., East Boston, Mass., has become vice-president and general manager of the Reading Valve & Fittings Co., Reading Pa. While with the Mead-Morrison Mfg. Co. Mr. MacMurray had charge of the building of six hundred 4-inch naval gun mounts for the U. S. Navy.

OSCAR WILLIAM SCHRICKER has been appointed assistant superintendent of the machine shop in the Department of Mechanical Engineering, University of Illinois, Urbana, Ill. He attended the Rankin School of Mechanical Trades and has had fourteen years' experience as a toolmaker, foreman, and chief inspector in various manufacturing plants.

FRANK R. BACON, president of the Cutler-Hammer Mfg. Co., Milwaukee, Wis., has been elected chairman of a new organization in Milwaukee known as the American Constitutional League, the activities of which will be confined solely to Americanization work and which will embrace all forms of education and publicity in favor of Americanization.

R. B. WOOLLEY, who has been director of publicity for the Society for Electrical Development, Inc., for the last two years, is now with Thomas F. Logan, Inc., advertising agency, 680 Fifth Ave., New York City. Mr. Woolley has been serving seventeen years in sales and advertising capacities. He will specialize on electrical and merchandising accounts.

A. E. DECLERCQ has recently joined the Cleveland sales force of the Tacony Steel Co., Philadelphia, Pa. Mr. DeClercq has been assigned to the territory of Detroit and vicinity. He is a metallurgist of twelve years' experience, having been connected with the Timken-Detroit Axle Co., Park Drop Forge Co., Chalmers Motor Car Co., and Fisher Body Corporation.

A. A. BLUE has been placed in charge of the heat-treating department of the Duff Mfg. Co., Pittsburg, Pa. Mr. Blue is a graduate of the Chemical Engineering Department of Cornell University. For two years he was connected with the Midvale Steel Co. in the heat-treating department, and during the war served as assistant superintendent of heat-treating and forge shop in the gun plant of the Watertown Arsenal.

ARTHUR ELLIOT ALLEN has been appointed district manager at New York City for the Westinghouse Electric & Mfg. Co., East Pittsburg, Pa., to succeed Edward D. Kilburn, who has been elected vice-president and general manager of the Westinghouse Electric International Co. Mr. Allen has been associated with the company since 1902, and previous to his present appointment, was executive assistant to the manager of the New York office.

ROSWELL MILLER RENNIE has been appointed superintendent of the machine shop in the Department of Mechanical Engineering, University of Illinois, Urbana, Ill. He is a graduate of the Massachusetts Institute of Technology, and was engaged in research work for one year and in production and experimental work in aeronautics for the United States Navy, including technical editorial work for the Aeronautical Personnel Training Section of the Navy.

CLYDE W. BLAKESLEE has resigned from the management of the Chicago store of the Abrasive Co., and will take up the duties of sales manager (domestic and foreign) for N. A. Strand & Co., 625 Jackson Blvd., Chicago, Ill., manufacturers of flexible shafts and equipments. Mr. Blakeslee will be in charge of the salesroom and office which has been opened at Room 201, Machinery Hall, Chicago, for the convenience of the trade in the machinery district, and out-of-town visitors.

P. J. FLAHERTY was elected president of the Johnson Bronze Co., New Castle Pa., at a recent meeting of the board of directors, to fill the vacancy created by the death of G. W. Johnson. Mr. Flaherty has actually been the executive head of the company since January, 1909. He was the chief factor in developing the automobile and bronze bushing part of the business. The company now manufactures every style of bronze bushing in all sizes and for all purposes, specializing particularly on automobile equipment.

S. M. WETMORE has been appointed district sales manager of the Detroit territory for the Hammond Steel Co., Inc., Syracuse, N. Y., manufacturer of high-grade tool and alloy steels and die-blocks, with offices at 912-915 Kresge Bldg., Detroit, Mich. Mr. Wetmore has had twenty-five years of practical experience with alloy and special steels. The Hammond Steel Co. has recently installed, and has in full operation, additional electric furnaces and large rolling and finishing mills to take care of its increased business.

C. N. KELL has been appointed assistant to the general manager of the forge department of the Duff Mfg. Co., Pittsburg, Pa., manufacturer of lifting jacks. For the last eight months he has been assistant to the general superintendent of this company in charge of efficiency work. Mr. Kell designed the equipment of the Rock Island Arsenal for testing the recoil mechanism of the French 75-millimeter gun. His previous experience included work as mechanical engineer with the Mandel Corporation of Chicago, and as assistant superintendent of the Denny Tractor Co., Cedar Rapids, Iowa.

JESSE BENJAMIN KOMMERS has been appointed special research associate professor of engineering materials, on the investigation of the fatigue of metals in the Engineering Experiment Station of the College of Engineering, University of Illinois, Urbana, Ill. He graduated from the University of Wisconsin with the degree of Bachelor of Science in electrical engineering, and was instructor in mechanics and assistant professor of mechanics at the University of Wisconsin. Mr. Kommers was granted leave of absence from the university to assist in the important investigation on the fatigue of metals that has just been undertaken in the University of Illinois in cooperation with the Engineering Foundation and National Research Council.

MATTHEW RUTHERFORD RIDDELL has been appointed assistant professor of aeronautic engineering and assistant to the director of the Engineering Experiment Station of the College of Engineering, University of Illinois, Urbana, Ill. Mr. Riddell is a graduate of the University of Toronto and has been instructor and lecturer in mechanical engineering in that university. He afterward engaged in organizing two companies for the manufacture of electrical heating goods and signs, and was later chief draftsman for the Curtiss Aeroplanes & Motors, Ltd. He was also connected with the Canadian Aeroplanes, Ltd., of Toronto, in the capacity of chief draftsman, testing engineer, and chief engineer, and had a prominent part in directing war work.

EDWARD A. WOODWORTH and C. E. LAVERENZ have been appointed special railroad representatives of the Chicago Pneumatic Tool Co., attached to the staff of manager of western railroad sales, with headquarters at the Fisher Bldg., Chicago, Ill. Mr. Woodworth has been for several years secretary of the Committee on Standards, U. S. Railroad Administration, Washington, D. C., and prior to engaging in government service, he was associated with the Oxweld Railroad Service Co. and the O'Malley Barre Valve Co. He was formerly chief clerk and general mechanical superintendent of the Chicago, Rock Island & Pacific Railroad, and has had experience in the shops of that road as a mechanic. Mr. Laverenz was for several years an inspector in the Ordnance Department of the U. S. Navy, and previously held positions as boilermaker and foreman of the Chicago & Northwestern, and Illinois Central Railroads.

EDWARD D. KILBURN, who has been New York district manager of the Westinghouse Electric & Mfg. Co., East Pittsburg, Pa., since March, 1917, was recently elected vice-president and general manager of the Westinghouse Electric International Co. MAURICE COSTER, who has been actively engaged for more than thirty years in handling the foreign interests of the Westinghouse company, continues as vice-president of the Westinghouse Electric International Co. with

SCREWS

MACHINE, WOOD, CAP, SET, LAG, ETC.

We Have the Assortment and the Quantity

Let us figure on your next specifications. We have managed to "take care" of some very large concerns both in price and delivery.

HAMMACHER, SCHLEMMER & CO.

HARDWARE, TOOLS AND SUPPLIES

NEW YORK SINCE 1848 4th AVENUE and 13th STREET

advisory duties. The president of the company is LOYALL A. OSBORNE, who is senior vice-president of the Westinghouse Electric & Mfg. Co., and was actively engaged in national work during the war. The Westinghouse Electric International Co. was formed in the spring of 1919 to succeed the Westinghouse Electric Export Co. The new company handles the Westinghouse foreign business and is world-wide in its scope, exclusive of the United States and Canada.

OBITUARIES

CHARLES A. SWAINE, president of the Fred I. Swaine Mfg. Co., St. Louis, Mo., died December 31.

GEORGE RHODES CULLINGWORTH, vice-president of the Garvin Machine Co., New York City, died December 15 in his eighty-third year. Mr. Cullingworth was born August 24, 1837 in Manayunk, Pa., which was then a suburb of Philadelphia. He attended public school there until he was about sixteen years of age, when he entered business with his father in Philadelphia, where he served his apprenticeship. In 1857, he went to work for Bennett, Dougherty & Sons of Philadelphia, leaving there in 1859 to go to the Colts Armory in Hartford. From there he went to the Star Armory at Yonkers as a toolmaker, and from Yonkers, to a gun shop in Trenton, N. J., where he had a contract for making guns. In 1865 he was employed by E. E. Garvin & Co., leaving there in 1870 to form a partnership with Sargent. He also did some work in the erection of the elevated railroad in New York City, at which time he invented the ticket chopper that is now in use. After selling out his interest in the Ingersoll-Rand Co., he went to work for the Garvin Machine Co. He was a member of the American Society of Mechanical Engineers.

ALBERT SCHMID, who represented the interests of the Westinghouse Lamp Co. abroad and who held the position of consulting engineer for the American Westinghouse Co., died December 31. Mr. Schmid had been closely identified with the early development of electrical machinery in the United States, and was also prominent in the electrical world of France, Switzerland, Italy, and Great Britain. He was born in Zurich, Switzerland, in 1857 and received his education in that city. He started his career in the employ of the French Westinghouse Air Brake Co., and it was there that Mr. Westinghouse met him in the early eighties and being impressed by his ability invited him to come to America. Soon after his arrival in this country he engaged in designing work for the Westinghouse Air Brake Co., then located in Allegheny, Pa., where his keen mechanical perception and insight brought him rapid advancement. When Mr. Westinghouse became interested in the Union Switch & Signal Co., he engaged Mr. Schmid as the chief designer and engineer in that field. He was afterward transferred to the newly created Westinghouse Electric Co., becoming its first chief engineer and later its general superintendent. In 1897, he went to Europe for the purpose of studying the continental development in the electrical art and the manufacturing possibilities there, and as a result of this trip the French Westinghouse Co. was formed of which he was made director general. He has also held the positions of a director of the Westinghouse Electric Co. Ltd. of England, and president of the Campagnie des Lampes a Filament Metallique, of France. Mr. Schmid was directly concerned with the original development of many forms of electrical apparatus, including the modern industrial motor, electric railway motor, and transformer. He was also granted a number of patents for electrical machines and apparatus. In addition, he did much to develop the gas and gasoline engine, and his latest work was on a carbureting system for internal combustion engines.

COMING EVENTS

February 2-6—First annual mechanical inspection equipment exposition and convention of the American Society of Mechanical Inspectors, on the Roof of the Hotel Astor, New York City. Secretary, Henry F. Winter, 35 W. 39th St., New York City.

February 17-19—National conference on concrete house construction at the Auditorium Hotel, Chicago, Ill. Secretary, A. J. R. Curtis, 111 W. Washington St., Chicago, Ill.

February 26—Monthly meeting of the Rochester Society of Technical Draftsmen, in Rooms 131-137 Sibley Block, 328 Main St., E., Rochester, N. Y. Secretary, O. L. Angevine, Jr., 547 Arnett Blvd., Rochester, N. Y.

March 6-13—Second annual aeronautical exposition, held by the Manufacturers' Aircraft Association, Inc., 501 Fifth Ave., New York City, in the Seventy-first Regiment Armory, Thirty-fourth St. and Park Ave., New York City.

March 9-11—First Annual New England Industrial Accident Prevention Congress, held at Hotel Bancroft, Worcester, Mass.

May 12-15—Seventh national foreign trade convention in San Francisco, Cal. Secretary of the National Foreign Trade Council, O. K. Davis, 1 Hanover Square, New York City.

May 20-21—Spring convention of the National Machine Tool Builders' Association at Atlantic City, N. J.; headquarters, Hotel Traymore. Secretary, Charles E. Hildreth, Worcester, Mass.

May 24-27—Spring convention of the American Society of Mechanical Engineers at St. Louis, Mo.; headquarters, Hotel Statler. Secretary, Calvin W. Rice, 29 W. 39th St., New York City.

SOCIETIES, SCHOOLS AND COLLEGES

North Carolina State College of Agriculture and Engineering, West Raleigh, N. C. Catalogue for 1918-1919, with calendar for 1919-1920, list of courses, etc.

School of Mines and Metallurgy of the University of Missouri, Rolla, Mo. Bulletin containing a bibliography on the roasting, leaching, smelting, and electrometallurgy of zinc, compiled by Harold L. Wheeler, librarian of the university.

University of Illinois, Urbana, Ill., announces that the Engineering Experiment Station of the university, in order to assist in the conduct of engineering research and to extend and strengthen the field of its graduate work in engineering, maintains fourteen research graduate assistantships. Two other such assistantships have been established under the patronage of the Illinois Gas Association. These assistantships, for each of which there is an annual stipend of $500 and freedom from all fees except the matriculation and diploma fees, are open to graduates of approved American and foreign universities and technical schools who are prepared to undertake graduate study in engineering, physics, or applied chemistry. Additional information may be obtained by addressing the Director, Engineering Experiment Station, University of Illinois, Urbana, Ill.

BOOKS AND PAMPHLETS

Publications of the Bureau of Standards. 149 pages, 7 by 10½ inches. Published by the Department of Commerce, Washington, D. C., as Circular No. 24 of the Bureau of Standards. Price, 25 cents.

This circular contains a list of the scientific and technologic papers as well as all the circulars and miscellaneous publications issued by the Bureau of Standards.

Principles of Industrial Organization. By Dexter S. Kimball. 325 pages, 6 by 9 inches. Published by the McGraw-Hill Book Co., New York City. Price, $3.

This is the second edition of the author's work on "Industrial Organization." In revising the book, the contents have been somewhat rearranged with the view to making the sequence of the discourse more logical. Some new subject matter has also been added in order to make the book more serviceable as a text-book, as well as of greater value to engineers engaged in practice. The book is divided into sixteen chapters, headed as follows: Fundamental and Historical; the Industrial Revolution; the Effects of the Great Inventions; Modern Industrial Tendencies; Forms of Industrial Ownership; Principles of Organization—System; Planning Departments: Principles of Cost Keeping; the Depreciation of Wasting Assets; Purchasing and Storing of Materials; Standards and Their Attainment; Location, Arrangement and Construction of Industrial Plants; Problems of Employment; the Compensation of Labor; Corrective Influences—Employes' Service; Resume—Theories of Management. The work is specifically of value as a text-book and has been so designed by the author, who is Professor of machine design and construction at Cornell University.

Foundry Cost Accounting. By Robert E. Belt. 271 Pages, 5½ by 8½ inches. Published by the Penton Publishing Co., Cleveland, Ohio. Price, $5.

The author of this book, who is a certified public accountant and the cost accountant of the American Malleable Castings Association, has aimed to set forth in this volume in a simple and direct manner the practical principles of accounting that are applicable to the foundry industry, and to show methods of collecting the cost data and of accurately determining production costs. The aim has also been to impress upon the executive and the management the importance of an accurate knowledge of costs and the dangers of a price policy that is not founded on production costs. The book is divided into twelve chapters headed as follows: Importance of an Accurate Knowledge of Costs; Uniform Cost Finding Methods and the Effect on Competition; Examining of Plant Practices and Operating Conditions; Installing and Operating a Cost System; Accounting Practice and Records; Operating Departments and Department Records; Classification and Definition of Accounts; Monthly Statements; Product Costs; Depreciation; Estimates and Quotations; and Profits. While there are many of the more successful foundries in the country that have good cost systems, most foundries do not have such systems and it is hoped that this volume will aid the latter class.

Electric Arc Cutting and Welding. 90 pages, 5 by 7 inches. Numerous illustrations. Published by the Electric Arc & Welding Co., 222 Halsey St., Newark, N. J. Price, $1.25.

This book deals with electric arc cutting and welding by alternating current and is intended as an instruction handbook for setting up and operating alternating-current cutting and welding machines and electrodes. It contains, in addition, a great amount of useful data on electric welding of different materials. The book has been especially prepared as a text-book for the welding school that is operated by the company at its plant, but it is also sold to the general public, and copies are distributed free of charge to customers who order either welding machines or quantities of electrodes. The book is divided into lessons, each illustrated with clear and simple line illustrations, the lessons dealing with the following subjects: Setting up and Operating; Welding Terms and Materials; Beading Method; Spreading Method; Padding Method; Fillet Method: Butt-welding Method; Special Butt-welding Method; Irregular Tube Welding; Tack Welding; Sheet Patching Welding; Heavy Section Welding; Cast Iron Welding; Non-ferrous Welding Methods; Preheating, Reheating, and Annealing; Cutting with the Electric Arc; Temperature and Heat of the Arc. A special feature of the book is the simplicity with which the instructions are given, making it possible for any operator to obtain from it the meaning that the author has intended to convey.

Applied Science for Metal-workers. By W. H. Dooley. 479 pages, 5 by 7¼ inches. Published by the Ronald Press Co., 20 Vesey St., New York City. Price, $2.

This is a text-book treating of the principles of physics, chemistry, and other sciences, and their application to shop work, the intention being to correlate these principles with shop observation and experience. The book is intended for use in technical, industrial, apprentice, and continuation schools, and for science classes in secondary schools. It has been written entirely from the practical point of view, the questions at the end of each chapter being so formulated as to bring out the application of the principles to the everyday work of the shop. The style is simple, clear, and concise, the student being led gradually from the elementary to the more difficult phases of the subject. The text is divided into thirty-seven chapters, headed as follows: Science and the Properties of Matter; Weights and Measures; Mechanical Principles of Machines; Leverage; Pulleys, Inclined Planes and Wedges; Laws of Motion; Mechanics of Liquids; Properties of Gases; Heat and Expansion; Light, Color and Sound; Principles of Chemistry; Acids, Alkalies, and

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NEW CATALOGUES AND CIRCULARS

Fafnir Bearing Co., New Britain, Conn. Calendar for 1920, advertising Fafnir ball bearings.

National X-Ray Reflector Co., Chicago, Ill. Calendar for 1920, illustrating reflectors for factory lighting and other lighting purposes.

Shepard Electric Crane & Hoist Co., Montour, Falls, N. Y., manufacturer of cargo-handling machinery, is distributing a calendar for 1920.

General Electric Co., Schenectady, N. Y. Calendar for 1920, showing views of electrical equipment and installations made by the company.

E. W. Bemis Machine Co., Worcester, Mass. Leaflet illustrating and describing the Bemis collet lathe chuck and the Bemis milling and auxiliary lathe head.

Pangborn Corporation, Hagerstown, Md. Circular reproducing letters from users of Pangborn sand-blast equipment, concerning the service obtained from it.

Urban Machine & Tool Co., 2424 St. Clair Ave., Cleveland, Ohio. Circular describing and giving specifications for the Urban direct-motor-driven screw-cutting bench lathe.

Veeder Mfg. Co., 39 Sargeant St., Hartford, Conn. Catalogue of Veeder products, including cyclometers, odometers, counters, speed-counters, tachometers and fine die-castings.

Western Tool & Mfg. Co., Springfield, Ohio. Circular illustrating and giving tables of dimensions, prices, etc., of the "Champion" line of vises and the "Champion" surface table.

Portland Cement Association, 111 W. Washington St., Chicago, Ill. Circular treating of concrete chimneys, illustrated with views of chimneys that have been constructed for various manufacturing plants.

Holz & Co., Inc., 17 Madison Ave., New York City. Bulletin 22-23, descriptive of the Holz universal photomicrographic and photomacrographic metallographic bench for magnifications from 1 to 3500 diameters.

Material Handling Machinery Manufacturers' Association, 35 W. 39th St., New York City. Pamphlet entitled "The Right Arm of Industry," outlining the purposes, organization, and work of the association.

Oliver Machinery Co., Grand Rapids, Mich. Circular illustrating and describing the Oliver No. 1 universal woodworker's vise, which can be rapidly adjusted to any desired angle for holding work of irregular shape.

Kent Vacuum Cleaner Co., Inc., Rome, N. Y. Circulars descriptive of the "Vacuna" vacuum cleaners for factory use and the "Utility" floor machine for polishing, scrubbing and sandpapering all kinds of floors.

Westinghouse Electric & Mfg. Co., East Pittsburg, Pa. Circular 1615, entitled "Westinghouse Underfeed Stoker," describing the leading features of design, principles of operation, efficiency, and capacity of this apparatus.

Gisholt Machine Co., 9 S. Baldwin St., Madison, Wis. Circular entitled "Plug that Hole with the Periodograph," advertising the use of the "Periodograph" for making records of costs, and thus avoiding leaks in production.

Wellman-Seaver-Morgan Co., Cleveland, Ohio. Calendar for 1920, illustrating the company's products of cranes, rolling mill machinery, electric hoists, reversing valves, loading and unloading equipment, gas generators, etc.

Products Sales Co., 606 Security Bldg., Milwaukee, Wis. Circular containing information on "Babbittrite" compound, for holding hot metals of all kinds, as for example, for holding babbitt metal while pouring journal boxes.

Davis-Bournonville Co., Jersey City, N. J. Bulletin of Davis-Bournonville lead burners' outfits, for welding lead sheets, storage battery connections, lead pipes, chemical apparatus, and all lead work that must be autogenously welded.

Griscom-Russell Co., 90 West St., New York City. Bulletin 231, descriptive of the Griscom-Russell instantaneous water heater for use in factories or other places requiring large quantities of water to be heated by live or exhaust steam.

Ohio Cultivator Co., Bellevue, Ohio. Leaflet descriptive of the Ohio automatic belt power baling press for use in salvage departments for rapidly baling all compressible materials into heavy bales of convenient size for handling, storing, or loading.

Jackson Compressor Co., Inc., Denver, Col. Bulletin 3, illustrating and describing the Jackson rotary compressor, which is made in capacities varying from 100 to 190 cubic feet of air per minute to meet various requirements in pressure, volume, and horsepower.

Summit Machine Works, Worcester, Mass. Catalogue of lathes, illustrating and describing Summit screw-cutting engine lathes of both the floor and bench types. The lathes shown include 10-inch screw-cutting engine lathes and 10-20 inch screw-cutting gap engine lathes.

Magnetic Mfg. Co., Milwaukee, Wis. Bulletins F, H, and L, descriptive of the three types of magnetic separators made by this company, for removing valuable metal from foundry and shop refuse. Bulletin P, descriptive of magnetic pulleys and magnetic pulley separators.

Walter A. Zelnicker Supply Co., St. Louis, Mo. Bulletin 275, containing a list of new and second-hand equipment, including rails, cars, locomotives, and other machinery and equipment used in the operation and maintenance of railroads, power plants, mines, and industrial plants.

Nelson Valve Co., Chestnut Hill, Philadelphia, Pa. Catalogue 10, covering bronze, iron, and steel valves made in gate, globe, check, and non-return patterns, which include types for practically every class of service found in power plant work, industrial establishments, and large building construction.

Standard Machinery Co., Auburn, R. I. Catalogue for 1920, illustrating and describing the line of rolling mills produced by the company, which are made in eight sizes, ranging from 3 by 5 to 12 by 18 inches. These mills may be equipped either with direct motor drive or friction clutch drive.

Union Switch & Signal Co., Swissvale, Pa. Circular of truck forgings and forgings for automobile and tractor work. Bulletin illustrating the latest types of forgings made by this concern, including crankshafts, camshafts and other automobile forgings, gear blanks, truck and tractor forgings, airplane forgings, etc.

Service Engineering Co., 25 Church St., New York City. Pamphlet containing a synopsis of the engineering service rendered by this concern, which covers consulting engineering, plant and machine tool appraising, planning, complete tooling systems, designing and building of tools, special and automatic machinery, and the development of inventions.

Lafayette Tool & Equipment Co., 21 S. 12th St., Philadelphia, Pa. Catalogue illustrating and describing the Lafayette universal grinder—a precision tool, designed for grinding threaded and plain cylindrical, internal, surface, cutter and tool work. It may be used on the bench or in conjunction with the lathe, shaper, milling machine, die-sinker, planer, boring mill, etc.

Shepard Electric Crane & Hoist Co., Montour Falls, N. Y. Circular descriptive of the technical night school maintained by the company for the benefit of its employes, containing announcements of courses for 1919-1920. The courses cover machine shop practice, blueprint reading, shop drawing, machine design, shop mathematics, practical electricity, shop mechanics, business English, typewriting, hygiene and health, and office training.

Fairbanks Co., 416 Broome St., New York City. Circular of the micro-automatic tape cutting and turning tool made by the Cruban Machine & Steel Corporation, 2 Rector St., New York City. The tool is adaptable for use on hand or automatic screw machines or lathes, and is made to cut tapers of from 1/16 to 3/4 inch per foot and up to 6 inches in length, or any irregular degree of taper within these limits.

N. B. Payne & Co., 23 Church St., New York City. Bulletin treating of the Lane electric cranes, which are manufactured by the Lane Mfg. Co., Montpelier, Vt., for which N. B. Payne & Co. are the sole agents. The bulletin illustrates and describes several styles of cranes, and gives a complete set of specifications, as well as a questionnaire for use of the prospective purchaser. A free copy will be mailed upon request.

Westinghouse Electric & Mfg. Co., East Pittsburg, Pa. Booklet entitled "Westinghouse Opportunities for Technical Graduates," describing the plan developed by the company for the training of graduates of technical schools at all its various works, in order to round out the students' egineering training by practical experience. Copies of the booklet will be sent to anyone interested, upon application to the Educational Department at East Pittsburg.

Link-Belt Co., 910 S. Michigan Ave., Chicago, Ill. Book 375, treating of Link-Belt freight and package handling machinery and other labor-saving elevators and conveyers. Book 380, of Link-Belt electric hoists and overhead cranes. Booklet containing an article entitled "Handling Coal and Ashes with Electric Hoists" by James Monroe, reprinted from "Power Plant Engineering," and illustrated with views showing Link-Belt equipment used for this purpose.

Smalley-General Co., Inc., Bay City, Mich. Circular containing suggestions to manufacturers who are interested in thread-milling, and giving a list of questions which should be filled out when manufacturers contemplate buying thread-milling machines, so that the requirements of the purchaser will be fully met. General bulletin F, giving data on nine common thread-milling jobs, which, it is claimed, can be done to better advantage on a thread-milling machine than by any other method.

Heald Machine Co., Worcester, Mass. Loose-leaf catalogue of Heald grinding machines and magnetic chucks, illustrating and giving specifications for the various styles of cylinder, internal, rotary, and surface grinding machines made by this company. Loose-leaf catalogue entitled "Heald Machines in Operation" containing bulletins showing the wide variety of work that can be performed on Heald grinding machines. These bulletins are illustrated by views taken in the shops, showing the machines engaged on various classes of grinding operations.

Jones & Lamson Machine Co., Springfield, Vt. Publication entitled "Hartness Screw Thread Comparator," a device intended for the accurate and rapid gaging of screw threads. This book, containing 46 pages, 6 by 9 inches, and substantially bound in cloth, contains a complete description of the construction and use of the Hartness screw thread comparator, which was briefly described in the January number of MACHINERY. It illustrates the uses to which the instrument may be put and calls attention to many of the difficulties arising from incorrect screw threads.

Brown Instrument Co., Philadelphia, Pa. Catalogue 12, containing 88 pages, 8 by 10¼ inches, covering the complete line of Brown indicating and recording instruments, which include pyrometers, resistance thermometers, recording thermometers, pressure gages, draft gages, tachometers, time and operation recorders, etc. The catalogue describes fully the construction of the pyrometers, and contains views showing their use for heat-treating and hardening, in blast furnaces, in cement plants, in foundries, for galvanizing and tinning, and for many other purposes.

Cutler-Hammer Mfg. Co., Milwaukee, Wis. Booklet A, describing Cutler-Hammer motor-operated brakes for alternating-current service, made for application on cranes, elevators, mine hoists, and other kinds of conveying and hoisting machinery. Booklet S, illustrating and describing the Cutler-Hammer magnetic separator pulley, which is used for removing iron from crushing, grinding, or cutting machinery; for the recovery of iron from refuse sands in foundries; and for the purification of products. These publications are both revised and reprinted in their present form.

Armstrong-Blum Mfg. Co., 343 N. Francisco Ave., Chicago, Ill. Circular descriptive of the "Marvel" all-steel punch, shear, and bender—a machine which is equipped with tool-holding bars in which punches and dies, cutters, and benders can be clamped for performing punching, shearing, and bending operations simultaneously or separately. Special tools to suit various requirements can, of course, be used in place of those mentioned. The machine is made in two styles, the larger size having an eccentric and link arrangement at both ends for applying pressure to the tool-holding bars, while the smaller size has only one such arrangement.

Climax Molybdenum Co., 61 Broadway, New York City. New 72-page book entitled, "Molybdenum Commercial Steels," which comprises practically a treatise on the subject. Data are given on the commercial production and use of these steels, and the text of the book is supplemented by many tables and colored charts as well as by photomicrographs. The book treats fully of the physical properties and the heat-treatments of the various types of molybdenum steels developed during the war and since. The material presented has been read and approved by prominent metallurgists and alloy steel manufacturers having a wide experience with molybdenum steels. The Climax Molybdenum Co. is associated with the American Metal Co., Ltd., the New York offices of both companies being at 61 Broadway. A copy of the book will be sent free upon request.

Alfred Herbert, Ltd., 54 Dey St., New York City. Bulletin 51, containing a reprint of three articles on cutting tools, from the "Monthly Review of Modern Machine Shop Practice." The first article treats of the design of lathe, planer, shaper, and slotter tools; the factors which decide what shape of tool will prove most efficient for any given cutting operation; the ideal tool to use for a known combination of factors; and the effect on the shape of the tools due to variation in these factors. The second article deals with the practical side of the subject of cutting tools, including their selection, use, manufacture, storage, and maintenance, and describes a set of standard tools that will cover general requirements. The third article entitled "The Toolmaking Department" contains suggestions regarding the equipment of a toolmaking plant. In connection with the latter article, a description is presented of the construction and operation of the Lumsden oscillating tool grinder.

Blanchard Machine Co., 64 State St., Cambridge, Mass. Operators' handbook for the Blanchard high-power vertical surface grinder, sizes 10 and 16. This book has been published primarily for the use of the operator and foreman in charge of the machines, with the idea of enabling them to obtain the maximum results from Blanchard surface grinders. The book, however, should also be useful to tool designers and to machinists and repair men. In addition to containing full directions for the operation of the machine, information is given on the selection of wheels for grinding various materials. It is pointed out that it is of the utmost importance to select the right wheel for the job, and several pages are devoted to this subject. Information is also given in regard to the magnetic chuck, the best means of chucking various kinds of work, and how to utilize the magnetism through simple magnetic fixtures for holding irregular shaped pieces. The adjustment and repair of these machines is also fully covered. Free copies of the book will be sent upon request.

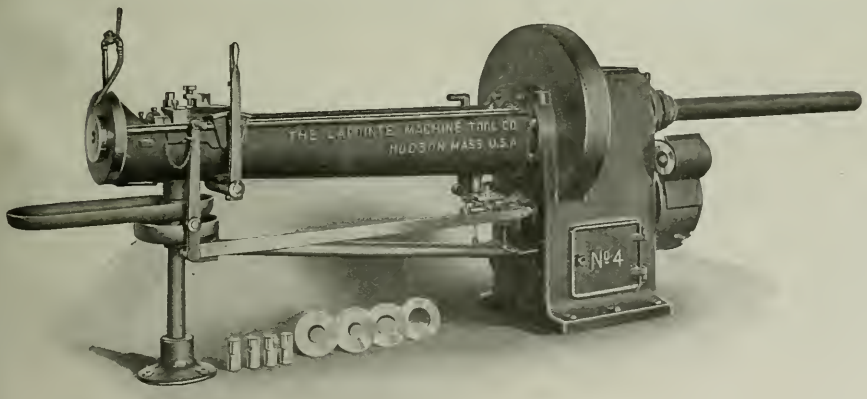
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TRADE NOTES

Hewitt Co., 9th Ave. and 13th St., Maywood, Ill., desires to obtain catalogues and printed matter on machine shop equipment of all kinds, as it expects to be in the market soon for equipment of this class.

Duff Mfg. Co., Pittsburg, Pa., has opened a branch sales office in the Book Bldg., Detroit, Mich., in charge of Frank J. Hunt. The new office will handle the output of the forge department of the company.

Ross Mfg. Co., Cleveland, Ohio, manufacturer of emery wheel dressers, has moved into its new plant at 3100 W. 106th St. This will enable the company to fill new orders promptly because of the increased capacity of the plant.

C. F. Braun & Co., San Francisco, Cal., announce that they have secured for their executive and engineering offices the entire tenth floor of the Atlas Building, 604 Mission St., which will bring them into closer touch with their factory.

L. Best Co., distributor of Sterling wheels, made by the Sterling Grinding Wheel Co., Tiffin, Ohio, has recently purchased a building at 28-30 West Broadway, which will afford ample space for the increased business to which the company looks forward in 1920.

M. Freedman & Bro., 78 Duane St., New York City, die-cutting specialists, announce that Albert Freedman has purchased his brother's interest in the business, and that Maurice Gralitzer has become a junior partner in the firm, which will continue under the same name as formerly.

Chicago Flexible Shaft Co., 1154 S. Central Ave., Chicago, Ill., has opened a New York office at 350 Broadway for the distribution and sales of its furnaces, forges, and heat-treating equipment. J. W. Lazear formerly with the Brown Instrument Co., in Chicago, will be in charge of the new office.

Richardson-Phenix Co., Milwaukee, Wis., lubrication engineers and manufacturers, have opened an office at 306 American Trust Bldg., Birmingham, Ala. James D. Scruggs, who has been associated with the Hills-McCanna Co., has been appointed district manager of the southern office.

Massachusetts Blower Co., Watertown, Mass., has reopened its Boston office, which is now located in the Kimball Building, 18 Tremont St., Boston, in charge of H. C. Bartlett. All inquiries regarding prices and the application of the company's apparatus should be referred to the Boston office.

Black & Decker Mfg. Co., 10 Guilford Ave., Baltimore, Md., has established a branch office at 6523 Euclid Ave., Cleveland, Ohio. Garth A. Dodge, formerly connected with the Austin Co., will be in charge of the Cleveland branch. Mr. Dodge is branch manager for the states of Ohio and Indiana.

Victor Saw Works, Springfield, Mass., held its annual salesmen's convention at Springfield on January 2 and 3. The activities of the past year were reported and satisfaction was expressed at the progress that had been made. The company announces that the prospects for 1920 are particularly good.

Star Tool & Mfg. Co., 4518 Lexington St., Chicago, Ill., announces the following changes in its personnel: C. C. Poucher is president and general manager; R. Richer, vice-president and chief engineer; J. O. Hessler, treasurer and superintendent; and E. J. Dumroese, secretary and office manager. These men will also comprise the board of directors.

T. A. Willson & Co., Inc., Reading, Pa., manufacturer of safety goggles and glasses for industrial and other uses, has changed its firm name in order to correspond more closely with the name of its product. The company is now known as Willson Goggles Inc., which is the registered trademark of its product. The ownership and personnel of the company remains the same.

Edgar Allen & Co., Ltd., steel manufacturers of Sheffield, England, announce that the company has incorporated as an American concern under the name of Edgar Allen Steel Co., Inc., with headquarters at 718-722 W. Lake St., Chicago, Ill. The American company has the following officers: J. C. Ward, president; O. R. Bennett, vice-president and general manager; F. C. Leiferman, secretary and treasurer.

Doehler Die-Casting Co., Court and 9th Sts., Brooklyn, N. Y., at the annual meeting of the board of directors re-elected the following officers: H. H. Doehler, president; H. B. Griffin, vice-president; O. A. Schroeder, treasurer; and O. A. Lewis, assistant secretary. The list of officers was also added to as follows: J. Kranlund was made second vice-president in charge of production, and Charles Puck, secretary and chief chemist.

Frank H. Nickle, Saginaw, Mich., manufacturer of agitator driving yokes—a standard power transmission device for driving agitator or stirrer shafts in open or closed chemical tanks, kettles, and other containers, announces the organization of the Nickle Engineering Works with office and factory at 729 N. Niagara St., Saginaw, Mich. The company will install additional machine shop equipment and will increase its scope of operation.

International Oxygen Co., Newark, N. J., is establishing a new branch plant at Toledo, Ohio, to furnish oxygen and hydrogen for all purposes to the manufacturers and industries in that section, who use either one or both of these gases in their process. The capacity of the plant will be 3,000,000 cubic feet of gas per month. Over two hundred I. O. C. system oxygen-hydrogen generating plants are now in operation, both in the United States and abroad.

Fred C. Dickow, Chicago, Ill., manufacturer of the Dickow universal dividing head for milling machines, is erecting a new plant at 3504-3512 W. Lake St., Chicago. The building is a one-story brick construction, 77 by 100 feet, with a saw-tooth roof. It is expected that it will be ready for occupancy by March 1. A large increase has been made in the equipment, which will enable the company to handle its rapidly increasing business more effectively.

General Fire Extinguisher Co., Providence, R. I. announces that on January 1 all of the sales and contracting business that has for many years been carried on by the company, was taken over by a new company known as the Grinnell Co., Inc., with executive offices in Providence, R. I. The business which the Grinnell Co. takes over from the General Fire Extinguisher Co. relates to fire protection; power and process piping, steam, hot water, and gas heating; drying; and sales of pipe fittings, valves and supplies.

Fairbanks Co., 416 Broome St., New York City, announces that it has recently signed a contract with the Lincoln Electric Co., of Cleveland, Ohio, for the exclusive distribution of Lincoln electric motors for industrial applications. The line includes alternating-current motors for two-phase and three-phase circuits, from ½ to 500 horsepower, for all commercial voltages and frequencies, and direct-current motors from ½ to 150 horsepower. The Fairbanks Co. will cooperate with the various Lincoln district offices in connection with the sale of the manufacturer's other products.

Joseph T. Ryerson & Son, Chicago, Ill., announce that they have recently formed an association with the Conradson Machine Tool Co., of Green Bay, Wis., for the sale of Conradson machine tools. The line consists of plain and universal milling machines, selective-head lathes, planers, and radial drilling machines, which are being sold under the trade name of Ryerson-Conradson. The Conradson plant in Green Bay has recently been completed, equipment has been installed, and production is now under way.

Cambridge & Paul Instrument Co., Ltd. has been formed through the amalgamation of the business carried on by Robert W. Paul of New Southgate, London, England, and the Cambridge Scientific Instrument Co., Ltd., Cambridge, England. Mr. Paul will join the board of directors, and the manufacture of scientific instruments will be continued both at Cambridge and at New Southgate. It is believed that the experience gained by the staffs of both firms, when combined, will lead to greater and more rapid advances in the design and manufacture of scientific instruments.

Cutler-Hammer Mfg. Co., Milwaukee, Wis., has added to the space devoted to the industrial electric heating department. The industrial heating line, which is now being expanded, includes electric space heaters, electric soldering irons, linotype pot heaters, metal melting pots, immersion water heaters, circulation water heaters, and heater units for application to all types of machinery. The manufacture of household electric appliances, such as irons, toasters, etc., has been discontinued, and the space formerly devoted to that line has also been turned over to the industrial heating line.

Allen Spindle Corporation has been organized, with a capitalization of $55,000, by Elliott A. Allen, for the purpose of manufacturing ball-bearing tool spindles. Mr. Allen has for eight years as sales engineer of S. K. F. ball bearings and was recently New England district manager for the S. K. F. Industries. A modern spindle plant has been leased, and production is well under way. It is stated that additional machinery is being purchased and an extension of the plant is already anticipated. The headquarters of the Allen Spindle Corporation are in the Little Building, 80 Boylston St., Boston, Mass.

Service Engineering Co., 25 Church St., New York City, has been incorporated under the laws of the state of New York with a capital stock of $50,000, to render general engineering service and to specialize in the design of tools, jigs, fixtures, and methods for interchangeable manufacturing of motor cars, motor trucks, typewriters, adding machines, and other products made in quantities. The officers of the new company are Albert A. Dowd, president; Donald A. Baker, vice-president; Fred E. Rogers, treasurer; and Thomas P. Orchard, secretary. The company employs a force of about sixty men, and is prepared to give engineering service on short notice.

Vonnegut Machinery Co., 43 S. Meridian St., Indianapolis, Ind., has let contracts and started work on a building, 100 by 300 feet, with five stories and basement, of reinforced concrete and metal sash factory type construction, which will represent an investment of about $300,000. The location is at 19-29 W. South St., opposite the Union Station, Indianapolis. The first floor and basement will be used for the entire business, including office, display floor and storage for the machine tool and machinery accessories department, as well as machine shop and storage facilities for the used machinery department. The second floor will be available for rental purposes. Exceptionally heavy construction is employed with the idea of adding three or four additional stories in the future.

Electric Furnace Co., Alliance, Ohio, has made a number of installations of electric furnaces recently which are of interest on account of the new type of equipment involved and the special alloys which are to be melted. Among these may be mentioned the installation of a Baily electric furnace for melting yellow brass, in the shops of the Standard Sanitary Mfg. Co., Louisville, Ky.; a 105-kilowatt furnace for melting red and yellow brass in the works of the Akron Bronze & Aluminum Co., Akron, Ohio; a 500-pound furnace for melting gray iron in the plant of the Wasson Piston Ring Co., at Plainfield, N. J.; a 105-kilowatt rase-tilting furnace of large capacity, with a special mutor-operated casting table so designed that metal may be poured directly into the molds, in the plant of Mitsui & Co., Japan.

F. J. Littell Machine Co., of Chicago, Ill. has been incorporated under the laws of Illinois with a capitalization of $35,000, and has taken over all the assets and liabilities of the Acme Machine Works 4125-4127 Ravenswood Ave., Chicago, Ill. The new company will continue the manufacture of roll feeds, dial feeds, and special feeds for punch presses. The officers are F. J. Littell, president and general manager; Edwin Swangren, vice-president and superintendent of shop; M. E. Wittich, treasurer; W. N. Stevenson, secretary, in charge of engineering department. The management remains the same with the exception that Edwin Swangren, who has been assistant superintendent of the American Can Co.'s Maywood machine shop for several years, will take charge of the manufacturing, as well as being vice-president. Additional capital is being added to take care of the increasing business of the company.

Wyman-Gordon Co., Worcester, Mass., manufacturer of forgings, announces that the company has consolidated with the Ingalls-Shepard Forging Co., of Harvey, Ill., the purpose of the consolidation being to improve the service to the customers of both companies. Plans are under way for increasing the capacity and efficiency of both plants and for specializing in forgings of importance in the automobile industry, such as crankshafts, camshafts, axles, gears, steering knuckles, etc. The Harvey, Ill. works will be known as the Ingalls-Shepard Division of the Wyman-Gordon Co. F. A. Ingalls, president of the Ingalls-Shepard Forging Co., will become a vice-president of the Wyman-Gordon Co., and will be in active charge of the Harvey works. The general offices of the company will continue to be located at Worcester, Mass., which will be the headquarters of George F. Fuller, president, and Harry G. Stoddard, vice-president and general manager.

Keuka Industries, Inc., Hammondsport, N. Y., announce that a new organization with that name has taken over the completely equipped motor factories of the Curtiss Aeroplane and Motor Corporation at Hammondsport, N. Y. The officers of the new company are L. J. Seely, president; John H. McNamara, vice-president; K. B. MacDonald, secretary and treasurer. The directors are Glen H. Curtiss, Hammondsport; K. B. MacDonald, Buffalo; John J. H. McNamara, Hammondsport; Hugh Satterlee, New York; and L. J. Seely, Hammondsport. With the exception of Mr. Satterlee, all the directors are men who for years have been connected with the Curtiss Aeroplane & Motor companies. It is the object of the new company to develop a very high-grade automobile engine, it being believed that this will be possible because the organization includes the men who have in the past turned out one of the best koown airplane motors in the country.

Norton Co., Worcester, Mass., announces that a Canadian company has been incorporated with a capital of $500,000 which will make grinding wheels for the Canadian market of the same kind and quality as those made at the Norton plant in Worcester. A plant is now being built at Hamilton, Ontario, of which the main building is in three stories, 50 by 100 feet, in addition to which there is a kiln building, 60 by 128 feet, two stories high, with provision for four kilns. It is expected that the Canadian company will employ 100 men at the start and that manufacturing operations will begin about April 1, after which Canadian orders will be filled directly from the Canadian plant. In order to insure the same quality of product as obtained in the Worcester plant, the superintendent and the foremen of the Canadian plant will be taken directly from the Norton plant in Worcester. Robert C. Douglas, who has been connected with the Norton Co. for many years and who has for years traveled in the Canadian territory, will be general manager of the plant.

A. L. Kirby Co., 828 Broad, St., Newark, N. J., opened offices on January 1 to engage in the sale of all kinds of sheet metal working machinery. A. L. Kirby of this firm was for the last thirteen years associated with the Loy & Nawrath Co., builder of draw-benches and sheet metal working equipments, and was vice-president and general manager of the company at the time of his resignation; he still retains the office of vice-president and continues as a member of the board of directors. A. J. Ellis who has been engaged in the manufacture of such sheet-metal articles as metal window frames, metal-covered doors, hollow steel doors, metal furniture, etc., is associated with Mr. Kirby of the A. L. Kirby Co. It is the purpose of the firm to give its customers specialized engineering service, a feature of which will be the development of sheet-metal products and the selection of equipment for use in manufacturing such products; also, the preparation of specifications for, and the supervision of the building and erection of the equipment. W. F. Burditt, Jr., formerly with the Loy & Nawrath Co., is chief engineer of the A. L. Kirby Co.

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Principal Articles to Appear in April MACHINERY

HOW PRECISION GAGE-BLOCKS ARE MADE ..... *Franklin D. Jones*

MANUFACTURING KRASCO SPRING MOTORS .... *Edward K. Hammond*

PNEUMATIC CUSHIONS IN METAL-DRAWING OPERATIONS. *John Nelson*

MACHINING AUTOMOBILE ENGINE PISTONS ..... *Ralph E. Flanders*

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FOREIGN MACHINERY MERCHANTS PAGES, 518-519—ADVERTISERS INDEX, 551-552—PRODUCT INDEX, 520-548

The Editor's Talk With MACHINERY'S Readers

THE automatic machine has the center of the stage. For fifty years the development of automatic machinery in America has been steady. The reason is obvious. Higher wages are paid here than anywhere else, and to make competition in the world's markets possible, labor-saving machines had to be developed. Progress has been made step by step until these machines are "almost human." They have hands, and arms, and fingers—and they really have brains, too, except that the brains are the brains of the machine designer and inventor.

The study of the various mechanisms employed in automatic machinery is as interesting to the mechanic in general as it is important to the machine designer. The article "Magazine Feed Mechanisms" in March MACHINERY is an important contribution to the recorded practice in automatic machine development—it deals with one of the important functions in the highly developed automatic machine. The examples are taken from an industry where machines of this type have been brought to a high degree of perfection—the driving-chain industry, and represent designs found in the plant of the Diamond Chain & Mfg. Co. It is the chief article on machine design in the March number.

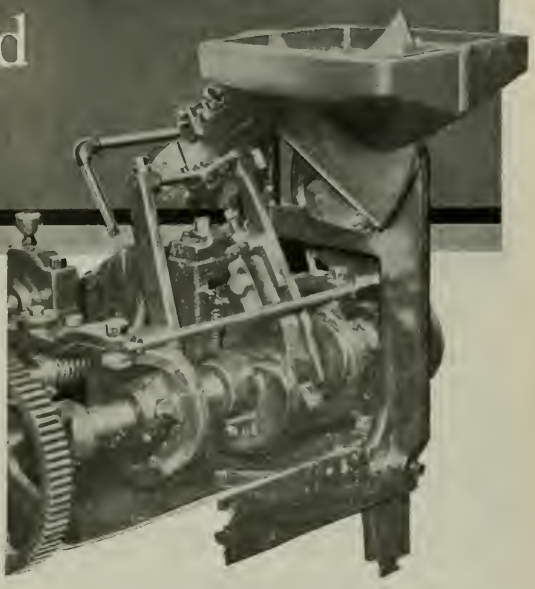
IN years past the machine designer was the most important factor in the development of a new machine or device and the tool designer had a secondary place. Today the tool designer occupies as important a position in the industrial field as the machine designer. The man who knows how to devise the tools and determine the methods whereby the machine on paper can be economically built to the required accuracy, is a man requiring a broad variety of experience. This experience he gains by observation, by actual work, and by study. A mechanical journal, to adequately function, must give the tool designer something that will aid him in his work. In March MACHINERY, various phases of tool design are dealt with in the article on "Dies for Automobile Wheel Hub" and "Taper, Plug, Ring and Profile Gages."

MR. Buckingham's article on Economic Procedure in Interchangeable Manufacture, deals with the broad phases of machine shop management, and the principles he lays down would save many a wasted dollar were they properly appreciated and applied in production. How much waste in the industrial field is due to the duplication of experiments in different places; to the same inadequate methods being tried again and again; to the repeated futile attempts to work with inefficient or unsuitable tools? And all because proper records of past experience are not kept and definite data and instructions not given to the shop on correct economical procedure!

IN April MACHINERY we shall be able to give our readers the first complete record ever published on the commercial manufacture of precision gage blocks. The article describes in detail the methods used in making the Hoke Precision Gage Blocks by the Pratt & Whitney Co. The making of precision gage blocks has been surrounded with extreme mystery, and has been regarded as an art that but few could master. It has remained for years one of the few mechanical achievements on which there has been no general information. It is quite natural that this should have been so, because the manufacture of gage blocks, which are both flat, parallel and true to a given size within a few millionths of an inch, is the greatest achievement in the art of precision lapping and measuring, as applied to a commercial product, known to the mechanical world. The article explains in detail how the Hoke Precision Gage Blocks are made, dealing with every essential feature, beginning with the kind of steel used, and continuing with the preliminary machining operations, the heat-treatment of the gages, the seasoning of the steel, the ingenious mechanical lapping process—which makes it possible to attain such marvelous accuracy—and the optical method of checking the finished gages, by means of which errors of a millionth of an inch may be detected.

THE difference between our civilization and that of past ages is mainly to be found in the application of mechanical power. Some have called this the golden age of engineering, but this statement is premature. When engineering finally reaches and becomes the servant of the thousand millions of human beings to whom its achievements are still practically unknown, then the real golden age of engineering will be ushered in.

Magazine Feed Mechanisms



A Description of Mechanisms and Mechanical Movements Used in the Design of Magazine Feeding Devices for Automatic Machines Employed by the Diamond Chain & Mfg. Co.

By EDWARD K. HAMMOND

MANY successful manufacturers have found it profitable to group machines that are used for the quantity production of duplicate parts, with a single operator to look after an entire group. Several benefits are secured from such a method of procedure, most important of which is the saving of labor costs that is effected. This method is also the means of increasing rates of production and reducing the idle time of the machines and operators, if the application of this principle has been worked out to the best possible advantage. No special equipment is needed, in cases where the length of time required to complete the operation performed by each machine is sufficient to allow the attendant to follow a predetermined routine in going from one machine to another, removing finished pieces and setting up fresh blanks in their place. But if the length of time required to perform each individual operation is very short, it is often necessary to equip each machine of such a group with some form of magazine feeding device which automatically delivers blanks to the machine as fast as the operations are performed and finished pieces ejected. Otherwise, it would be obviously impossible for a workman to look after more than one machine without having a prohibitive amount of idle time charged against all such machines in the group.

In the present article it is intended to illustrate and describe a number of ingenious magazine feeding devices which have been developed at the plant of the Diamond Chain & Mfg. Co., Indianapolis, Ind., for use in handling parts of the sprocket chains manufactured by this firm. Many of the machines and the feeding devices used on them are of a special character, and have been designed to meet the requirements of some unusual job; but these mechanisms are called special because their designs have been adapted to the peculiar requirements of individual jobs, and not due to the fact that the basic principles of their construction and operation are only fitted for the requirements of one operation. As a matter of fact, most of these principles are entirely general, as regards their possibility of application, and for that reason men who are engaged in designing special tools to meet the requirements of a great variety of manufacturing operations will see possibilities for the employment of similar devices for handling parts of their own product.

Conditions to be Considered in Designing Magazine Feed Mechanisms

A designer who undertakes the development of magazine feed mechanisms with a reasonable chance that his work will eventually be the means of effecting substantial reductions in production costs must bear in mind the fact that the purpose of such equipments is to enable an attendant who is assigned to look after a number of machines, to periodically furnish each one with a supply of blanks sufficient to allow it to run for a considerable period of time without further attention. If the special equipment which the designer puts on a machine for this purpose is not perfectly designed, the transfer of blanks from the hopper to the cutting tools may be stopped, and this will often result in a serious loss of output on a machine that is so affected, because the attendant may not notice that production is not continuing until such a time as his regular round leads him back to the machine in question.

Precautions taken to overcome such difficulties will depend upon the nature of the work and of the operation to be performed, but as a general proposition, it may be stated that great care should be taken to provide an efficient form of agitator to stir up the blanks in the hopper and to assure their uniform delivery to the feed-chute or other means of transferring them from the hopper to the tool. Care must also be taken to so proportion and arrange the feed-chute that there is no danger of blanks becoming clogged in it. Another precaution is that of examining the condition of the work as it is left by the preceding operation. For instance, there may be burrs or other irregularities on the blanks which will retard their uniform feeding through an automatic mechanism, and in such cases it may be possible through a slight and inexpensive modification of the way in which the preceding operation is performed to bring the blanks to a condition where they will run uniformly from the magazine to the tools that perform the following operation.

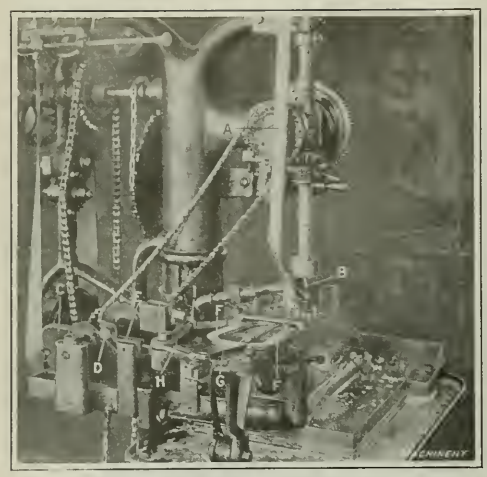


Fig. 1. Drilling Machine equipped with Automatic Magazine Feed, Transfer Slide, and Chucking Mechanism for holding the Work during the Drilling Operation

Feed Mechanism on Center Block Drilling Machine

For use in drilling rivet holes in the center blocks for bicycle sprocket chains, a battery of drilling machines is employed, built by Norton & Jones; but in order to adapt them for their peculiar work, the original design has been greatly modified, including the application of an interesting magazine feed mechanism shown in Figs. 1 and 2. The blanks to be drilled are fed to the work-holding fixture on the machine from a feed-chute *A* and as there are two holes to be drilled in each blank and only a single drill *B* is employed for the performance of this operation, it will be apparent that each piece must be reset after drilling the first hole, in order to locate it in the proper position for drilling the second hole. The feeding of each successive blank to the machine and the indexing of the work for drilling the second hole are automatically controlled by means of a cam-actuated mechanism, and after the finished work has been drilled, it is automatically ejected and another blank delivered to the fixture ready for the following operation.

The mechanism by which these results are accomplished may be briefly described as follows: At the back of the machine there will be seen a cam *C* which receives its motion from a sprocket chain drive. Carried by arm *E* there is a roller *D* that runs in contact with the cam. A pivotal support carries the entire fixture that holds the work to be drilled, so that connection of one end of the fixture with arm *E* results in swinging the fixture around this pivot in order to bring the opposite end of the work into position for drilling the second hole, after the first drilling operation has been completed. Reference to the form of cam *C* will make it apparent that two circular portions or dwells are provided, which allow the work-holding fixture to remain in a stationary position while either of the two drilling operations is in process. After the first operation is completed and the drill has been raised out of the hole, a rise on the cam between the smaller and larger sections of circular form results in pushing forward roller *D* and arm *E*, and thus swinging over the work-holding fixture in order to bring it into position for receiving a fresh blank. After the first hole has been drilled in a blank and the drill withdrawn from the work, roller *D* comes into engagement with a drop on the cam between the larger and smaller circular sections. Consequently the roller runs down the cam and allows arm *E* to move backward, thus swinging the fixture over into position for drilling the second hole in the work.

Jaws of V-form hold the work while it is being drilled, and secured to these jaws there are two fingers *F* which have their back ends in contact with a triangular shaped block *G*. When this block is pulled back to the position shown, it causes fingers *F* to swing about their pivotal supports so that the front ends of the fingers, which are in contact with the jaws, move inward and securely grip the work. After the second drilling operation has been completed and it is required to release the work, this result is accomplished by pushing triangular block *G* forward in order to allow a spring to draw the back ends of fingers *F* together. Block *G*, which controls the opening and closing of the work-holding jaws, is controlled by means of a bellcrank *H* that has a hook at its rear end, which is engaged by a second hook *I*. As roller *D* runs up the rise on cam *C*, it will be apparent that bellcrank *H* will also be pushed forward, because the pivotal support of this link is carried by a boss on the work-holding fixture which is caused to swing by the cam movement. It must be understood that hook *I*, which engages the hook on the back end of bellcrank *H*, is not connected to the work-holding fixture, and so it will be apparent that the forward movement of the bellcrank will result in pulling the bent end of the bellcrank under hook *I*, the only way in which this result can be accomplished being to push the opposite end of bellcrank *H* inward, thus causing the sliding triangular block *G* to move between the ends of fingers *F*.

Secured to block *G* there is a transfer slide or pusher, which is made just enough thinner than the blanks carried in feed-chute *A* to afford clearance. This pusher normally rests beneath the column of blanks in chute *A* and holds them up in place, but as cam-block *G* moves back to close the jaws for a drilling operation on a blank that has just been advanced into position, the pusher slides out from under the column of blanks and allows one to drop. Then on the next forward stroke of the pusher it engages the side of the bottom blank and advances it into place for drilling, while the pusher, on account of its thickness being less than that of the blanks, is able to slide under the next blank carried in feed-chute *A*. This cycle of operations proceeds automatically, and as a result it is only required for the attendant to put loaded feed-chutes into place and remove the empty tubes. One cheap girl operator is able to look after a number of the machines and also attend to loading the feed-chutes on the machine shown in Fig. 5.

Feed Mechanism for Center Block Reaming Machine

Use is made of single-spindle drilling machines equipped with two spindle heads, to provide for simultaneously reaming the four holes in two bicycle sprocket chain center blocks, and in Figs. 3 and 4 there is illustrated the means employed for feeding these parts to the machine. In this case the device used may be styled a combination hopper and

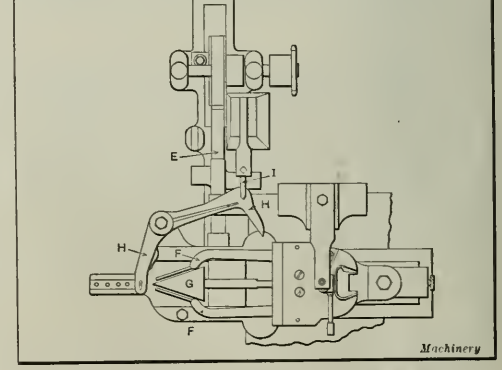


Fig. 2. Plan View of Transfer Slide and Chucking Mechanism on the Drilling Machine shown in Fig. 1

feed-chute, as it serves the double purpose ordinarily accomplished by two separate members. The work to be reamed is shown at *A*, and will be seen to consist of blocks made of steel, the cross-section of which is similar to the shape of a figure 8 with a hole through each lobe. These blocks are strung on U-shaped wires which are termed "hair pins" in the Diamond Chain & Mfg. Co.'s plant. These are held in a vertical position as shown, and the blocks slide down by gravity and are received by an automatic transfer mechanism which carries them across from the base of the wires to the chuck. The way in which this result is accomplished is as follows: Cam *B* engages the end of a cross-slide *C* that carries two vertical cam-rollers *D*. These rollers run in inclined grooves in plates *E*. As cam *B* pushes slide *C* toward the left, rollers *D* move in their inclined grooves and push plates *E* forward.

In the plan view of the mechanism shown in Fig. 4, it will be seen that each of the magazines delivers blanks at the points *F*, and sliding beneath the stack of blanks supported by each hopper there is a transfer slide *G* secured to the corresponding plate *E*. As plate *E* is pulled back, slide *G* is withdrawn from beneath the stack of blanks, allowing them to drop down on the bed of the fixture and then, as the slide moves forward on its return stroke, it pushes out the bottom blank and advances it to a position between the chuck jaws, which are V-shaped. In order to accomplish this result, the transfer slide is made slightly thinner than the blanks to be handled. The chuck jaws are secured to the ends of pivoted arms *H* which are normally held open through the tension of springs. It will be seen that on their outsides, these jaws are tapered to correspond to tapers on the inner sides of the openings in plates *E*, and as the plates are drawn back the tapers engage the corresponding fits on jaws *H* and force them inward, so that the V-blocks obtain a secure grip on the work. Each time the transfer slides *G* move forward they not only carry two blanks to positions where they can be gripped by the jaws, but also push out the blocks that were reamed by the preceding operation. The action of the mechanism is entirely automatic, thus reducing to a minimum the amount of attention which the machine requires from the attendant.

Method of Loading the U-wires

Anyone who gives at all careful thought to the question of employing a U-wire chute for feeding blanks to a machine is likely to ask the question: "How can the U-wires be quickly loaded with blanks?" It is found that this can be very simply and rapidly done by using a long-tined fork which is thrust into a container holding a large number of drilled blanks. The tines of this fork go through the holes in a large number of blanks and enable them to be quickly gathered up, but it is important to note that the spacing of the tines is such that it is impossible for two of them to go

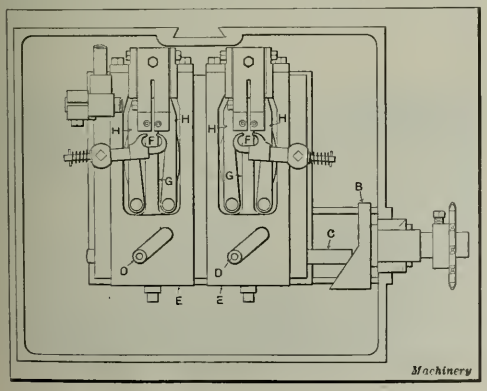


Fig. 4. Plan View of Transfer Slides and Chucking Mechanism on the Machine shown in Fig. 3

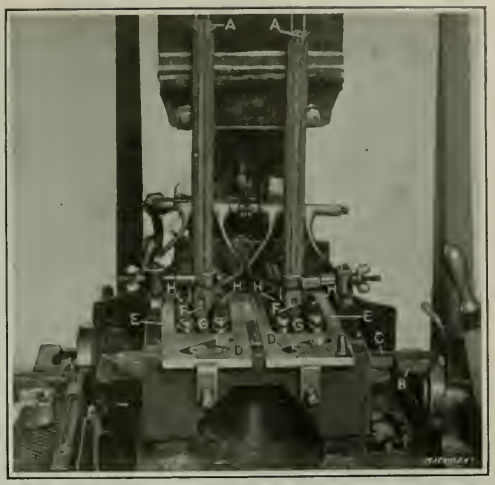


Fig. 3. Single-spindle Drilling Machine equipped with Two-spindle Head, U-wire Type of Blank-feeding Device and Cam-operated Automatic Chucking Mechanism

through two holes in the same blank. As a result the fork is lifted out of the container with a row of blanks suspended from each tine, and the girls employed to do this work have learned by experience to take a row of the blanks between their thumb and index finger and draw them off the fork with the holes in perfect alignment so that the blanks can be readily dropped over the legs of the U-wire. Experienced girls devote all their time to loading these U-wires which are then taken to the machines and set in racks ready to be put in place for delivering blanks to the machine as they are required.

Feed-chute Loading Machine

For use on machines of the type shown in Fig. 1, which are employed for drilling holes in bicycle chain center blocks, and for the performance of other operations where the work has no holes in it to provide for the use of the so-called "hair pins" or U-wires, tubular feed-chutes made to conform to the shape of the blanks can often be successfully employed. The method of using this type of carrier is the same as that governing the operation of U-wires, except that the chute embraces the periphery of the work instead of having two wires passing through holes in the blanks. In Fig. 5 there is shown a simple machine that provides for quickly loading these feed-chutes. One of the chutes is shown on the loading machine, suspended horizontally at *A*, and hopper *B* contains a quantity of the blanks to be placed in the chutes. The blanks pass down from hopper *B* through a chute *C*, which is so proportioned that it is only possible for the blanks to enter endwise, and with the axes of the two lobes of the blank in the desired position. Surrounding the feed-chute there is an agitator *D* consisting of a sleeve that embraces the chute and receives an oscillating vertical movement by means of a three-lobed cam *E*, from which power is transmitted through a cam-roller *F* secured to link *G*, which is connected to the agitator *D*.

Rotation of cam *E* keeps the agitator continually moving up and down, and thus stirs up the blanks and insures a constant flow of them through the chute *C*. Carried on the same shaft with cam *E* there is a cam *H* from which movement is transmitted to a transfer slide. At the back end of bellcrank *I* there is a cam-roller carried by pivot *J*; and at the front end of the same link, pivotal connection is made with a transfer slide which is of such a size that it just runs in slot *K*. Coiled spring *L* holds the front end of bellcrank *I* forward, thus keeping roller *J* in firm contact with cam *H*. The bellcrank is pivoted at the center and through the oscillating movement imparted by cam *H*, a similar reciprocating

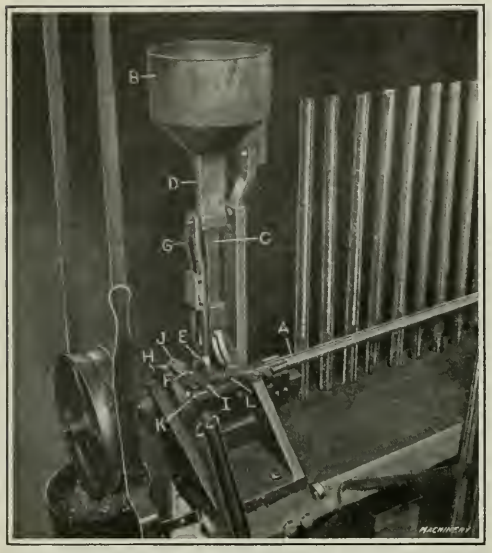


Fig. 5. Automatic Machine for loading Solid Blanks into Tubular Feed-chutes of the Kind shown in Use on the Drilling Machine shown in Fig. 1

movement is imparted to the transfer slide running in slot *K*. As a result blanks slide down chute *C* and are pushed forward into the horizontal feed-chute *A* by means of the slide, thus enabling the chutes to be quickly loaded and stood up in a rack at the back of the machine, where a supply of loaded ones is kept, pending their being needed for use on the machines to which they are to feed blanks.

U-wire Loading Machine

In some types of sprocket chains made by the Diamond Chain & Mfg. Co., there are three different members in each cross-bar of the chain, namely, a central rivet, a bushing surrounding the rivet, and a roller that fits over the bushing and comes into actual contact with the sprocket teeth. For feeding these rollers to machines that are used for performing machining operations on them, use is made of U-wires similar to those employed for reaming blocks as shown in Figs. 3 and 4. The smaller sizes of rollers are of light weight, and it has been found possible to employ an ingenious method for loading them on U-wires which hold a column of rollers on each leg of the U. The apparatus employed for this purpose is illustrated in Fig. 6 and the name "Merry-go-round" has been applied to it. This name will give the reader a clue as to the manner in which the apparatus operates. It consists of a pan that has a stationary wall to retain the bushings contained in it, while the base revolves, being driven by belt *A*. The U-wires *B* to be loaded are supported in an inclined position, and as the base of the pan revolves it carries the rollers around with it, forcing them up on the U-wires which can be very rapidly loaded by this method. The rim surrounding the rotating base is made a separate part and held stationary in order that an opening *C* may be cut into this member to allow the wires to be inclined at a very gradual angle, as the more nearly horizontal the position in which they are held, the more rapidly will the rollers be run up on the wires.

Use of Sprocket Wheel as a Transfer Slide

Figs. 7, 8, and 10 show a machine used for countersinking bushings and rollers for sprocket chains, and the form of magazine feed mechanism with which this type of equipment is provided. So far as the feed hopper and agitating mechanism are concerned, the general arrangement is similar to that shown on the machine illustrated in Fig. 5, although there is a slight difference in the way in which power is transmitted from the cam to the agitator. This is made quite clear by the illustrations, so that a detailed description is uncalled for. The feed-chute leading from the hopper makes a quarter turn to bring the blanks carried by it into a horizontal position; and these blanks enter spaces between the teeth of a sprocket wheel *A*, which carries them into place for the countersinking operation. Referring to Fig. 7, attention is called to cam *B* which operates a ratchet and pawl to provide for indexing sprocket wheel *A*, to cam *C* that operates the agitator on the magazine, and to cam *D* which applies pressure for holding down the work while the countersinking operation is in process. Located beside the work-carrying sprocket wheel *A* there is a ratchet wheel which is engaged by a pawl carried at the inner end of lever *E*, to provide for indexing wheel *A* to carry the work from the feed-chute into position between the opposed countersinking tools. Lever *E* carries a cam-roller at the outer end, that runs in contact with cam *B*, and each time the rise of this cam causes a movement of lever *E* it advances the sprocket wheel *A* through two tooth spaces and brings two new pieces of work into position to be countersunk.

During the time that the countersinking operation is being performed, it is necessary to have the work securely held against movement and this result is accomplished by means of cam *D* and lever *F*. When the two blanks have been advanced into position between the countersinking tools, cam *D* swings lever *F* downward, and this brings a notched clamp down on the work, thus serving the double purpose of holding the work in place in the sprocket wheel and preventing the wheel from turning. It will, of course, be apparent that the agitating mechanism keeps the chute constantly full of blanks and these come down and abut against the sprocket wheel. The thickness of the wheel is slightly less than the length of the pieces of work, so that a blank can drop into place in a tooth space and be carried away, allowing the following blank to drop into the next space in the sprocket wheel, this sequence of movements being continued indefinitely. Fig. 8 illustrates in greater detail the arrangement of the magazine feed and auxiliary mechanism on a countersinking machine of similar design to the one shown in Fig. 7, except that it is arranged to handle only one piece of work at a time; and Fig. 10 shows details of the work-clamping device and agitator for the magazine, which are used on this machine. Another form of magazine feed agitating mechanism for use on a countersinking machine of this type is shown in Fig. 9.

Hopper Feed Mechanism on Rivet Countersinking Machine

In Figs. 11 and 12 there are shown front and rear views of a special machine built by the H. P. Townsend Mfg. Co., of Hartford, Conn., for use in countersinking the ends of rivets used in assembling Diamond sprocket chains. This machine is provided with an unusually interesting hopper feed mechanism and means of transferring blanks from this hopper to a position between the spindles. It will be apparent

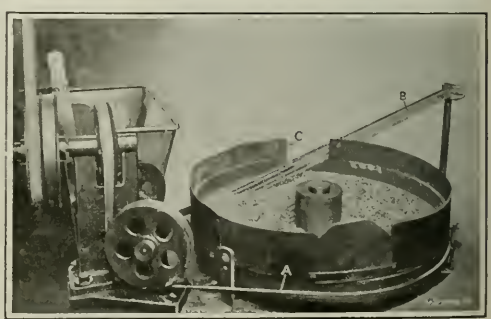


Fig. 6. "Merry-go-round" Device for loading Work on U-wire Magazines

that contained in the hopper there is a crescent-shaped agitating and elevating member *A*, which is caused to rise and fall through the action of a cam. This plate descends below the surface of the rivets in the hopper, which are of quite small size, and then rises with a number of rivets held in a groove along the top edge of the plate. As the cam continues to raise the elevating member *A*, the incline of the groove cut in its upper edge becomes more abrupt, until finally frictional resistance is overcome and the rivets held in this groove slide down into a feed-chute located at *B*. At the end of this feed-chute there is a quarter-round dial plate *C* which also has an oscillating movement imparted to it, and at the right-hand edge of the quadrant a groove is cut to receive one of the rivets *D* each time that the groove in the quadrant comes into position opposite the end of feed-chute *B*. This quadrant takes the rivet and carries it down until the right-hand edge of the quadrant, as shown in Fig. 11, is in a horizontal position. At this point a spring clip *E* carried by arm *F*, is pushed down over rivet *D* and lifts it out of the transfer quadrant. The clip then descends again until it reaches a position where the rivet can be grasped by the jaws of chuck *G*, ready to have the countersinking operation performed.

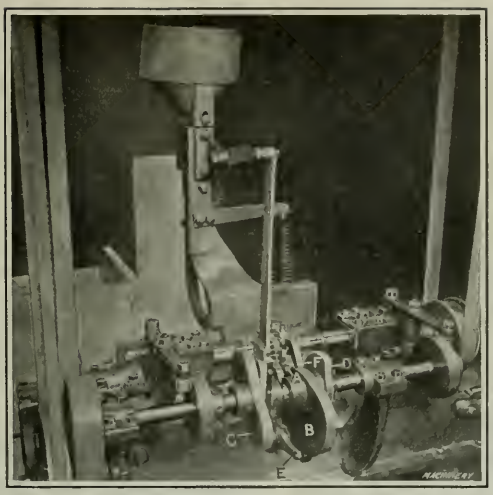


Fig. 7. Countersinking Machine with Chute to carry Blanks from Hopper to Sprocket Wheel that serves as a Substitute for a Transfer Slide

It will be apparent to any mechanic who has had experience with the use of automatic machinery that the timing of various parts of the mechanism of a machine of this kind must be very carefully worked out in order to have all of the movements properly synchronized. This result is accomplished through the medium of a camshaft extending along the back of the machine as shown in Fig. 12, by means of which the different parts of the mechanism are operated. It will be seen by reference to this illustration that there is a crank *H* carrying a cam-roller *I* that runs in contact with the under edge of the agitating and elevating plate *A*. Through the action of cam-roller *I* on the under edge of the elevating device, an oscillating motion is provided as previously described. The transfer dial *C*, Fig. 11, is carried on a shaft; and in Fig. 12 it will be seen that at the back end of this shaft there is a short crank from which a connecting-rod *J* runs down to an eccentric carried on the main camshaft. In this way an oscillating movement is imparted, which is transmitted from the eccentric through the connecting-rods, crank, and supporting shaft to the transfer dial, to provide for taking blanks from the delivery chute *B* and carrying them down into position to be picked up by the spring clip *E* that transfers the work to the chuck. This spring clip is carried at the upper end of a bellcrank lever *F*, at the lower end of which there is a cam-roller that runs in contact with cam *K* on which there are two rises and two low spots. The result is that this cam causes the spring clip to first advance to pick the blank *D* out of transfer dial *C*, after which the spring clip recedes from the dial and again advances far enough to deposit the blank in place in chuck *G*. There is another cam on the shaft which provides for opening and closing the chuck in unison with the other parts of the mechanism.

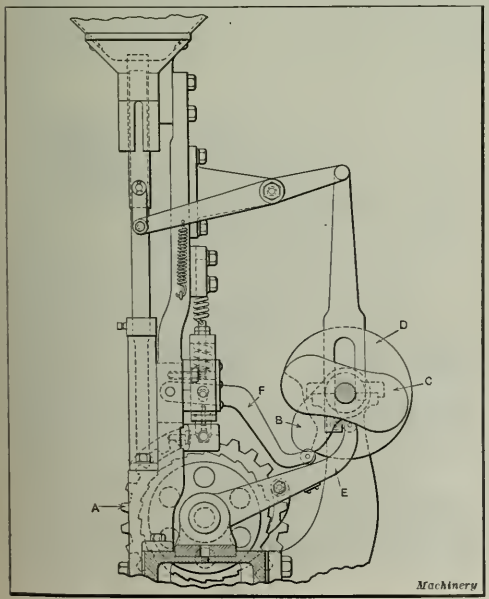


Fig. 8. End Elevation of Automatic Blank-feeding Mechanism on a Countersinking Machine

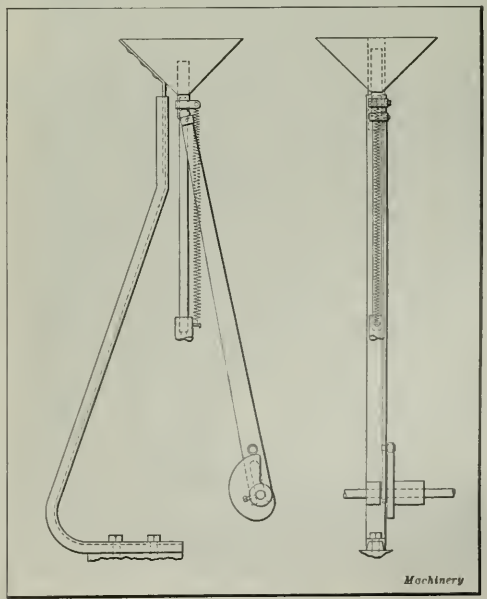


Fig. 9. Cam-actuated Agitator for Use in Blank-feeding Hopper of Countersinking Machine

Loading Pierced Blanks on Magazine Wires

Fig. 13 illustrates a power press equipped with a follow-die for use in first piercing two holes in ribbon stock and then blanking out a sprocket chain side plate from the material surrounding the two pierced holes. In a subsequent operation it is required to bevel the rough edge of these side plate blanks, that was left on the "break-out" side of the work, that is, where the blank is pushed out of the strip of steel. Machines used for performing this beveling operation are equipped with the U-wire or so-called "hair pin" type of magazine, and a great deal of time would be required to take the small pieces of work and load them on the U-wires with the break-out side of each piece at the top. To overcome this loss of time and lack of efficiency, a practice is made of having the power press on which these pieces are blanked out arranged with a magazine, as shown in Fig. 13, so that as each blank drops through the die it will be picked up on the U-wire at *A*. The press is equipped with a twin die so that two pieces of work are blanked out at each downward stroke of the ram, and so there are two wires to catch the work.

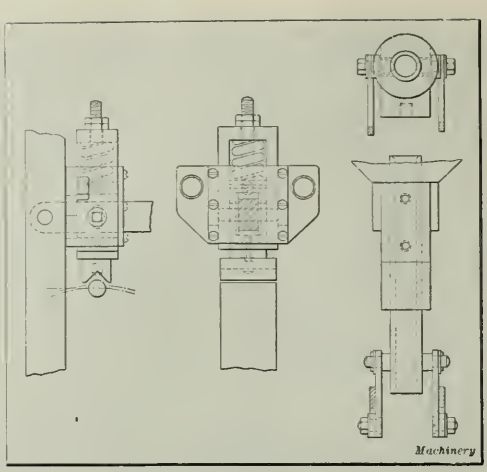


Fig. 10. Work-clamping Mechanism, and Agitator used on Machine shown in Fig. 8

A very simple method is utilized for supporting the U-wires in such a position that the blanks will drop over them. Immediately beneath each opening in the blanking die there is a pocket of sufficient size to hold a column of blanks about 3 inches in height, the pocket being arranged to stack these blanks with the holes in accurate alignment. At the bottom of each pocket there are two spring fingers with tapered sides, that are held against the bottom blank with sufficient tension to support the weight of the column of blanks in the pocket, although the spring tension will relax and allow the fingers to move back and drop the bottom blank when pressure is applied to the top of the column of blanks by the ram of the press engaging the top blank of the column when the pocket becomes filled. The column of blanks that are always held in each pocket with the holes in alignment, serves as a guide for the two legs of the U-wire which are pushed up to enter these holes. Then at each downward stroke of the press one blank is cut out of the ribbon stock and a continuation of the downward stroke of the ram applies pressure to the top of the column of blanks held in the pocket beneath the die, thus pushing the bottom blank of the column through the spring fingers which allow it to drop down on the U-wires. A short column of blanks will be seen at *B* in the illustration on each of the U-wires.

A machine equipped with an automatic feed mechanism and follow-die blanks out the work without requiring attention from the operator, and with an equipment of the kind just described it also loads the magazines ready for the blanks to be passed through the next operation that is required. There is, however, one point to which attention is called, namely, that for the following operation the blanks must be held on the U-wires with the break-out side at the top. It is for this reason that each loaded U-wire, as it comes from the machine shown in Fig. 13, is taken to a tray, Fig. 14, where the press operator very carefully withdraws the wire, leaving a row of blanks lying on edge with the holes in accurate alignment. These trays are then transferred to the next machine, when it is a simple matter for the operator to push the U-wires in from the opposite end, thus enabling the column of blanks to be set up on the machine with the break-out side at the top. Were it not for the necessity of turning the work over, it would be more convenient to have a sufficient supply of U-wires so that the columns of blanks and the

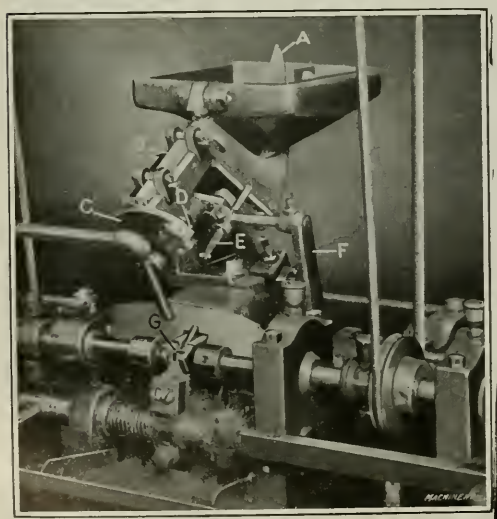


Fig. 11. Front View of Countersinking Machine furnished with an Unusually Interesting Hopper, Feed-chute, and Transfer Mechanism for delivering Work to Tools

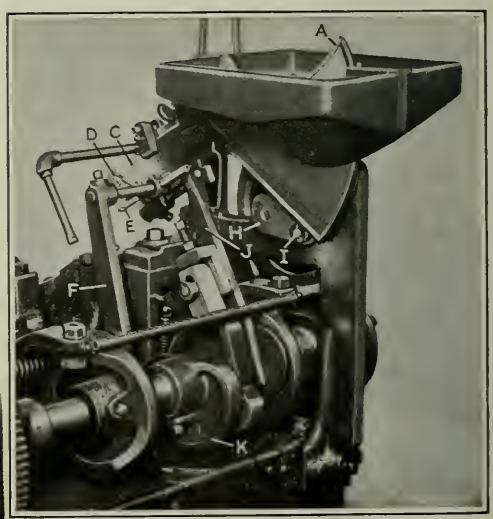


Fig. 12. Rear View of Machine shown in Fig. 11, illustrating the Arrangement of Cams and Auxiliary Links for actuating the Agitator and the Transfer Mechanism

wires could be sent right along from the machine on which the magazines were loaded to the next machine on which they are to be used.

Power Press with Magazine Feeding and Magazine Reloading Devices

It is often desirable to equip a power press with a magazine feed mechanism for delivering blanks to the dies, and if the next operation to be performed on the work is of a character where a magazine feed can be successfully employed, much time may also be saved by reloading the work into a magazine for delivery to the next machine. Figs. 15 and 16 illustrate a power press used by the Diamond Chain & Mfg. Co. which is equipped in the manner to which reference has just been made. At the front side of the machine shown in Fig. 15 there is a magazine *A*, from which blanks are carried by a transfer mechanism to a position between the upper and lower dies that perform a cold-forging operation to bevel the edge of the work. After this result has been accomplished, the transfer mechanism carries the blank over to a position beneath the hopper *B*, which is shown at the back of the machine in Fig. 16, where suitable mechanism is provided to pick the blanks up and elevate them into this hopper.

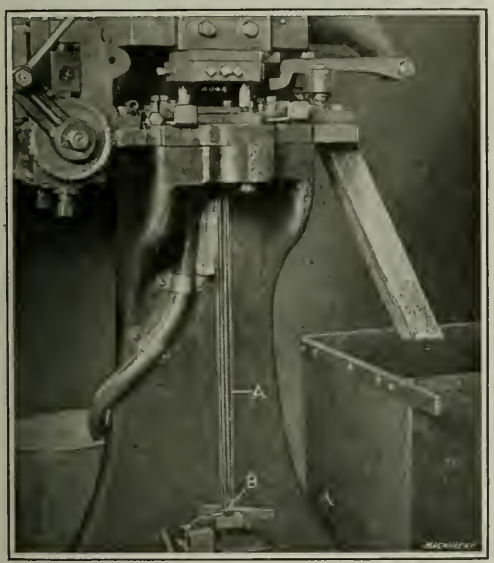


Fig. 13. Power Press equipped with Device for automatically loading Blanks on U-wire Magazine as they drop through the Blanking Dies



Fig. 14. Arranging Blanks from Machine shown in Fig. 13 in Trays Ready for Delivery to Machine for performing Next Operation

Having made a preliminary statement of the way in which the auxiliary equipment on this power press functions, we are in a position to present a detailed explanation. Coupled to the end of the main shaft on the press there is a slotted crank that imparts an oscillating motion to a connecting-rod shown at *C* in Fig. 16, and this rod, through a link mechanism *D*, imparts an oscillating movement to a slide that actuates the transfer mechanism.

In order to provide for carrying over blanks from feed-chute *A* to the dies, a pusher which is connected to the oscillating slide moves back and forth under the column of blanks. The thickness of this pusher is slightly less than that of the work, and as it moves out from under the blanks, the entire column drops into contact with the bed of the fixture; then on the next forward stroke, the end of the pusher strikes the side of the bottom blank and pushes it forward into position for the dies to perform their cold-forging operation. An approximate location is provided by the pusher, after which the blank is accurately located between the dies by means of two V-shaped jaws carried by cross-slides. These jaws engage opposite ends of the blank and locate it accurately so that the die will come down and bevel the edge.

An interesting method is employed for actuating the opening and closing of these jaws, this result being accomplished through the influence of a friction washer that is tightened sufficiently to retard the sliding movement of the pusher that transfers blanks from the chute to the dies. Attention is first called to the general outline of the mechanism shown in Fig. 15 where it will be seen that there are two bellcranks *E* which are supported by pivots *F*, so that as they swing about these pivotal supports the opposite ends of the long arms move away from each other and, through the action of crossed arms, carry the V-shaped jaws inward to engage the work in the manner to which reference has been made. The pusher that carries the blanks into the dies is not shown.

After the pusher has carried a blank into approximately the desired position between the dies and has started on its return stroke, movement of the reciprocating parts of the mechanism is retarded by the frictional resistance furnished by a screw *G*, and the fiber washer beneath this screw which is tightened on the top of sliding bar *H*. There are two links *P* which project through from the actuating mechanism at the rear of the machine, these links being connected to the ends of a block that is free to slide in the frame of the fixture. The movement of this block actuates the mechanism. Owing to frictional resistance imparted by screw *G* and the friction washer beneath it, there is a tendency at the beginning of the return stroke of the pusher, for links *P* to cause a slight movement of the block to which they are secured, rather than for bar *H* to slide. This results in imparting a forward movement to pivots *F* on which bellcranks *E* are mounted, while sockets *I* at the corner of the bellcranks, which receive the two ends of a cross-member on bar *H*, are held stationary, with the result that the long ends of bellcranks *E* are caused to move away from each other. Owing to the high ratio between the long and short arms of bellcranks *E*, a very slight movement of pivots *F* relative to sockets *I* imparts a sufficient movement to the opposite ends of the bellcranks to enable them to move the V-shaped jaws through a sufficient distance to locate the work. The long ends of the bellcrank arms move away from each other,

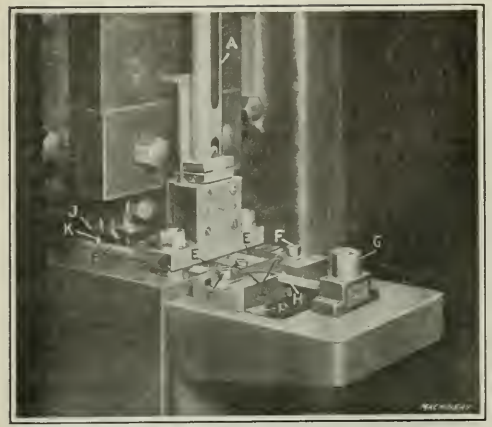


Fig. 15. Front View of Power Press equipped with Feed-chute and Automatic Transfer and Chucking Mechanism for locating the Work between the Dies

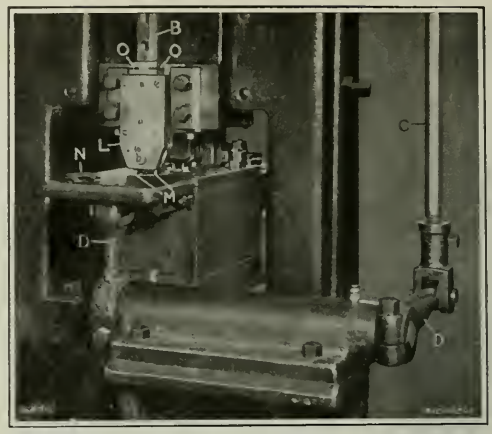


Fig. 16. Rear View of Machine showing Link Mechanism for actuating Transfer Slide and Tubular Hopper into which Blanks are automatically elevated

and for this reason it will be evident that links extending from these arms to connect with the V-blocks must overlap so that each link connects its bellcrank arm with the V-block at the opposite side of the fixture from the arm that pulls it into contact with the work. After the V-shaped jaws engage the work, further movement of the driver is made possible by the sliding of bar *H* under the friction washer at *G*.

After the operation has been performed on a piece held in the die, it is necessary to reload it into the magazine *B* at the back of the machine (Fig. 16) in the manner to which reference has been made. The transfer slide carries the work across to a position under this magazine, and secured to the bottom of the magazine tube there is a supporting box or bracket *L* that oscillates up and down with the ram of the press. Inside of this bracket there are two latches *M* which are carried on pivots, so that as the entire mechanism comes down with the ram of the press, the tapered inner faces of the latches slide over the piece of work to be picked up. These latches swing back on their pivotal supports against spring tension until such a time as the shoulders on the latches are reached. Then the spring tension causes the latches to snap in under the work and as the ram of the press rises the work is picked up. The latches just described support the entire column of blanks inside of feed-chute *B*, and after the chute has been completely loaded and it is required to put an empty tube in place, a gate *N* is slipped into the notches *O*, thus holding the blanks up in the tube so that it can be easily lifted off and an empty tube substituted in its place. Reference to Fig. 15 will show that a similar form of gate is used to hold the work in the magazine at the front of the machine.

Power Press with Hand-filled Magazine Feed

In the power presses which we have at present had under consideration, provision has been made for automatically loading the magazine ready for handling a subsequent operation. Figs. 17 and 19 show a different type of equipment in which larger pieces of work are handled and where the magazine must be filled by hand. Referring to these illustrations, the magazine is shown at *A*, and blanks put into it drop by gravity so that they may be caught by a transfer slide *B* which is slightly less than the thickness of the work. Transfer slide *B* receives its movements from a lever *C*, which is reciprocated by the link mechanism, clearly shown in the illustrations, that receives power from the slotted crank carried by the main shaft of the press. Connected to the transfer slide *B* there is a cam-block *D* that reciprocates with it. This cam-block is provided with grooves to receive rollers *E* that are carried at the inner ends of fingers *F* that

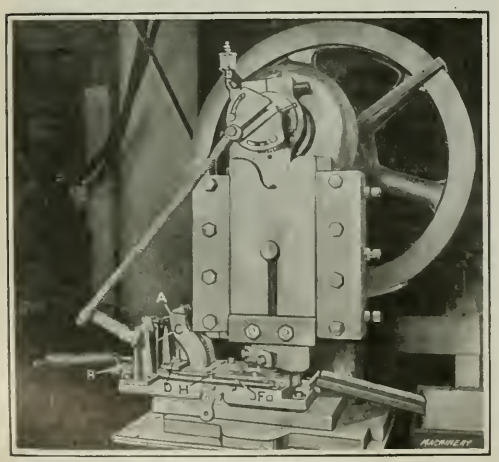


Fig. 17. Piercing Press equipped with Magazine Feed, Transfer Slide, and Automatic Chucking Device for locating Work

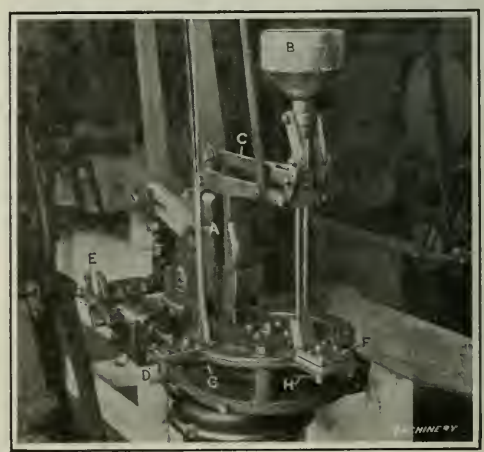


Fig. 18. Power Press equipped with Magazine for Solid Rivets, a U-wire for Pierced Blanks, and a Work-carrying Dial

actuate V-blocks *G* to locate the work under the trimming dies. As the cam-block *D* moves to the right, the rollers *E* run in contact with the outside of the grooves to cause the V-blocks *G* to be withdrawn from the work by swinging fingers *F* about their pivotal supports *H*, and as the cam-block *D* is withdrawn to the starting point, it is the inside of the grooves which engages rollers *E* to cause fingers *F* to swing about their pivotal supports in the opposite direction, thus gripping and locating the work in the desired position. It will be noticed that a row of blanks to be trimmed extends along the channel in the bed of the fixture, and after each blank has been released by the V-jaws *G*, the next forward movement of the transfer slide causes the adjacent block to the left to push this block out of the dies so that it may drop into a receiver placed in position for that purpose.

Magazine Feed Mechanism on Assembling Machine

In assembling various types of sprocket chains made by the Diamond Chain & Mfg. Co., it is necessary to press two rivets into holes at opposite ends of a piece known as a "side plate." This constitutes the first step in the process of assembling. For use in the performance of this operation a power press is employed, that is equipped with a hopper and two feed-chutes through which rivets are delivered to the holes at opposite ends of the side plate; and there is a U-wire magazine from which the side plates are fed to the machine. The power press is furnished with a dial feed with pockets around the circumference of the dial, each of which receives a side plate and two rivets, so that these parts may be carried around to the die that pushes the rivets down into the holes in the side plate. Fig. 18 shows a press equipped for the performance of such an assembling operation, and referring to this illustration it will be seen that the side plates are carried on a U-wire at *A*, and hopper *B* contains the rivets. This hopper is furnished with an agitator operated by link mechanism *C* in order to assure uniform delivery on rivets through the two chutes. These rivets drop into place in V-shaped notches in the edge of the dial, which locate them over the holes in the side plates, that are pushed into pockets located on the under side of the dial. For this reason it is necessary for the side plates as they drop off the U-wire *A* to be pushed into successive pockets on the dial. This result is accomplished by a cross-slide *D* that is actuated from a slotted crank *E* through a suitable arrangement of links and cams. A slide is also required to push the rivets forward as they drop out of the feed-chute from hopper *B* into place in the notches in the dial. The end of the slide employed for this purpose is shown at *F*, and it is actuated by an arrangement of links located under the table which supports the dial feed mechanism. Both slides *D* and *F* are returned by a positive mechanism, and their forward movement is accomplished by means of tension springs, the two springs used for this purpose being shown at *G* and *H*, respectively.

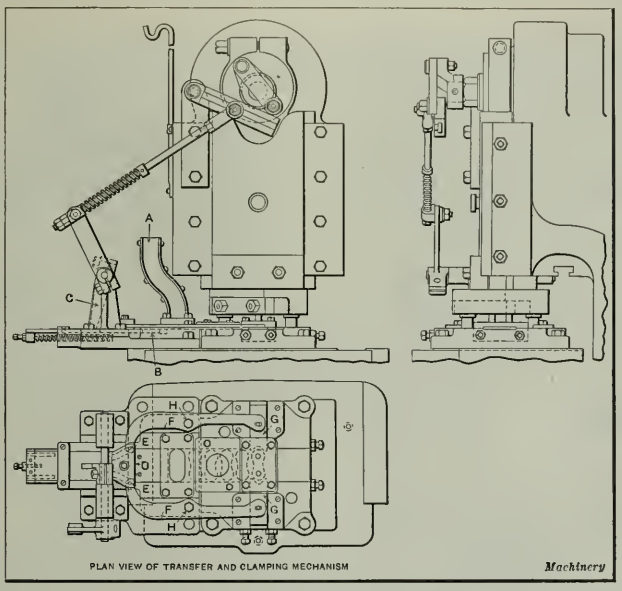


Fig. 19. Front and Side Elevations and Plan of Transfer Mechanism used on the Power Press shown in Fig. 17

Advantages of Magazine Feed Mechanisms

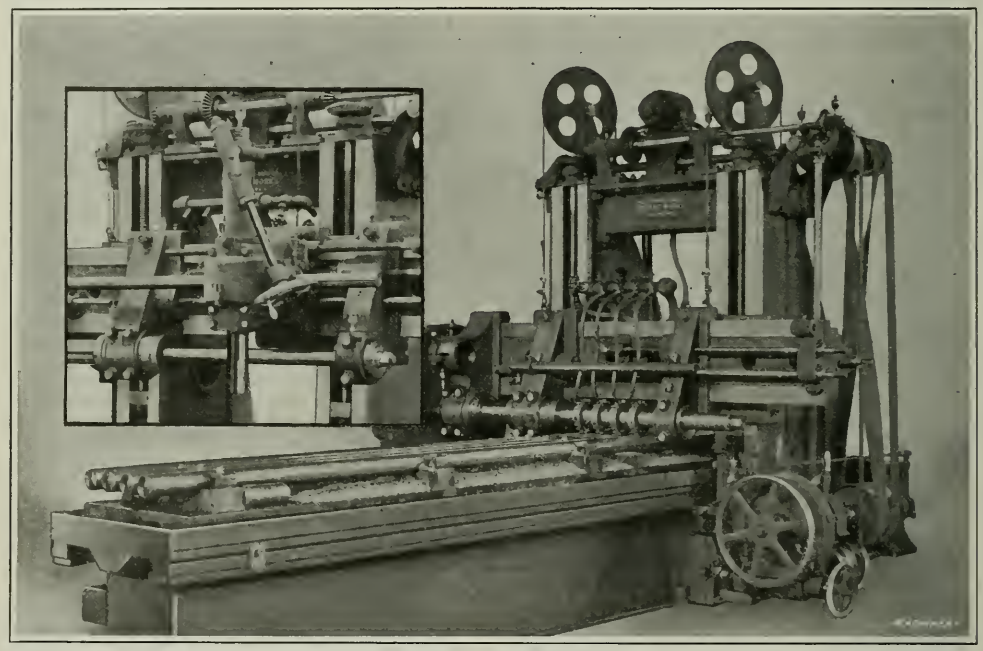
There are a number of noteworthy advantages which should commend the use of magazine feed mechanisms to the attention of manufacturers who are engaged in the quantity production of small or medium sized duplicate parts. Important among these is the fact that devices of this kind may be modified in such a way that they are well suited for handling a very great variety of work that is done by a large number of different classes of machines. In addition to this feature of adaptability, which is often a very important consideration, attention has already been drawn to the saving of idle time for both machines and their operators which is accomplished through the provision of automatic means for supplying a fresh blank directly an operation has been completed, without requiring the operator to give the machine attention each time that the piece of work on which it is engaged has been finished. There is a third factor that may assume very considerable importance during periods of great industrial activity, when the labor supply is less than the demand. It is the fact that machines equipped with these automatic feeding devices are made practically independent of the operators, who are only required to provide a fresh supply of blanks as rapidly as those contained in the hoppers become exhausted. Not only does this conserve the operators' time, and by reducing the number of operators that are needed to produce a given volume of product, make it possible to effect a corresponding reduction in labor costs against the job; but it also is a very important factor in enabling manufacturers to secure the necessary number of employes to handle their work in times when there is keen competition in the labor market. Fewer operators are required where magazine feeding devices are used, and they can be of an unskilled class and easier to find than those who have received mechanical training.

* * *

The most successful specialists are those who, after having gained a thorough general experience, devote the knowledge thus obtained to the improvement of a single type of mechanism or line of machines. Then, after having become thoroughly familiar with this product, they will be able to incorporate in their work all the experience, training, and knowledge gained from other lines. Such a specialist does not usually become narrow or one-sided. While he applies himself to a single line of thought and work, he is generally still open to new ideas, is able to see the value of improvements and can apply principles employed in other lines to the specialty to which he devotes himself. Furthermore, such a man, with a comparatively brief period of preparation, should be able to apply his mind to the solution of any problem in machine design, and to turn successfully from the problems of one specialty to those of another without having to begin at the beginning.

MILLING KEYWAYS IN LONG SHAFTS

Some shops have found it expensive to provide for cutting keyways in long shafts, where the available tool equipment does not include a machine that is well suited for handling such a job. In connection with the following description, there is shown a 36- by 36-inch by 14-foot horizontal slab milling machine built at the Bement-Miles Works of the Niles-Bement-Pond Co., 111 Broadway, New York City, for use in simultaneously cutting keyways in four long shafts. It will be apparent that four inserted-tooth cutters are provided on the arbor for milling the keyways and that a simple form of work-holding fixture is mounted on the table, which consists of cradles to support the shafts, and straps for holding them down in place. This machine was originally designed with a vertical spindle as shown in the upper left-hand corner of the illustration, to provide for using an end milling cutter for removing fillets from the ends of the keyways that are left by the curvature of the large cutters; but as the Niles Tool Works of the Niles-Bement-Pond Co., where the machine is used, do not spline any keyways except those which extend the full length of the shafts, it was considered unnecessary to provide the machine with a vertical spindle.



Niles-Bement-Pond Slab Milling Machine equipped for milling Keyways in Long Shafts—Detail View of Vertical Spindle for removing End Fillets

A carbon steel, containing from 0.30 to 0.40 per cent of carbon, is used for making the shafts on which this keyseat milling operation must be performed. These shafts are 3.686 inches in diameter by 14 feet 2 inches long, and the spline grooves to be cut are $\frac{3}{4}$ inch wide by $\frac{3}{8}$ inch deep by 10 feet 6 inches long. The inserted-tooth milling cutters were made by the Niles Tool Works and have blades made of Rex AA steel, alternate blades having one and two chip breakers. The cutters are $8\frac{3}{8}$ inches in diameter. They are driven at 12 revolutions per minute, corresponding to a cutting speed of 26.3 feet per minute with a feed of 2 inches per minute. The time required for setting the work-holding fixture up on the milling machine table is approximately eighty minutes, and forty minutes is occupied in setting up four shafts in the fixture; then it requires sixty-three minutes to actually cut the spline grooves.

In connection with the figures showing the speed and rate of production, attention is called to the fact that the driving motor was not equipped with a proper controller at the time these data were obtained, only one speed being available which was not ideal for the conditions of operation. It should be possible to mill this steel at a cutting speed of from 40 to 50 feet per minute, but the rate of feed could not be increased, as there is a tendency for the cutters to exert a tearing action on the work. Any increase in feed would cause a loss of time through making it necessary to subsequently finish the keyways. The shafts have double keyways cut in them, and the production figures refer to the cutting of one keyway. Approximately one hour would be needed to prepare the shafts for performing the second operation.

* * *

SWEDISH INDUSTRIAL STATISTICS

The Scandinavian countries, particularly Sweden, are destined to become leading industrial nations in Europe. Sweden is rich in water power, iron ore, and other minerals necessary for industrial development. In 1916, nearly 7,000,000 tons of iron ore and over 720,000 tons of pig iron were produced. Of other minerals, the manganese and zinc ores are important. The metal industry ranks first among the manufacturing industries of the country, the other important industries being wood, pulp, paper, textiles, leather, and chemicals, in the order mentioned. In 1915, there were nearly 10,000 factories in operation employing over 400,000 workers. The available hydraulic power is estimated at nearly 7,000,000 horsepower, of which in 1916 over 1,100,000 had been developed and put into operation. The increase in the foreign trade from 1910 to 1918 was 75 per cent. At present there is an active development of the abundant water power resources and a more general electrification of the railways has begun. Electric power is also being transferred by submarine cable to Denmark. It is believed that the favorable location of Sweden with reference to the principal markets of Europe, and the possession of a large merchant marine will stimulate the development of Swedish commerce and industry.

Dies for Automobile Wheel Hub

By J. BINGHAM
President, The B. J. Stamping Co., Toledo, Ohio



IN the production of a wheel hub for a small automobile, nine dies were required to complete the part. The methods pursued in the production of this hub and some of the dies employed will be described in this article. The illustrations show the dies that are to be dealt with and the appearance of the work after each successive drawing operation has been performed. Unless otherwise stated, all of the die parts are made of steel and are hardened and ground. The work was drawn from hot-rolled strip steel, 5/32 inch thick.

The first operation, which consisted of cutting the blank to a diameter of 7 inches, was performed by a blanking die of standard construction, and consequently is not illustrated. The first drawing operation on the shell was performed by the double-action type of die shown in Fig. 1, which was used in connection with a double-action press. Prior to operating, the punch *A* and the blank-holder *B* are in a raised position, with the lower face of the punch somewhat higher than the lower face of the blank-holder. The blank is placed within the gaging ring *C* and rests on the forming ring *D* and the die-block *E*. On the downward stroke of the press ram, the blank-holder descends until it comes in contact with the blank, in which position it remains and holds the blank while the punch continues to descend and draw the shell as shown. By this arrangement, pressure is applied on the blank by the blank-holder during the drawing operation. On the return stroke of the press ram, the punch is raised from the die, somewhat in advance of the blank-holder, and thus the blank-holder prevents the shell from adhering to the punch. The knock-out pad *F* is provided for ejecting the shell from the die. The punch and blank-holder are both made of cast iron.

The die illustrated in Fig. 2 is employed to make the first reduction in the diameter of the shell and to continue the formation of the flange. The shell is placed on the forming ring *A* and as punch *B* descends it is drawn to the shape illustrated. The punch is equipped with a knock-out rod which operates in the hole *C* and which forces the shell from the punch after the operation has been performed. The knock-out pad *D* is provided for ejecting the shell from the die. The punch *B* is made of cast iron. Similarly constructed dies are used to make the second, third, and fourth reductions in the diameter of the shell and to continue the development of the flange. Fig. 3 shows the shell as it appears after each of these operations. It should be noted that, in the first reducing operation, the shell was drawn to an over-all depth of 2 5/32 inches and the flange formed to a diameter of 5⅞ inches. As these dimensions are maintained during the successive reducing operations, it is obvious that as the diameter of the body is decreased, more metal is formed in the flange. It will be noted that the metal which connects the flange to the body is, in each case, formed to a large radius. By this method of gradually forming the

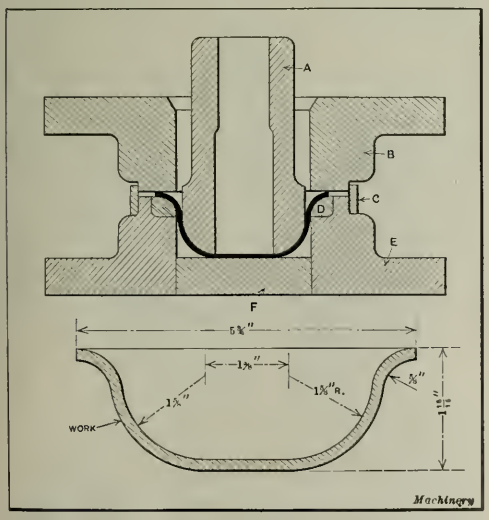


Fig. 1. Double-action Die which performs the First Drawing Operation on the Shell

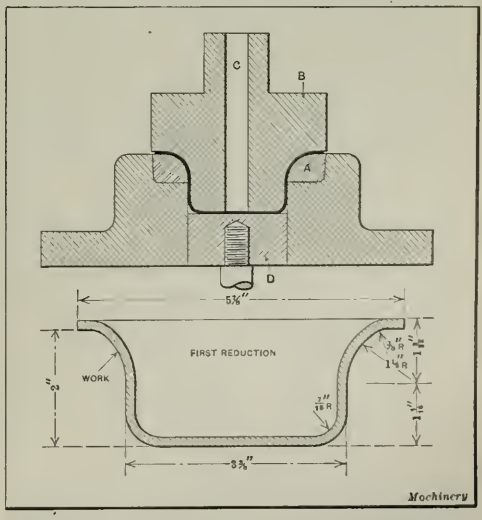


Fig. 2. Type of Die used for reducing the Body Diameter and forming the Flange

flange by several operations, comparatively large flanges can be readily produced on work of this nature.

The final drawing operation is performed by the die illustrated in Fig. 4. In this operation, part of the flange is formed to an angle of 30 degrees, a portion of the body is straightened, and the diameter of the flange is increased slightly. The next operation consists of trimming the flange to the desired diameter, for which purpose a plain blanking die is employed which is equipped with a device for locating the shell in the die properly preparatory to the operation.

The work is completed by the die shown in Fig. 5. In this operation, a hole is cut in the end of the shell and six holes are pierced through the flange. The hole is cut in the body as punch *A* passes the upper edge of cutting ring *B* on the downward stroke of the press ram. At the same time, the holes are pierced through the flange by the punches *D* as they pass the upper face of the bushings *E*. Punches *D* are held in the punch through the use of set-screws. The scrap metal resulting from punching these holes, and also the scrap from the large hole, falls through openings in the die-block into a suitable receptacle. The sleeve *G* is provided for locating the shell concentrically with the die prior to the operation. The die is equipped with stripper *H* for forcing the shell from the punches after the operation has been performed. This stripper is attached to punch-holder *J* by means of fillister-head screws. If the shell adheres to punches *D* and *A* on the return stroke of the press ram, it will cause the stripper to be raised until pusher *K* comes in contact with a knock-out bar on the machine. This is accomplished near the end of the stroke. At this point rods *L* prevent the stripper from being raised further; consequently the shell is forced from the punches by the stripper as the ram continues to ascend, which brings the shoulder on punch *A* into contact with the lower side of stripper *H*. The dies described in the foregoing were made while the writer was superintendent at the Acklin Stamping Co., Toledo, Ohio.

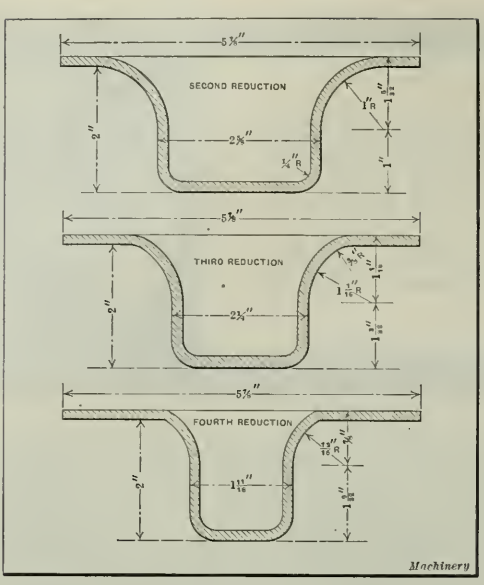


Fig. 3. Appearance of the Shell after the Second, Third, and Fourth Reductions

* * *

The Association of Railway Executives with headquarters at 61 Broadway, New York City, has published some information concerning the relation of railway freight rates to the increased cost of living, pointing out that freight rates have played a very small part in the rising cost of living. The fact that the waste of war, under-production, and other causes have added dollars to the cost of necessities of life while freight charges have added only cents is emphasized. For example, a suit of clothes that sold at $30 was carried before the war from Chicago to California for 16½ cents; today the railroads charge 22 cents for carrying the same suit to California, but the suit sells for $50. In other words, the cost of the suit has increased $20 while the freight has increased only 5½ cents. In the same way, the $5 pair of shoes that now costs $10 is carried from the New England factory to the Florida dealer for less than 6 cents at the present time, and this is only 1 cent more than the freight rate before the war.

* * *

The depression in the European industries is strikingly indicated by the condition of the Swedish iron industry. The export of pig iron from Sweden during 1919 was less than half the exports during 1918, and the same holds true of the exports of finished iron and steel.

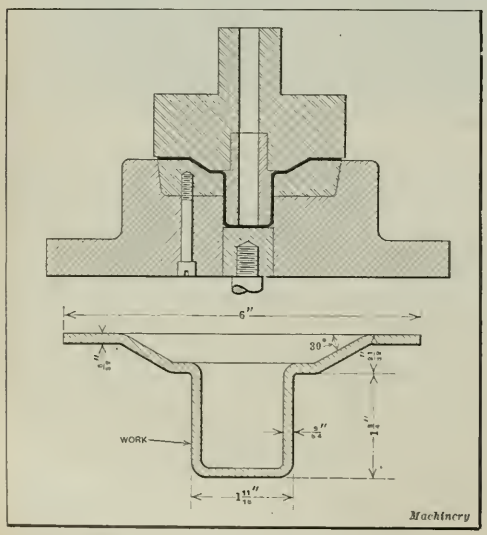


Fig. 4. Die which performs the Final Drawing Operation

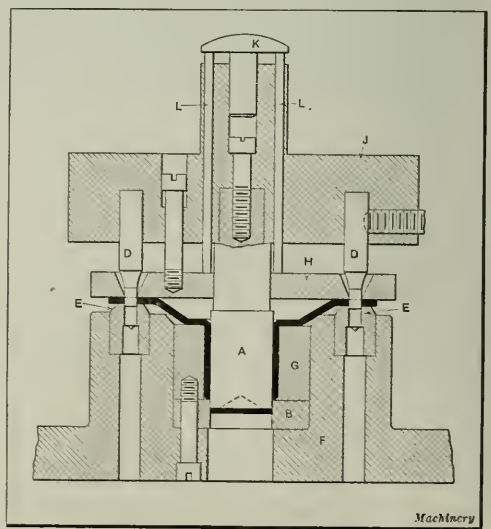


Fig. 5. Die which cuts Holes in the Flange and Body



Indicating and Recording Changes on Drawings



Description of a Method by which Alterations on Drawings may be Definitely Recorded for Future Reference

By FRED R. DANIELS

THE system used by a large machine manufacturer in recording changes on drawings is described in this article. In the manufacture of machinery on which many parts are employed, especially if such parts are subject to frequent changes, owing to minor improvements from time to time, the system will furnish a ready means of discovering the history of a changed piece. The exact state of the part at the time preceding any particular change can be readily determined, so that when entering repair orders or in ordering parts for special attachments to be applied to machines of older models, no guesswork or assumption need be resorted to in this connection. This is accomplished by consulting a card file to obtain the date of the change, and then inspecting the blueprint made on that date showing the desired change, as well as the blueprint of the previous date showing the part before being changed. A complete set of blueprints showing every change (except the most insignificant ones) that has occurred on each detail on a drawing is kept on file in suitable fireproof cabinets. These prints are so filed that they are readily accessible for inspection and are chronologically arranged by the drawing number so as to facilitate locating the desired blueprint. This arrangement will be more fully described in a later paragraph.

Simple Equipment Required in the System

Very little special equipment is employed in this system. The rubber change stamp shown on the drawings reproduced in Figs. 3 and 4, is placed on every new drawing at the time of its completion, whether it contains one detail or several, and regardless of whether or not changes are liable to occur. Frequently changes are not required, but as this is never known at the time the drawing is made, the stamp is always used, being located on the drawing, if possible, about as shown in the illustrations. Besides recording changes, the stamp is also used for each subsequent addition of a detail to the sheet or for each transfer of a detail from one sheet to another; in short, it is the indicator of all work performed on the drawing. In connection with the change stamp, a drawing change slip (thin paper) is made out by the draftsman at the time the change is made. This change slip is shown in Fig. 1. A carbon copy of the wording on the change slip is made on what is known as a change card. A change card, recording changes Nos. 4 and 5 on the drawing shown in Fig. 4 is reproduced in Fig. 2.

After making a change, the first step is to indicate it on the detail as illustrated in Fig. 4. In this instance, six changes have been made on the drawing at various times, the illustration showing just how the changes are indicated. A small circle, not more than 3/16 inch in diameter, enclosing the number of the change, with a leader pointing to the change, is placed on the drawing as shown. A similar circle and number are placed in the first space on the change stamp, together with the part number, the draftsman's initials, and the date of the change. A small spur from this circle pointing in the direction of the change assists the eye in detecting the location, which otherwise might not be readily discovered. After this has been done, the thin paper change slip and the carbon copy on the card are carefully made out.

The general wording of the change slip (and card) for change No. 1, would be as shown in Fig. 1. A circle, change number, and spur also appear on the slip and card corresponding to those on the drawing itself. This circle and spur on the slip and card may be useful as a check for the change stamp entry, and in case the latter becomes obliterated or does not properly indicate the change, its appearance on the card (which is filed in the drawing-room) will readily establish the facts. It is quite improbable that a draftsman would err in locating the circles on the drawing and then carry the error along when making out the change slip and card. The drawing number, the date of the change, the number of the changed part, the authority for making the change, and the initials of the draftsman are placed at the head of the change

DRAWING CHANGED: A-397 DATE: Nov. 19/18
PART NO: A-47 PER: W.H.P. BY: E.D.
① Changed Extension Arm A-47 by increasing size of hole from 0.875" to 0.880" to accomodate change in stud used
PATTERN: No ORDER DEPT: ✓
PERMANENT FILE: Yes COST DEPT: ✓

Fig. 1. Drawing Change Slip, which is made out by Draftsman when changing Drawings

DRAWING CHANGED: A-397 DATE: July 14 19
PART NO: A-47 PER: M E F BY: E.D.
④ Changed Extension Arm A-47 by counterboring 3/4" drilled hole 1" diameter and 1/8" deep to allow assembly of headed stud as per change in design
⑤ Changed Extension Arm A-47 by finishing hub to 0.748" by straddle milling as per complaint by assembling Department
PATTERN: No CHECKED BY: W.H.P.
PERMANENT FILE: Yes DATE: 11-25-18

Fig. 2. Drawing Change Card, which is finally filed in Drafting-room Card Index File

slip, and duplicated on the change card as shown, the slip and card then being attached to the drawing which has been changed, and sent to the checker.

Use of Change Record in Checking and for Assignment of Shop Blueprints

The information contained on the change card (Fig. 2) indicates to the checker immediately the location of the change and by whose authority the change was made. Then by securing the correspondence, or the order for the change, from the manuscript file, he can readily determine whether the changes have been made in accordance with instructions. After the drawing has been properly checked both in regard to the actual change and to see whether or not it agrees with the requirements, the checker is required to sign and date the card in the spaces indicated in the lower right-hand corner.

From the checker the drawings pass to the man in charge

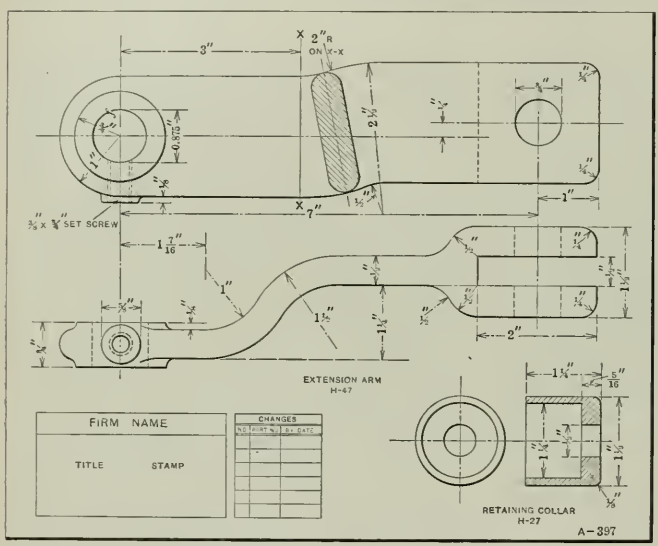


Fig. 3. Detail Drawing before being changed, showing General Arrangement and Location of Change Stamp

of sending the blueprints to the shop departments. He first investigates the change, considers its effect upon the pattern work, machine work, etc., and sends blueprints to those departments which will be directly affected. Whether or not the change affects the pattern work is indicated by him in the space provided on the card and slip, and a blueprint is sent to the pattern shop if necessary. If the change is of a minor character he will not send a print to the fireproof file, previously referred to, but in all other cases, a print is made for these files. In either event, he indicates the fact on both card and slip. He also removes the card and slip from the drawing before it is sent to the blueprinting department. This assignment of blueprints is made the first thing every morning, and the drawings, when sent to the blueprinting department, are accompanied by suitable instructions as to the number of prints to be made and also the department numbers to which they are to be sent. After the cards and slips have been removed from the drawing, the former are used by the clerk in charge of the drafting-room records to aid in making changes that may be necessary in the drafting-room files. The cards are then filed in chronological order in the drafting-room, and constitute a permanent reference file. After the cards have accumulated to the maximum capacity of the file, the older cards should be removed and preserved indefinitely in an auxiliary file or box.

How the Change Slips Affect Records of the Order Department and Cost Department

The change slips are first sent to the order department. This department has charge of preparing lists of parts required for all orders, and in conjunction with maintaining these records the slips are referred to as a means of detecting any change which will affect directly or indirectly the order sheet or list of parts. From this department investigation is carried on in the shop to ascertain whether the required change on the piece has actually been made in accordance with the drawing change. It is in regard to those changes which affect the machining operations rather than the design that the order department is chiefly concerned. The reason for this is, of course, that many changes occur such as No. 1 or No. 3, Fig. 4, and it is evident that changes of this nature affect directly the size of the studs or shafts on which these parts are assembled, and indirectly, in many instances, a great many other parts, so that it becomes necessary to change the order accordingly.

After the slip has been used to revise the orders in the order department, it is checked as shown in the lower right-hand corner of Fig. 1 and sent to the cost department. The cost department is also vitally concerned in the machining operations as affected by the change. In the manufacturing plant in which this system was employed, a piece-work system is used; consequently it will at once be evident that changes which affect machining operations must necessarily result in a readjustment of the piece ratings, not only for the actual machining but also for assembling, trucking, etc. It is the duty of the cost department to investigate the change and to make the proper rate changes to agree with the additional or reduced time consumption. In most cases, changes in machining operations will affect the jigs and fixtures, and the additional expense incurred must, of course, be taken into consideration when rearranging the cost accounts. The receipt of the slip by the cost department is also acknowledged by a check mark as shown. These slips are finally filed in this department.

Examples Illustrating the Practical Value of the System

When a new part is added to a drawing, the procedure is not different from that followed when changes in detail are made. If the detail H-27, Fig. 3, had been added or transferred to the sheet after the drawing had originally been made, an index circle and spur pointing to the pattern number would be entered in the stamp just as though a change had occurred. There is a date in the title data stamp which indicates the date on which the drawing was made. All other subsequent additions can be readily traced by means of this date and the date opposite the circle indicating the addition. Fig. 3, however, shows the drawing as it would appear when the two details are simultaneously drawn. The first change (see Fig. 4) occurs on the extension arm H-47 and consists of changing the size of the hole from 0.875 to 0.880 inch to accommodate a change in the diameter of the stud employed. Of course, the reason for changing the stud would be stated on the change card which accompanies the drawing of the stud. The change slip and card for this change would be worded about as shown in Fig. 1, and should be complete enough to furnish all information that would be required in looking up the change. However, if this does not satisfy the requirements, the correspondence connected with the change may be readily found in the manuscript file entered under the name of the part changed or under some

other heading which will readily identify it. In this case the authority is W. H. G., these being the initials of the man from whom the change order was originally received.

If often happens that the nature of the change is such that it affects the pattern work, particularly in the case of interferences in the operation of the machine. Change No. 2, Fig. 4, consists of adding a reinforcing rib for additional strength, and of course, this affects the pattern work, but it would not ordinarily change the method of molding. It is frequently necessary to throw away old castings of changed patterns which may be in storage. The determination of this question is the prerogative of the chief draftsman, and decision is arrived at after consultation with the foreman of the pattern shop. If, however, it is possible to use the pieces at some future time on orders of an early model, for instance, these parts will be retained in storage and the records properly changed to indicate this fact. In the case of change No. 2, however, it would be unwise to keep the castings in storage, because this change was made to assure additional strength. Therefore those castings without the rib would obviously be too weak and not suitable for use. When the change in the pattern affects the process of molding, the method of handling the change is directed by the foreman of the pattern shop.

In rare cases the change is such as to necessitate an entirely new pattern on account of the molding proposition. This contingency, however, is always guarded against in the drafting-room. Change No. 3 also affects the size of a hole, but in this case the hole was previously not finished, so this change constitutes establishing a new machining operation. This is a matter to be taken care of by the cost department, and necessitates the making of a jig or some form of holding arrangement.

Further Examples of Recording Changes

It will be seen that the dates of changes No. 4 and No. 5 are concurrent but that a different change number is used for each change. This eliminates the possibility of overlooking the fact that two changes were made at the same time, which would be liable to occur if only one change circle and two spurs were employed. Fig. 2 shows the change card as made out for these two changes. As in the previous instance for change No. 1, the wording is such as to furnish adequate information when investigating the exigency for making the change (as the order department in entering repair orders is frequently required to do). This investigation may bring to light the fact, for instance, that a certain change was made in order to facilitate assembling. Facilitating assembly does not usually entail an appreciable amount of saving, except where large quantities of parts are involved; therefore the extra amount of energy required to assemble the unchanged part on the repair order is negligible. The storage records may show that there are a few unchanged castings of this pattern in stock. The repair order man's problem is then immediately solved and the unchanged part is sent on the order, which results in a considerable saving in time and labor.

Change No. 4 consists of counterboring the ¾-inch diameter hole to a diameter of 1 inch, ⅛ inch deep. The blueprints for this change would, of course, be sent to the drilling department. Change No. 5 is an entirely new operation because the piece was not formerly finished on the hub. This change demands that a blueprint be sent to the milling department and a new piece rating must be established. Change No. 6 illustrates the procedure when a change is made upon a change, which sometimes occurs. It will be noted that the indicating circle for the No. 3 change remains as formerly, and in connection with the corresponding change card will tell the story quite clearly. This change is simply an increase in the size of the finished hole from 0.505 to 0.567 inch.

Contrary to what might be believed, the appearance of these circles and pointers does not confuse the reading of the drawing but, on the other hand, they stand out prominently as distinct, separate indicators. It rarely occurs that more than one change stamp is required on a drawing. Sometimes this does happen, however, and sufficient allowance should be made by the detailer in arranging a drawing to permit the use of an additional stamp if necessary. If the change in the piece is quite radical it may be advisable to redraw and rearrange the drawing. In this case the old sheet is preserved and filed in a separate cabinet. This enables the redrawn sheet to start anew with no changes

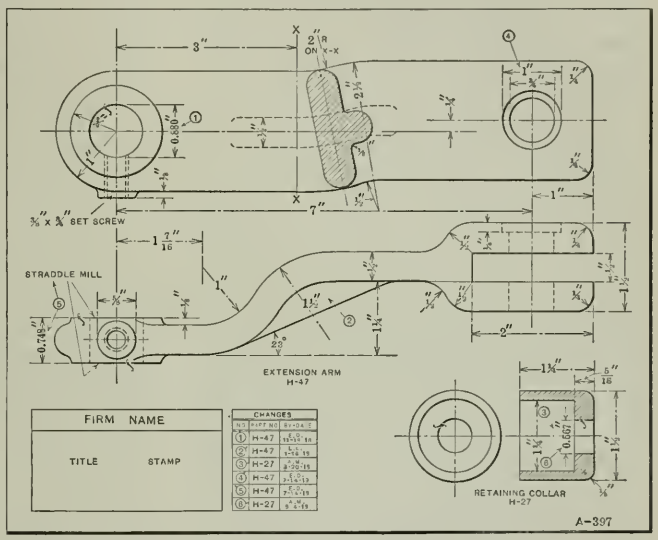


Fig. 4. Appearance of Drawing shown in Fig. 3, after a Series of Changes has been made on the Details

appearing on it, but as an indication that the sheet has been redrawn, a note stating that fact with the date of the redrawn sheet is entered at the lower margin of the new drawing. The new date in the title data stamp will furnish the date of redrawal.

How the System is Utilized by the Order Department when Entering Repair Orders

The cabinet files previously referred to in which the blueprint of every change is preserved as a permanent record are for general use and are very carefully maintained. The order department, in handling orders for repair parts or for separate attachments, can readily find the blueprint of the desired date by consulting these files. It often happens that ten or a dozen, or even more blueprints of the same number of various dates are filed in this cabinet. Thus, in the case of drawing A-397, Fig. 4, there would be six prints, one for the original drawing and five for the five dates on which the six changes were made.

As an illustration of the value of this system to the order department on repair work, let it be assumed that on September 29, 1919, an order was received for the retaining collar H-27 for repairs. The man handling this particular job would first obtain from his records the entry date of the original order for which the desired repairs are required. The repair part must conform in every important detail to

the design of the part on the entry date, which, for example, may be December 6, 1918. If it is discovered that changes have been made and if the order department records do not furnish sufficient information to establish beyond all doubt the nature of the change, the first step would be to consult the change card in the drawing-room card file. Evidently the order department records show that changes have been made on the part on March 20 and September 4, 1919. In the card file a number of cards for both these dates may be found, but it is only a matter of a moment to select the desired cards from which it would be found that on March 20, 1919, a change had been made on the hole, and that on September 4, another change had occurred on the hole. The wording on the cards should be such as to furnish all the information that would be desired. Since the date of the original order (December 6, 1918) for which the repair is required is prior to that of either change, the fact has been established that those finished parts now in storage cannot be used on this order. The next step would probably consist of determining from the storage record whether or not any parts of No. 3 change are carried in the storage bins, for it is obvious that such parts can be used on this order since the hole was then merely changed from ½ inch to 0.505 inch diameter.

If the change cards do not furnish complete information the permanent blueprint file may be resorted to, in which, under the proper date, a blueprint for each change will be found, indicating the exact nature of that change and the appearance of the piece before it was changed. It is evident that this method is especially valuable in the case of repair parts which are so old that no authentic records of them have been made. For such parts it is assumed that the piece to be sent on repairs would be so described that identification could readily be made; if not, a rough sketch of the part or the broken or worn casting itself is usually required.

In connection with making changes, it may be well to mention a fact which is of considerable importance when making erasures on drawings. The original drawing of the extension arm H-47, Fig. 3, shows a section through the offset curve. This perhaps was necessary to avoid making an additional view, or perhaps the proper space for making a separate section was not allowed. In any event, the addition of the rib, change No. 2, Fig. 4, would ordinarily require that a separate view be drawn. However, by drawing in the web and changing the section as shown, the necessity of making a new drawing at this time is eliminated and the drawing work greatly reduced. Should this sheet ever be redrawn, a general rearrangement in this regard would probably be made at that time.

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SCIENTIFIC MANAGEMENT AND LABOR

The *Bulletin of the Taylor Society* calls attention to the almost incomprehensible opposition on the part of the American Federation of Labor to scientific management. Doubtless this opposition is due to a misunderstanding of the aims and objects of this method of management. Organized labor, it seems, is inspired by fear that the differential rate system would impair one of the fundamental principles of the labor unions—the union rate. The management of the American Federation of Labor also appears to have accepted certain opinions held by a great many workers, such as, that increased output will cause unemployment and other erroneous ideas concerning the operation of scientific management, which do not conform to facts. As a matter of fact, scientific management is nothing but a method whereby everyone's labor is made to count for more than it did formerly, and as each individual's labor becomes more productive, his earnings are also increased. Neither organized nor unorganized labor can possibly suffer from a proper application of scientific management. On the contrary, the earnings of all will increase, because earnings depend upon quantity of production. Furthermore, this is the only way in which prices will ever be reduced.

A MACHINE TOOL BUILDER'S OBSERVATIONS OF PRESENT EUROPEAN CONDITIONS

Commenting upon the conditions abroad, Charles D. Oesterlein of the Oesterlein Machine Co., Cincinnati, Ohio, who recently returned from Europe, calls attention to the difficulties under which the industries in Europe generally are working at the present time. Germany particularly is in a difficult position due to the lack of means of transportation, as it has not yet been able to replace the rolling stock that under the armistice conditions had to be turned over to France. It seemed to Mr. Oesterlein that about one-fourth of all passenger and freight cars in France were formerly German, as indicated by the double eagle which had only a white cross painted through it. Germany is also turning the surplus stocks of all kinds of materials and goods into cash at a great sacrifice in order to close a deal. This is particularly true of machine tools. Last fall, for example, there was an entire shipload of machine tools forwarded to Italy, two-thirds of which were unloaded in Genoa and the other one-third at Naples. One German firm has already opened offices in Milan and others have commercial travelers doing business in Italy. In a large meadow near Delft in Holland, thousands of machine tools were unloaded in the open and prospective buyers were asked to name their own price for them. It would appear that the reason for the selling off of German machines and goods in this manner is mainly because of the critical shortage of food, coal, and other raw materials, making it necessary to sell whatever can be sold to be able to buy some of these necessities. Austria and Poland seem to be in a still worse condition and the industrial situation in Italy is not much better. With the exchange situation as it is at present, the conditions seem quite grave.

All this has a bearing upon foreign machine tool trade. Imitations of American machines are frequently seen especially in the neutral countries where the machine tool industry was largely developed during the war. Mr. Oesterlein mentions having seen a cylindrical grinding machine of exactly the same type as the No. 8 Brown & Sharpe machine and asked what firm was making this machine. The answer was that in Sweden alone, eleven different firms imitated this machine. Four copies of an American milling machine were also seen. In Switzerland, where before the war there were only a handful of machine tool builders, of which only one was important, there are now approximately 150, this statement being based upon statistics published there. Mr. Oesterlein was surprised to see imitations of his own milling machine built in Christiania, Norway. In a similar way other industries have been developed in most of the neutral countries because during the war they were unable to obtain the products required from the former sources of supply. Mr. Oesterlein concludes by stating that American machine tool builders before making extensions to present plants to take care of immediate domestic business, should give thorough consideration to the European situation and the question as to how much foreign trade will be available in the future.

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National Safety Council, 168 N. Michigan Ave., Chicago, Ill., requests manufacturers to make use of the Safety Council's library, which is a working reference library specializing in safety literature. A small booklet has been published describing this library and information bureau, calling attention to how safety engineers may make use of the library to the best advantage. It is pointed out that the library of the National Safety Council is a service bureau for all interested in safety literature, and that the library is always glad to give assistance freely. The council has also increased the scope of its activities along other lines by the publication of a weekly news-letter called the *National Safety News*, and by the preparation of posters emphasizing the need of care and thought in order to avoid accidents.

TRAINING FOREMEN IN EFFICIENCY METHODS

The Warner Gear Co. of Muncie, Ind., has inaugurated a plan of training for their foremen and other members of the supervisory force which is of considerable interest. A class of one hundred men has been formed to pursue a course in modern production methods, which comprises the study of specially prepared text material, the solution of practical factory problems, and the discussion of this material at six bi-weekly meetings held in the plant after hours. These meetings are providing an opportunity to bring home the application of the work to the special production problems of the company. At each meeting a lecture is delivered by an experienced production man, which is followed by a round-table discussion. Included in the group, besides foremen, are the chief plant executives, which insures that the policies of the management will be correctly interpreted to the members of the class. The subjects covered in the training are: (1) How to promote teamwork in the shop; (2) handling workers by methods that make for harmony and efficiency; (3) improved methods of factory organization; (4) handling materials and equipment productively; (5) reducing costs and stopping leaks; and (6) modern ideas of management. The course is conducted under the direction of the Business Training Corporation of New York, who supply the text material and the instruction service. The lectures are also given by the staff of the Business Training Corporation. The course is not technical but deals in basic facts and principles.

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SPRING MEETING OF THE A. S. M. E.

The spring meeting of the American Society of Mechanical Engineers will be held at St. Louis, Mo., May 24 to 27, with headquarters at the Hotel Statler. In view of the interest throughout the Mississippi Valley and in the territory contributory to it, one session will be devoted to a discussion of river-transportation problems, and the movement now under way for the development of transportation on the Mississippi River, with New Orleans as the port for shipment of goods to South American and other countries. Another session will be devoted to the subject of the valuation and appraisal of industrial properties, using as material the papers presented at the last annual meeting, upon which discussion is being solicited by the Committee on Meetings and Program. Papers are also in prospect on fuels, oil engines, measurement of the flow of water, transmission of heat, pumping engine tests, airplane design, etc. A paper is to be presented by the recently elected honorary member of the society, A. C. E. Rateau, of France, on "Turbo-compressors for Increasing the Power of Airplanes at High Altitudes." It is also expected that papers will be presented by the Mid-Continent Section, representing the oil districts of Oklahoma, on subjects relating to the distribution and use of oil for industrial purposes. In addition many papers of general engineering and industrial interest will be presented.

MEETING THE INDUSTRIAL DEMAND FOR TECHNICAL MEN

Realizing that technical schools are not serving the industries to a maximum degree, the Technology Clubs Associated have called a meeting at Drexel Institute in Philadelphia for March 25 to 27, at which plans will be discussed for more adequately meeting the industrial demand for engineers. The president, Dr. Hollis Godfrey, who was chairman of the engineering education section of the Council of National Defense during the period of the war, foresaw an alarming shortage of trained men. He saw that there was much waste in present technical education and that to eliminate this waste the requirements of industry for the engineer must be specified exactly. The following plan therefore was formulated: Educators, who were also engineers, were sent out into the industry to make a study of manufacturing processes and determine what knowledge was essential if men were to be successful in the various fields. These men called conferences of executives and obtained facts from them regarding training. They attended foremen's shop meetings and talked with operators at their machines. Every possible effort was made to determine the industrial demand upon the educational institution. The findings thus obtained, together with the suggestion of the representative plants visited, were submitted to a board of educational experts, who outlined courses and formulated plans to meet the demand with the possible educational supply. At the meeting of the Technology Clubs Associated there will be gathered representatives of educational institutions and of industry, and a composite plan for future education will be worked out. The results of the preliminary studies and of the meeting will be put into a permanent record in book form.

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A COMPARISON OF EXCHANGE RATES

In a recent issue of *The Nation's Business*, published by the United States Chamber of Commerce, a comparison is made of exchange rates at various intervals from July, 1913, to December, 1919, under the heading "What Does a Dollar Cost Abroad?" In giving the present value of the dollar abroad, a comparison is made with the normal exchange rate or the average exchange rate previous to the war. It is of the greatest importance to the American manufacturer who finds his foreign trade curtailed, to take note of the present conditions abroad in regard to the exchange rates. It is interesting to see, for example, that trade with Spain, Holland, and Japan is not appreciably influenced by abnormal exchange rates either one way or the other; whereas, trade with France, Belgium, Italy, and Germany is facing extremely unfavorable conditions at present.

As a comparison, the following figures giving the relative value of the dollar apply to the exchange rates February 10 of this year: England, 1.45; France, 2.80; Belgium, 2.70; Italy, 3.60; Switzerland, 1.16; Spain, 1.10; Denmark, 1.82; Norway, 1.54; Sweden, 1.44; Holland, 1.06; Germany 23.0; Japan, 0.98.

VALUE OF THE DOLLAR FROM 1913 TO 1919

Countries	July 1913	July 1914	July 1915	July 1916	July 1917	July 1918	May 1919	June 1919	July 1919	August 1919	Sept. 1919	Oct. 1919	Nov. 1919	Dec. 1919
England	$0.998	$0.997	$1.019	$1.021	$1.021	$1.021	$1.021	$1.049	$1.059	$1.115	$1.160	$1.160	$1.167	$1.215
France	1.000	0.995	1.094	1.139	1.109	1.099	1.169	1.206	1.248	1.401	1.571	1.650	1.700	1.597
Belgium	1.006	1.001	.....	.....	.....	.....	1.223	1.254	1.289	1.457	1.605	1.644	1.605	1.814
Italy	1.024	0.996	1.187	1.229	1.395	1.698	1.439	1.524	1.534	1.659	1.864	1.876	2.084	2.379
Switzerland .	1.001	0.996	1.039	1.031	0.922	0.764	0.951	0.994	1.041	1.071	1.090	1.077	1.077	1.057
Spain	1.076	1.075	0.965	0.955	0.834	0.696	0.947	0.960	0.973	1.006	1.009	1.007	0.998	0.975
Denmark ...	1.002	0.999	1.017	0.924	0.926	0.859	1.072	1.133	1.136	1.210	1.239	1.239	1.255	1.330
Norway	.....	.....	1.001	0.919	0.919	0.846	1.038	1.061	1.072	1.130	1.165	1.155	1.178	1.246
Sweden	.....	.....	1.001	0.918	0.884	0.755	1.002	1.047	1.041	1.076	1.100	1.094	1.121	1.196
Holland	1.002	0.999	1.005	0.968	0.974	0.796	0.995	1.024	1.031	1.061	1.079	1.068	1.057	1.054
Germany	1.000	1.000	1.159	1.304	.....	.....	.....	.....	.....	3.967	5.471	5.447	7.329	10.136
Japan	0.999	0.999	1.009	0.987	0.972	0.940	0.968	0.963	0.977	0.977	0.987	0.984	0.984	0.989

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THE ERA OF THE AUTOMATIC MACHINE

Since the automatic screw machine was first conceived by the pioneer machine tool builders of New England, its development has been continuous, until today it is an indispensable machine tool in many lines of work. Yet we are only at the beginning of the real era of the automatic machine. The war did more than any other factor to necessitate its use, for previous to that, while automatics were coming into more and more general use in America, most of the European countries were restricted users of these machines on account of their lower labor costs.

Now that labor all over the world is demanding higher wages and shorter hours, production cannot be maintained except by the ever-increasing use of automatic machinery in the manufacturing industries, so that quantity output may be maintained in spite of shorter hours.

The designer of automatic machinery encounters numerous interesting problems, for in no other class of machinery is there a greater opportunity to introduce ingenious mechanisms and carefully thought out mechanical movements. "Magazine Feed Mechanisms"—the leading article in this number of MACHINERY—deals with one of the many phases of this problem, and the mechanisms therein described are selected from automatic machines taken from an industry where machines of this type had been developed to, perhaps, as great a degree of perfection as in any other mechanical industry—except the manufacture of watches. The mechanisms described are employed in machines used in the making of driving chain, a product which must be produced both accurately and cheaply. The examples show some of the many ingenious devices developed in one branch of automatic machine design.

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TRADE WILL FOLLOW EDUCATION

That trade follows the flag was the old idea by which enterprising statesmen justified themselves in extending, by whatever methods, the colonial possessions of their nations. But the real statesman of the new era—the man who today extends the power and influence of his nation abroad—is the business man who engages in international trade. He has invented a new maxim—*Trade Follows Education*. Instead of colonizing in distant parts of the world, he has found that the surest way to obtain the trade of foreign peoples is to educate them in regard to the use and the quality of the things he wants to sell them and to win their confidence by fair methods and square dealing.

On page 616, Julean Arnold, American commercial attaché at Peking, China, who speaks from an experience of eighteen years in the celestial empire—now the celestial republic—points out that the most certain way in which the American machine-building industries can obtain Chinese trade is by educating Chinese engineering students to appreciate the practical usefulness and superior merits of American machinery. The British maintain an engineering college at Hongkong, and previous to the war the Germans had a similar college at Shanghai. Mr. Arnold makes it clear that by so doing those countries were able to greatly further their trade with China.

America maintains no great engineering college in the Far East, but one well-known American machine tool manufacturer, realizing the importance of general educational facilities maintained by America, has individually endowed such institutions under the auspices of the Young Men's Christian Association. If one man alone can accomplish so much, what could not be done for the future of American trade in China, with its great potential markets, if American manufacturers as a whole would endow a really worthwhile engineering school in that country, preferably at Shanghai. Here Chinese students in engineering would be made familiar with American machinery, American manufacturing methods and American ways of doing business, and as these men later would be the leaders in Chinese industries, it is easy to understand how, through educational facilities, a closer relationship would be created between the two nations.

This question should be earnestly considered by the large associations of manufacturers and by the Chamber of Commerce of the United States. China is the greatest of the less developed but highly potential markets at the present time. The large European nations have their eyes fixed on the Chinese market and are using every means to obtain the future trade of the country. Americans have the advantage of being regarded with a more friendly feeling in China than any other nation. Why not cement that friendship by some definite constructive work that will not only advance the cause of practical engineering education in China on American lines, but will also build up a closer trade relationship between the two nations? Mr. Arnold, the commercial attaché of the American Government at Peking, is in a position to give complete and detailed information upon the subject to any manufacturer or association that wishes to take active steps in this connection.

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INCREASED EFFICIENCY A RESULT OF THE STEEL STRIKE

An interesting result of the steel workers' strike is reported by steel companies operating in Mahoning Valley, Ohio. It appears that in steel mills in this district there has been a noticeable improvement in the efficiency of labor as a result of the strike. During and after the strike many new men came into the mills who rapidly learned the trade, and as they started without preconceived ideas as to the amount of work they should perform in a day, their efficiency in many cases is greater than that of the old employes. In the past, it is said, many of the men restricted their production to a certain definite amount; and not only did they limit their own output but they also discouraged others, particularly new men, from setting a better pace. If the strike has aided in correcting this condition and if greater efficiency, larger production and better quality is the result, the new men have struck the keynote; for it is only through increased production that higher wages can be paid.

Recent Impressions of Industrial Conditions in Europe

By CARL F. DIETZ, Vice-president and General Sales Manager, Norton Co., Worcester, Mass.

Having just returned from Europe after a four months' stay, Mr. Dietz's observations on the European industrial conditions will prove of interest and value to American manufacturers. During his visit to Europe, Mr. Dietz had an opportunity to obtain first-hand information on the situation in England, France, Belgium, Holland, and Germany, and in view of the increasing difficulties with the foreign trade, due to the abnormal exchange rates, an accurate statement of present conditions, which have changed materially in the last few months, is indispensable.

EUROPE is in at least as great a chaotic state economically if not greater than that indicated by the picture that we have obtained through the medium of the press. Because of the marked difference in the industrial situation in the various European countries, any attempt to generalize would be futile. Much of the information published in the daily newspapers appears to be based upon rather superficial observations, or incomplete information, and should generally be accepted with caution. This is particularly true of some of the statements that have been made with regard to Germany—as exemplified by the claim that German workmen have volunteered to give an extra hour or two gratis, or to work twelve hours a day, to help in quickly rehabilitating the German industries. Not one instance of this was observed during my stay in Germany, nor did I hear of any such condition existing there in any part of the country. This is merely mentioned to indicate the unreliability of the stories circulating in the daily press. In the following paragraphs the general conditions in England, France, Belgium, Holland, and Germany will be briefly reviewed as they existed about January 1. No important change has taken place since then in any of the countries visited.

Industrial Situation in Great Britain

In Great Britain there is a very strong effort, already productive of visible results, to revive and expand the pre-war industries and to create new ones. In every field where there are large markets, domestic or foreign, industries are being established on an extensive basis, and the principle of mass production is being developed in the same manner as in the United States. This is especially apparent in the automobile, truck, machine tool, and small tool fields. There is a marked tendency toward industrial consolidation, and the bringing together of coordinated industries under group management, thereby utilizing the best industrial executive brain capacity of Great Britain in the most effective manner, and under a broad comprehensive plan. The well-known machine tool building combination is one example of this, and a still more significant one is the large consolidation of steel-making and machine-building plants for the production of automobiles. The aggressive policy that England will develop is apparent in the manner in which her machine tool industry is planning to extend its trade in all the European countries as well as beyond Europe; the entry of England into the American machine tool market has already begun and will doubtless be pushed still more vigorously.

Improvement in British Labor Situation

Probably the most important phase in the British situation is the improvement in labor conditions. The serious disputes of last fall, when the railroad workers, the coal miners, and the molders went on strike, have been settled, and a more stable condition has been reached. There still are, and will be, strikes to contend with in various industries, but these are not likely to be of national character or importance as were those already settled. There appears to be a more general appreciation than last year, on the part of the workers, of the fact that they must produce in order to enjoy the benefits of production. While there are many radical labor leaders who are still preaching strife and trying to stir up trouble, most of the influential labor leaders take a more conservative stand, and there is every reason to believe that, on the whole, British labor is settling down on a sound basis, and that there will be an increase in production.

Wages and Comparative Productiveness of British Labor

The average wages in the British metal industries—including all shop labor—are now just about 2 shillings an hour. The average output of the British workers, compared with that of the American shop men, is about two-thirds of the latter, in the mechanical industries. Hence, the cost of unit labor in England is as high or higher than in America, and British production costs today are much higher than pre-war costs. This condition will make it much more difficult for England to compete with America in the world's markets, everything else being equal, and is one of the most direct reasons for the decided tendencies toward the adoption of American methods. As soon as the industries have fully organized themselves for mass production, the output per wage unit will be greater, and England, of all nations, will bring to bear the greatest competitive pressure upon the United States. In no field is this truer than in the machine tool field, because here England has definitely set out to capture much of the former American market both in Europe and in non-European countries—especially South America and the Far East.

French Industrial Conditions of Today

France has had less labor disturbances than any other country in Europe. There have, of course, been local strikes, but none of these have been of national scope or significance. It is believed that the peak of the high wages has been reached. In the mechanical industries, this wage is now 3 francs per hour for the highly skilled men, compared with 1 franc per hour before the war. The average wage in the mechanical industries is 2 francs per hour, compared with 0.75 to 0.80 franc before the war.

France suffers from lack of coal, which interferes seriously with her industrial output and rehabilitation. In the districts that were unaffected by the war, full industrial activity cannot be resumed because of lack of labor, coal, iron, and steel. The reconstruction work in the devastated regions takes the labor from the industries not directly affected by the war, and thus no part of France is able to go ahead fullblast industrially.

There is, however, a carefully laid out program, on which both the government and French financial interests are working in harmony, for making France much more of an industrial country than before the war. Investors are placing their funds in French enterprises so that France may be able to produce more of the products to meet her needs right at home. The country is, however, seriously handicapped in carrying out this program by the fact that so large a proportion of the French iron and steel industries lie in the

devastated regions, and the reconstruction work is of necessity slow, in spite of all efforts to speed it up.

The French mechanical industries will concentrate on automobiles and trucks, airplanes, engines, turbines, and, in general, on machinery requiring highly refined mechanisms. They will probably not build machine tools to any great extent, although the few firms that have been in that field in the past are planning to increase their output somewhat. It is doubtful if France will ever supply her own needs in machine tools, let alone becoming an important factor in international machine tool trade. America and England will probably continue to supply France with a large part of her machine tools; and the machine tool building countries of the future will doubtless be the same as in the past—America, England, and Germany.

Machine Tools Bought from Germany

All of Europe is now buying commodities from Germany, and naturally machine tools are among the first, and certainly the most important, transactions. It was stated by a reliable authority that the exports of German machine tools already amount to 50,000,000 marks a month. This seems large but it does not represent so tremendous a volume when it is considered that the prices, expressed in marks, range from twelve to seventeen times the pre-war rates.

In spite of these increases in price, it is still economically of a tremendous advantage to France and Belgium and other European nations to purchase their requirements in machine tools from Germany instead of from the United States, on account of the great depression of the German mark and the high value of the American dollar. The situation is such that France and Belgium can buy for about one-half the price that they would have to pay for similar tools imported from the United States. It is douhtful whether Germany can continue to export at this rate because of her limited supply of coal and iron, and also because of the probable further increase in export prices in order to meet the difference in the rate of exchange.

The Germans are clamoring for some form of industrial protection. They feel that foreigners are buying them out, and that even at enormous prices in marks, their products, when bought with foreign currency, give the foreign buyers a tremendous advantage. The result of a great amount of trade on this basis further depresses the value of their currency in foreign markets.

There is a decided movement on foot to regulate export prices, which may be accomplished by quoting in the currency of the country to which the goods are being exported, or by determining the price in marks based on the current rate of exchange. Any steps in this direction will immediately counteract the economic advantages other nations now have in dealing with Germany.

Belgium is Recovering

Belgium is probably in a better industrial position than any of the continental nations, and she is pulling herself together more rapidly than the rest. She is better off economically, and food is better and more plentiful than elsewhere in Europe. An important factor in the rapid reconstruction was the sale of the United States Government machine tools to Belgian manufacturers, who thus obtained quick deliveries and have been enabled to re-establish their industries without much delay. That our country performed a distinct service in this respect is without a doubt. In France, the tools sold by our Government are held by the French government to be used for equipping the reconstructed factories in the devastated regions, and are not permitted to be sold to any other French industrial enterprises. Hence, in France, they have not yet been put to use.

Another factor that aided Belgium in her rapid reconstruction was the small size of her country, making it easy to organize for rehabilitation. Furthermore, few Belgian plants were utterly destroyed as were the French; the greatest difficulty was caused by the removal of the machinery to Germany, but the Belgian commissions that have been locating this machinery in Germany are now returning it by train-loads to Belgium.

The frightfully run-down transportation system provides a serious problem for both Belgium and France, the permanent way as well as the rolling stock being in very poor condition. German locomotives and cars are more largely used than Belgian or French; but even with this reinforcement, many trains, both passenger and freight, are cut off because of shortage of coal, especially in France.

Labor Conditions in Belgium

The labor situation has been more disturbed in Belgium than in France, but there has been no trouble of national importance. The people are getting back to work, and being naturally industrious, are showing results. The great industrial works and the coal fields in the Meuse valley appear to be working to their maximum capacity. Wages are about the same as in France, and probably will become somewhat lower as conditions are stabilized.

Belgium will devote herself to the same industries as in the past, with some development in the automobile industry where cars of high quality will probably be the Belgian standard. The old lines of industry, however, are being expanded, and Belgium will provide a good, but naturally limited, future market for machine tools.

Belgium has to find some way to dispose of the seven and one-half billion German marks called in by her government after the armistice. The only outlet for this amount is in exchange for German goods, and she is shrewdly satisfying her needs with a distinct economical advantage. France, likewise, will find it to her decided economic advantage to purchase goods from German factories so long as the dollar is at a high premium and the mark at a big discount.

The Dutch Industrial Expansion

Holland is going more strongly into the mechanical industries. Dutch factories now turn out a varied product—automobile parts, screw machine products, hardware, small tools, etc. Great projects are under way, and with the capital accumulated during the war, new industries are being financed. One plan is to develop the iron and coal resources of the Dutch East Indian possessions, especially of Java, and to bring the iron and steel from there to Holland for its final manufacture into finished products. During the war many manufacturers in Holland had to build their own machine tools—copies of American, English, and German makes—as they were unable to buy from abroad. But now that the world's markets are again open to them, they will not continue to produce machine tools in any appreciable quantity. The Dutch are good business men and have taken advantage of the depreciation of the German mark, having invested largely in German industries and bought other properties in Germany.

Present Conditions in Germany

The conditions in Germany are not generally understood in the United States, because they are so abnormal. There has been a mental and moral collapse since the war. Life is viewed with indifference, and it is as if the whole people suffered from a mental fever that must run its course. The cost of living is fully ten times what it was before the war. The average wages in the mechanical industries are from 2½ to 3 marks per hour. Rates are constantly increasing, and as the exchange falls still further, the cost of living and wages will increase proportionately. The attitude of the workers in the industries is one of apathy. They try to get all the wages they can, and perform as little work as possible. The working day is eight hours. Food is scarce and food cards are still in use. White bread is unknown, and meat almost as rare.

The industrial situation is very unsatisfactory, both on account of the attitude of labor and because of the shortage

of raw materials. Strikes are the order of the day, and when working, the production per man per day is low. Coal, iron, and steel are lacking, and transportation facilities are very poor. There is a tremendous shortage of rolling stock, and what there is, is in a run-down condition. Where formerly there were eight or ten passenger trains in each direction there is now only one. The freight service is equally curtailed. Everything looks neglected—everything is permitted to run down shiftlessly. The uncertainty of the indemnity has something to do with this. There is a feeling that whatever is produced will go toward the indemnity.

Industrial leaders in Germany are doing little at present to remedy the situation. They look upon the conditions as a disease. They believe that in time, perhaps one or two years, the distemper will have run its course, and then Germany will gradually come back; but even after that it will be years before Germany will regain her industrial footing.

In the machine tool field, Germany now offers some competition; but that will last only as long as present stocks and raw material last. After that there will be a period when German machine tool competition will not be very serious. When Germany finally gets on her feet the machine tool industry will be among the first to revive, and the Germans will then make a very decided drive to regain their lost trade. It will be pushed with vigor, as will their other industries. During the war, while Germany was completely cut off from all the other big industrial countries of the world, and entirely depended upon herself, she made many copies of well-known foreign makes of tools and in other cases embodied the principles of foreign equipment.

Her industrial units are practically intact. Given raw material, fuel, and a stable labor market she will again quickly become a factor in world production. She will probably never again revert to the low price levels of pre-war years, and given anything like a normal rate of exchange on which to fix prices in international trade she will have to rely more upon merit than price in the world's markets.

The Exchange Situation

Much has already been said and written about the exchange situation. This affects practically all the European countries, but of course to a much lesser degree the neutrals, particularly Holland and Spain, whose currency relations with the American dollar have not materially altered. The main point is that the exchange rates cannot return to normal until we buy from Europe at least as much as we sell, and for a time a great deal more.

The extension of credits alone is not a cure, and while they must be extended in some form with the result that temporarily a still more unfavorable exchange will result, such credits should be limited to what is necessary in order to give the European nations an opportunity to begin production on a large scale. Europe must produce and sell in large quantities, and we must be prepared to buy in large quantities the goods we require. We cannot hope to right present conditions by selling vastly more than we purchase.

Many methods of credit extension have been proposed, most of which are nothing more than gambling on exchange rates. The most constructive plan appears to be the extension of credits in the form of raw material to be worked into the finished products by the European factories, and then shipped to the credit givers, or to some market for their account. This scheme is being given serious consideration in several directions.

For example, we learned of negotiations between American interests and a large German shipbuilding firm, which contemplate furnishing the yard with all the raw material necessary for the construction of ships. Thus the yard would have the benefit of the work to do, keep labor and equipment employed, and obtain a profit on the actual work performed. In other words, the yard would be a sort of job shop. Trade experts from other foreign countries are studying similar plans in other industries. The fundamental need is to get the shops of the world to work again.

ADOPTION OF A STANDARD SAFETY CODE

As a result of a conference called by the Bureau of Standards at Washington, a movement has been started to create a uniform national safety code, so that the rules and regulations relating to the safeguarding of machinery in the industries may be uniform in the different states. The program includes a method for unifying the large number of conflicting safety codes in existence, which have been formulated by various state authorities and by insurance and other organizations. It is planned to formulate these safety standards under the general auspices of the American Engineering Standards Committee, which was recently organized by the five national engineering societies and the War, Navy, and Commerce Departments of the United States.

The proposed procedure is as follows: If a standard is desired on any engineering subject whatsoever, the American Engineering Standards Committee will designate some organization to act as a sponsor in the formulation of such standard. This sponsor may be an engineering or manufacturing association, a government bureau, etc., and need not be a member of the committee. The sponsor body then organizes a representative committee to have charge of the formulation of the standard or code in question, this committee including representatives of all organizations and interests affected by the proposed standard, regardless of whether such organizations are members of the main committee. In other words, the representative character of this code committee insures that the standard to be formulated will be a reasonable one, having due regard to all parties interested. The code or standard as prepared by this committee must then be approved by the sponsor body and finally by the American Engineering Standards Committee—the latter, however, not going into the details of the code, but merely satisfying itself that the code has been prepared with proper regard for all interests involved.

* * *

INDUSTRIAL TRAINING SCHEME

A unique educational project has been developed at Spartansburg, S. C., in connection with the Textile Industrial Institute of that city. A modern mill for instruction purposes has been built, which is said to be one of the finest mills in the world in its appointments. The students will operate the mill as part of their instruction in the Textile Institute and will manufacture a line of high-grade cotton cloth which is to be sold direct to consumers by means of the parcel post. Every student in the mill will be given special training in the classroom, so that he will understand the theory of the process upon which he is engaged. The student is expected to be self-supporting, working every other week in the mill and receiving sufficient pay to cover his living expenses for two weeks. There are to be two separate student organizations, each having a superintendent, overseers, etc.

* * *

HOOVER ELECTED PRESIDENT OF MINING ENGINEERS

The American Institute of Mining and Metallurgical Engineers has elected Herbert Hoover as the next president of the institute. Barring the names of President Wilson and General Pershing, Mr. Hoover's name is perhaps better known than that of any other American, both at home and abroad. Mr. Hoover received his early training at the Stanford University, California. He then served with the United States Geological Survey and was later engaged in mining activities in Australia and China. He has also been consulting and managing engineer in metallurgical, mining, and railway operations in Mexico, Russia, Africa, and India. Directly after the beginning of the war he became active in various kinds of war services, and in October, 1914, organized the Commission for the Relief of Belgium. His activities from that time on are too well-known to require mention.



View on the Hotel Astor Roof Showing Arrangement of Booths

Convention and Exhibit of American Society of Mechanical Inspectors

THE first annual convention, in conjunction with an exhibition of mechanical inspection equipment, held by the American Society of Mechanical Inspectors, at the Hotel Astor, New York City, February 2 to 6, gave evidence of the great activity and enterprise of this society, which promises to place it in an important position in relation to the mechanical industries in the future. During the convention the following papers were read, relating to important phases of gaging and inspection: "The Need of Inspection Laboratory Education," by H. F. Winter, secretary of the American Society of Mechanical Inspectors, New York City; "Tolerances and Allowances," by Irvin H. Fullmer, associate physicist, Gage Section, U. S. Bureau of Standards; "American Advancement in Precision Measuring Appliances," by B. H. Blood, general manager, Pratt & Whitney Co., Hartford, Conn.; "A Few High Lights on Gage Practice," by A. W. Schoof, gage engineer, Greenfield Tap & Die Corporation, Greenfield, Mass.; "Inspection Practices," by Frank Higgins, superintendent of inspection, Willys-Morrow Co., Inc., Elmira, New York.

In connection with the convention, the society had arranged for an exhibit of inspection equipment for the mechanical industries, and this exhibit proved to be one of the valuable features of the convention. The Gage Section of the United States Bureau of Standards had an exhibit which included apparatus for testing the length, flatness, and parallelism of the faces of precision gage-blocks to a millionth of an inch by optical methods. The bureau also had on exhibition a projectograph for the checking of thread profiles of thread gages. In addition, there were exhibited a number of other devices including a universal sine plate fixture for testing angles and radii of profile gages and templets; Hoke precision gage-blocks as manufactured by the Bureau of Standards; a lead-testing device built at the bureau; a set of precision balls ranging from 1/16 inch to 4 inches in diameter; a balance micrometer for measuring the pitch diameter of thread gages by the three-wire method; various gages; and photographs illustrating methods of testing gages.

Among the commercial exhibitors were the following: William Brewster & Co., New York City; Coats Machine Tool Co., New York City; Greenfield Tap & Die Corporation, Greenfield, Mass.; Holz & Co., Inc., New York City; C. E. Johansson, Inc., Poughkeepsie, N. Y.; Jones & Lamson Machine Co., Springfield, Vt.; Inspection Engineering Equipment Co., New York City; Arthur Knapp Engineering Corporation, New York City; Pratt & Whitney Co., Hartford, Conn., Shore Instrument & Mfg. Co., New York City; West & Dodge Co., Boston, Mass.; Wilton Tool & Mfg. Co., Boston, Mass.

In addition there were exhibits by the College of the City of New York in connection with its evening courses in mechanical inspection, machine shop practice, automobile and aeronautical engineering, etc. The Inspector Publishing Co., which publishes the official organ of the American Society of Mechanical Inspectors, *The Inspector*, also had a booth. MACHINERY also had an exhibit of the work that this journal has done along gaging, inspection, and similar lines, and of the books published by MACHINERY on gaging, inspection, toolmaking and machine shop practice, and design in general.

The following officers for the coming year were elected: President, Paul E. Theis; vice-presidents, Ernst Mentor, technical supervisor, C. E. Johansson, Inc.; Arthur Knapp, president, Arthur Knapp Engineering Corporation; Benjamin Gilpin, factory manager, Remington Typewriter Co. plants; Guy W. Vaughan, vice-president and general superintendent, Van Blerck Motor Corporation, Monroe, Mich.; Earle Buckingham, engineer, Pratt & Whitney Co.; Albin Rothoff, president, Rothoff Tool & Mfg. Co., Brooklyn, N. Y.; treasurer, H. L. Bailey, service manager, Chevrolet Motors Corporation, Metropolitan Headquarters; secretary, H. F. Winter.

One of the features of the convention was the dinner on the opening night, which was attended by about seventy members and guests of the society, and at which a number of men prominently connected with the gaging and inspection equipment industry spoke on subjects of importance to this branch of the industry.



Some of the Exhibits at the Convention of the American Society of Mechanical Inspectors

China as a Machine Tool Market

By JULEAN ARNOLD, American Commercial Attache, Peking, China

Julean Arnold, American commercial attache at Peking, China, gives his views of the possibilities of a future machine tool trade with China in this article. He outlines the present conditions in China's industrial developments and points out that the Chinese engineering schools provide one of the best means for advertising American machine tools to the Chinese. Mr. Arnold, having lived in China for eighteen years, during which time he has been intimately in touch with the industrial conditions there, is able to speak authoritatively on this subject, and his views should be of interest and value to American manufacturers.

THE imports of machine tools into China during past years have not been large enough to make American machine tool builders realize that there is a potential market for machines of this kind in China. The last few months' imports of machine tools into China have amounted to about $10,000 a month, which, of course, seems unimportant. But the fact that should be impressed upon the American machine tool builder is that there is at present an industrial awakening in China, which, without question, will greatly increase the foreign trade in machine tools within a few years. As an example, it may be mentioned that at the present time thirty cotton mills are being built in China, each one of which is provided with a small machine shop for repair work and minor alterations on machinery. The iron and steel industries have also been developed to an important degree during the past few years, and China is now beginning to make use of its vast natural resources in iron ore and coal, the value of which was not appreciated or understood by the Chinese themselves until within recent years. Railway building is likely to have an unprecedented growth within the next decade, because the Chinese realize the necessity of more railroads, and the only thing that has held up the development has been the difficulty of financing during the war period. There are only 6500 miles of railways in China—in a territory larger than that of the United States and with a population at least three times as large. With the coming industrial development of China, more railways must be built, and this will mean more repair shops and even new industries for the building of railway cars and locomotives. To one that has seen the development of China during the last ten or fifteen years, it is easy to imagine what the next ten or fifteen years can bring, provided foreign interests, particularly American, will take the lead.

Cooperation between American and Chinese in Industrial Developments

At this point it should be emphasized that the Chinese are more friendly to the Americans than to any other foreign nation, and that cooperative enterprises in which American and Chinese capital are both represented, are greeted with much favor. America has the good-will of the Chinese, and if Chinese business men see that American capital can be interested in a Chinese undertaking, they will also come forward with capital, because there is a great deal of capital in China lying dormant, which can be brought into active play only by foreign, particularly American, activities. Many large American enterprises are now entering into this field in various industrial lines, and as more industries are being established in China, the demand for machine tools is sure to grow.

How Chinese Trade can be Encouraged

At the present time the Chinese trade in machine tools is too small to warrant the individual American machine tool builder's going after this trade by the use of a direct representative. There are, however, a number of big firms representing American machine builders in China, especially in Shanghai, and one of the best methods for obtaining information about the details of the Chinese trade would be for the American machine tool builder interested in this market, to get in touch with the American Chamber of Commerce at Shanghai or with the Bureau of Foreign and Domestic Commerce at Washington. The Bureau can assist a great deal in spreading knowledge about American machinery and methods in China, if manufacturers will take advantage of the facilities at their command. One method which is being employed is the showing of moving picture films of industrial subjects. Chinese business men are interested in moving pictures showing how the industries are managed in the United States. The pictures should not be too technical in their nature, but should deal with their subject in a broad, general way, showing for example, the general lay-out of plants and their appearance, the use of labor-saving devices, the results of systematic methods, and the production obtained by modern machine tools. These films should be sent to the Bureau of Foreign and Domestic Commerce, Washington, with instructions that they be forwarded to the commercial attaché, Peking, who will see that they are effectively circulated and used.

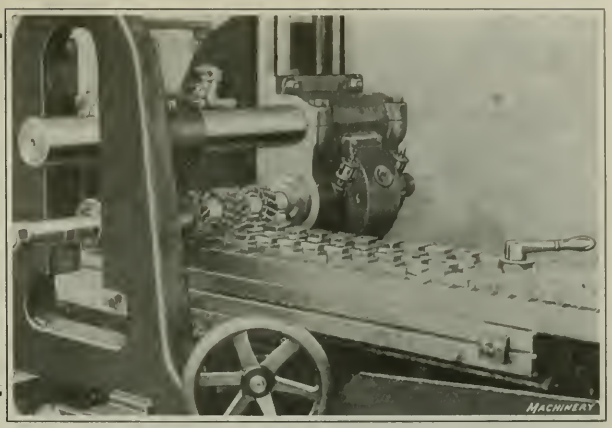
Chinese Engineering Schools a Good Advertising Medium

It is believed that one of the best ways in which the value of American machine tools could be brought to the knowledge of the Chinese would be through their introduction into the Chinese engineering schools. Previous to the war, the Germans maintained an engineering college in Shanghai, and by this means were able to greatly further the German trade with China in the products of the machine building industries. The British maintain an engineering college at Hongkong; and the British, French, and Japanese have also taken advantage of the opportunity to place machinery built by them in the engineering schools of China, thereby acquainting the students with these machines.

It has proved difficult to interest American manufacturers in this method of advertising their machines, but doubtless this method is both cheaper and more effective than the exposition of machinery at great industrial fairs. American manufacturers are willing to spend large sums of money in order to exhibit their machines at an exposition where they are only temporarily on exhibit; but they have shown very little interest in the permanent exposition of their machines that they would get in an engineering college where the future leaders in Chinese industries are being educated. The office of the American commercial attaché at Peking will give all the information required by an American manufacturer interested in this phase of the subject. It is desirable that the machines be given outright to the colleges, but if this cannot be done, they may be sold on favorable terms. The main thing is that the interest of the American machine tool builders is aroused and that they give some attention to this matter. The Chinese market is not large at present, but it will be large in the future, and it is a question whether American machine tool builders or those of Great Britain, France, Germany, and Japan will get the biggest part of this market. Now is the time to lay the foundation for our future business there.

Indexing Milling Fixtures

Second of a Series of Three Articles on the Use of Indexing Fixtures for Obtaining Increased Production in Milling Practice



IN the first article in this series, published in the February number of MACHINERY, some of the general principles involved in the solution of the problems for obtaining increased production in milling practice, were dealt with, and a general review was made of the general types of indexing fixtures in common use. Several examples of these fixtures were illustrated and described. The present article continues this description, dealing specifically with the indexing type of string fixtures, and other special indexing fixtures.

Indexing Type of String Fixture

At the plant of the Armstrong Mfg. Co., Bridgeport, Conn., No. 33 Lincoln type milling machines, built by the Kempsmith Mfg. Co., of Milwaukee, Wis., are used for face-milling operations on blanks for pipe-threading dies. One of the machines equipped for these operations is shown in the heading illustration and in Fig. 10, which illustrate opposite sides. It will be apparent from these illustrations that the miller is provided with a rather unusual type of work-holding fixture, which combines features of the so-called "string" and "indexing" types. In other words, this tool consists of two stations, on each of which there are mounted clamps for holding four strings of pieces to be milled. The fixture is mounted on a pivot, and while the milling operation is being performed on pieces set up in one station, the operator has ample time to unload the milled parts from the other station and substitute fresh blanks. It will be seen that the four plain milling cutters that are used for the performance of this operation are set up on the arbor with the spiral angles of the teeth opposed to each other, the purpose being to have these four cutters arranged in opposed pairs to neutralize the end thrust.

In designing a fixture of this type, the main table *A*, on which the work is mounted, is carried by a pivot mounted in an intermediate plate *B*, which is secured to the table of the milling machine. At the left-hand end of the table, there will be seen a notch *C*, and there is a similar notch at the right-hand end. This is the locating point for the tapered index-pin which locates the fixture in either of the two positions in which it is used. It will, of course, be apparent that after indexing the table must be clamped, and this is done by a binder manipulated by lever *D*. In the performance of this operation, the cutters are driven at a speed of 56 feet per minute, and the work is fed to the cutters at a rate of 3 9/32 inches per minute. The material being milled is carbon tool steel.

Indexing Fixture for Face-milling Connecting-rods

A No. 3 plain Kempsmith milling machine is illustrated in Fig. 11. This machine is used by the Holt Mfg. Co., of Peoria, Ill., for the performance of straddle-milling operations at both ends of connecting-rod forgings. As the bearings to be faced are of different widths at opposite ends of the work, it is obvious that the man who planned the method of machining had to choose between the alternatives of resetting the work for performing the second milling operation, or else provide for indexing the fixture in order to reach the opposite ends of the forgings. The latter plan was adopted, and in order to secure constant operation of all of the four pairs of cutters which are placed on the arbor for milling opposite ends of these forgings, the fixture was designed to hold two forgings, with their small ends facing the cutters, and two other forgings with their large ends facing the cutters. With this arrangement, the ends of four forgings are straddle-milled simultaneously, after which the fixture is indexed to provide for milling the opposite ends of the same forgings.

It will be seen that this machine is set up with a fixture at each end of the table, the purpose being to avoid the necessity of having the machine idle while the operator is removing milled forgings and reloading the fixture. With a machine set up in this way, the sequence of operations is as follows: First, mill one end of the forgings held in the left-hand fixture; second, traverse the table over to mill one end of the forgings held in the right-hand fixture; third, index the left-hand fixture while pieces held in the right-hand

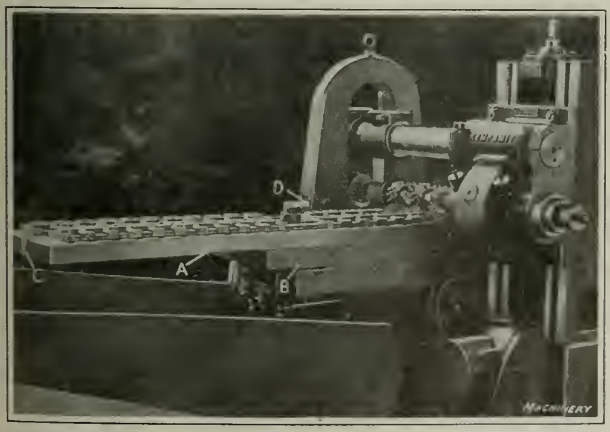


Fig. 10. Milling Threading Die-blocks, using a Fixture which combines Features of the Indexing and String Types of Equipment

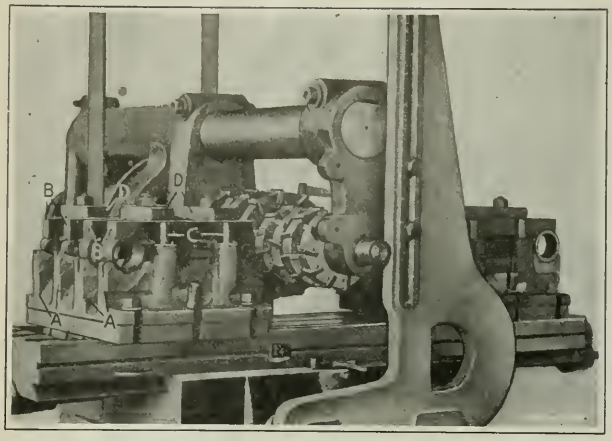


Fig. 11. Straddle-milling Both Ends of Connecting-rod Forgings. One Fixture is loaded while Forgings held in the other Fixture are being milled

fixture are being milled, and then traverse the table over to complete milling the forgings held in the left-hand fixture; fourth, index the right-hand fixture while the other milling operation is proceeding, and then traverse table over to complete milling the forgings held in the right-hand fixture. While the final operation is being performed on the forgings held in this fixture, the completely milled connecting-rods are removed from the other fixture and fresh forgings are set up. In this way, excellent rates of production may be obtained, as there is practically no idle time for either the machine or its operator. This fact is well demonstrated by results obtained with the equipment shown in Fig. 11 at the Holt plant, where 400 connecting-rods are milled in a ten-hour working day.

It will be of interest to briefly describe the way in which the forgings are held in this fixture for performing the milling operation. Each fixture is provided with four walls *A* in which transverse V-notches are cut to receive the bearings at each end of the connecting-rod, and longitudinal grooves to receive the bolt bosses. After four rods have been dropped into place, four bars *B* are placed on top of them. These bars also have been provided with longitudinal grooves and transverse V-notches to conform with the contour of the work. It is necessary to obtain sidewise adjustment of the work (longitudinal adjustment is effected by the V-blocks in which the work is carried), and this is accomplished by having pins *C* engage the finished sides of bars *B*. After the desired location has been secured for each of the four rods, straps *D* are tightened, four of these straps being provided for holding down the bars *B* and the connecting-rods secured by them. With a fixture designed in this way, the machine operator is allowed ample time to remove the milled forgings and substitute fresh parts while the remaining operation is being performed on parts held in the opposite station of the fixture.

Milling Spring Shackle Forgings

At the plant of the National Motor Car & Vehicle Corporation, Indianapolis, Ind., use is made of horizontal milling machines built by Gooley & Edlund, Inc., Cortland, N. Y., which are equipped as shown in Fig. 12 for use in milling spring shackle forgings. It will be apparent from the line illustration of the work, Fig. 13, that there are eight surfaces to be milled, and this result is accomplished by a gang of eight milling cutters which provide for simultaneously machining four surfaces on each of the two shackles which are mounted in the fixture. In order to conserve the operator's time by enabling him to be kept constantly employed in setting up work on the machine, a duplex fixture is provided which allows the workman to set up new forgings in one fixture while the machining operation is proceeding on pieces held in the other fixture. The method of procedure is as follows: When a milling operation has been completed on the two shackles held in the first fixture, the table is traversed over to provide for bringing the forgings held in the second fixture at the opposite end of the table into place to provide for milling them with the opposite sides of the cutters carried on the milling machine arbor.

While this operation is progressing the operator removes the milled pieces from the first fixture and sets up forgings in their places. By this time the ends of the shackles on which the milling operation was being performed will have been machined and the table may be traversed over to perform the first step of the milling operation on pieces held in the first fixture. While this operation is proceeding, the machine operator indexes the second fixture through an angle of 180 degrees to provide for bringing the opposite ends of the forgings into position for milling. The next step will be to traverse the table to bring these pieces into the operating position for the final milling operation, and while this machining is in progress the first fixture will be indexed ready to complete milling the pieces carried in it. The cycle of operations will be finished by feeding these forgings up to the milling cutters, after which the finished spring shackles will be removed from the second fixture.

This milling operation is performed with cutters 6 inches in diameter, which run at a speed of 40 revolutions per minute. Quick traverse is used for bringing the work into position for milling, after which a feed of 1 inch per minute is employed for the actual machining. Each milling cutter is required to face off a round surface on the spring shackles which is 1½ inches in diameter, and approximately 3/32 inch of stock is removed from each face. The rate of production on this job is 22 completely milled spring shackles per hour. It will, of course, be apparent from the illustration that the work-holding fixture is of very simple design. It consists merely of a bridge carrying two screw-operated clamps which hold the pieces down on a pad at the base of the fixture. A

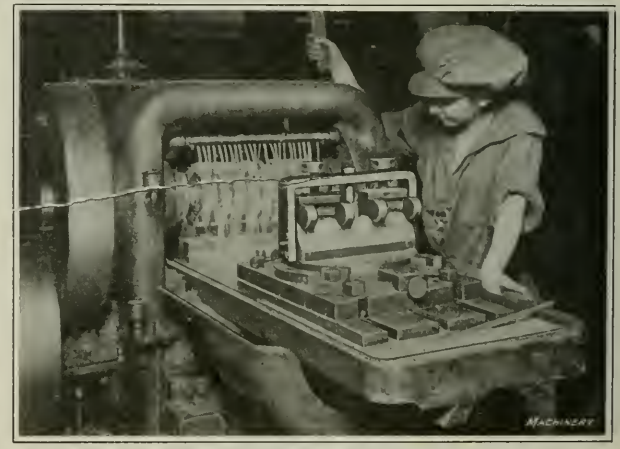


Fig. 12. Straddle-milling Spring Shackle Forgings: the Two Fixtures on the Table are used alternately

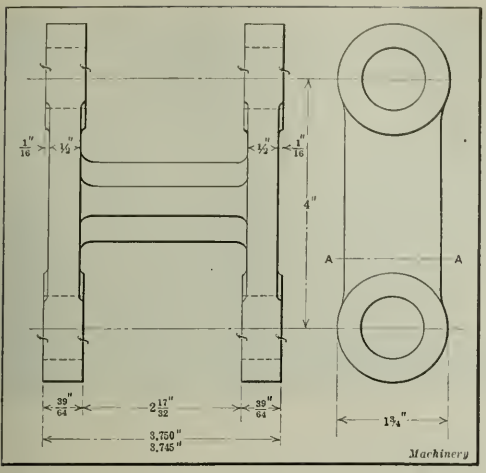


Fig. 13. Design and Dimensions of Spring Shackles milled on Machine shown in Fig. 12

simple form of locating bolt provides for securing each fixture in either of the two stations in which it is required to operate.

The third and last installment of this series, which will be published in the April number of MACHINERY, will describe additional special types of indexing fixtures which can be used to advantage for milling operations on a quantity basis.

* * *

BLUEPRINT PROTECTOR

A means for protecting blueprints while handled in the shop so as to prevent them from getting dirty, wet, greasy or torn has been developed by E. I. Du Pont De Nemours & Co., Inc., Wilmington, Del. This blueprint protector consists of a sheet of transparent material cut to the desired size. A piece of thin leather substitute fabric is then cut about ½ inch larger all around than the piece of transparent material. This extra ½ inch allows for overlap on all but the top side of the protector. The lap is stitched down to the transparent sheet so that a large flat pocket is formed, open at the top for the insertion of the blueprint. The transparent material from which the face of the protector is made is flexible so that the holder may be rolled up, if desired, in the same way as an unprotected blueprint; and as both the transparent face and the leather substitute back are water- and grease-proof, the blueprint can be kept in good condition.

PLANER FIXTURE FOR HOLDING TRAILER-BOX SHELLS

By NORMAN McCLEOD

One of the most difficult problems encountered in machining brass trailer-box shells is that of holding the work in place on the planer bed when planing the 45-degree surface shown at *F* in the accompanying illustration. This is especially true when the demands for quantity production make it desirable to fasten as many castings to the planer bed as can be conveniently machined at one time. The fixture shown at *C*, designed for a double-head planer has a capacity for two shells and has proved an efficient and economical means of solving this problem. The casting which constitutes the main body of the fixture has a locating seat *G*, planed at an angle of 45 degrees with its base.

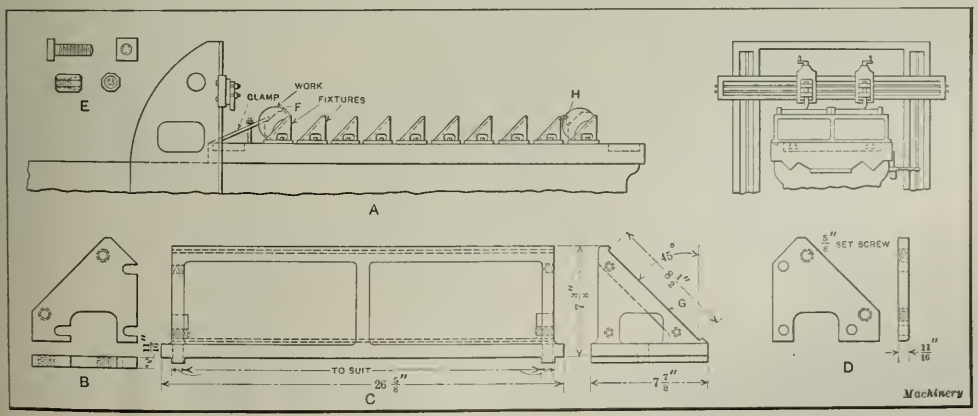
The plate shown at *D*, which is attached to the right-hand end of the casting *C* by means of cap-screws, is provided with two ⅝-inch set-screws which act as stops for locating the work laterally. The plate shown at *B*, which is attached to the opposite end of the fixture, is also provided with two set-screws, which when tightened serve to hold the work in place. In order to facilitate loading and unloading, the cap-screw holes in plate *B* are slotted, so that the plate may be readily removed from the end of the fixture by simply loosening the three cap-screws.

In addition to the set-screws employed to hold the work in place, each fixture is provided with two special bolts and nuts such as shown at *E*. When in use, these bolts are set as shown at *H*, the head of the bolt bearing against the top of the preceding fixture while the hollow pointed nut contacts with the work, and is adjusted to bind the piece in place.

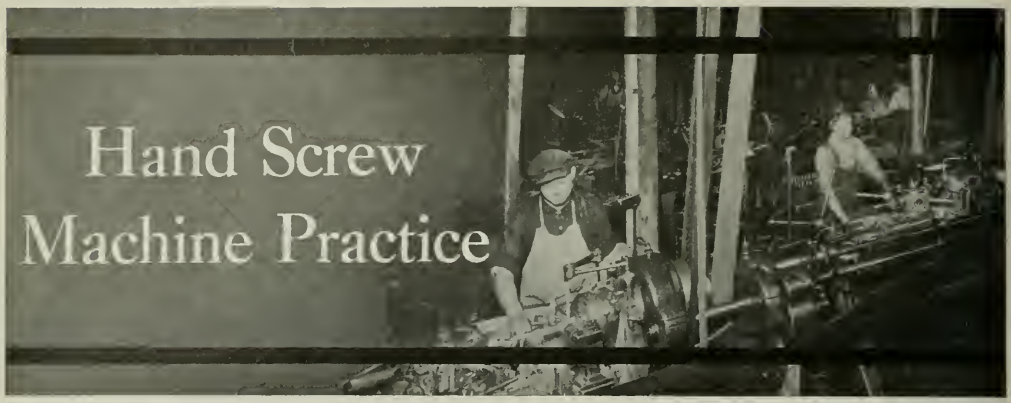
The planer bed shown at *A* in the illustration is 96 inches long by 32 inches wide and readily accommodates ten fixtures, thus permitting twenty trailer boxes to be planed at one time. When loading the fixture, plate *B* is removed, and two shells are slid into place along the fixture, located in the 45-degree recess. By adjusting the set-screws in the end plates the work can be properly centered so that both rows of castings will be finished to the required dimensions simultaneously.

* * *

Of the 75,288,851 gross tons of iron ore mined in the United States in 1917, the Lake Superior district produced nearly 85 per cent, and the Birmingham district 8 per cent. The Lake Superior district furnishes ore to the great pig-iron producing centers in Pennsylvania and Ohio, and the Birmingham district is the center of the iron-making industry in the southern states. The imported ore is of comparatively little importance, being not more than one or two per cent of the quantity annually mined in this country.



Planer Fixture employed to hold Trailer-box Shells, and Method of mounting Fixtures on Planer Bed



Hand Screw Machine Practice

Examples of Work Finished in the Hand Screw Machine—Based on the Practice of the Warner & Swasey Co., Cleveland, Ohio

HAND screw machines are often considered as machines to be used only in the production of small parts, the machining of which is a comparatively simple proposition, and the purpose of this article is to show how this type of machine can be employed for other purposes. Examples have been selected which show how these machines are used to finish castings and produce comparatively long parts from bar stock. These examples are typical of the work performed in the shops of the Warner & Swasey Co., Cleveland, Ohio, on machines of its manufacture. In each case, a dimensioned drawing of the work is presented as well as a diagram of the tooling equipment used in finishing or producing the part, and one or more photographs of the set-up of the tooling equipment on the machine employed. The total time required to machine each part is given, which includes the time consumed in placing the work in the chuck and removing it. The various steps in each chucking are described in detail so that the reader will be able to thoroughly understand the methods employed and know what types of tools are used in each step. The surfaces of the castings finished by the tooling equipments to be described are indicated by heavy lines in the illustrations that show the dimensioned drawings of the castings. The same reference letters are used in each case, both in the drawing of the part and in the tooling lay-out, to indicate the same surfaces.

Machining a Differential Gear Case—Flange Side

Fig. 1 shows a malleable iron differential gear case for an automobile, which is finished in two chuckings on a No. 6 geared friction head turret screw machine. The total time required to machine this part is 7.5 minutes, the first chucking requiring 5.3 minutes. A lay-out of the tooling equipment employed in this chucking is shown in Fig. 2. A dot-and-dash outline of the work is shown in this illustration with each tool-holder mounted in the turret, so as to indicate clearly the method of finishing the various surfaces. In the first chucking the hole *A* is machined and all other

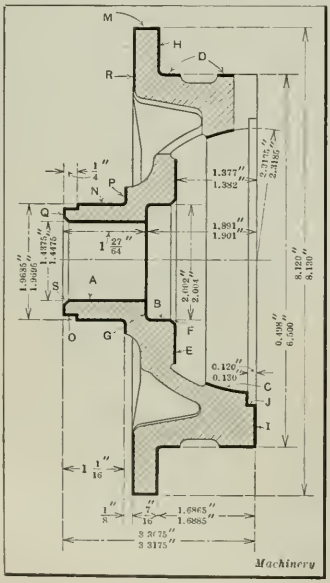


Fig. 1. Differential Gear Case

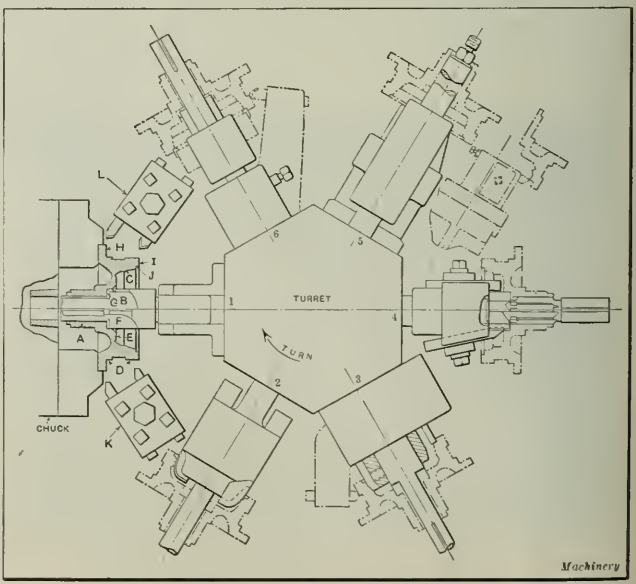


Fig. 2. Tooling Equipment for finishing Part shown in Fig. 1

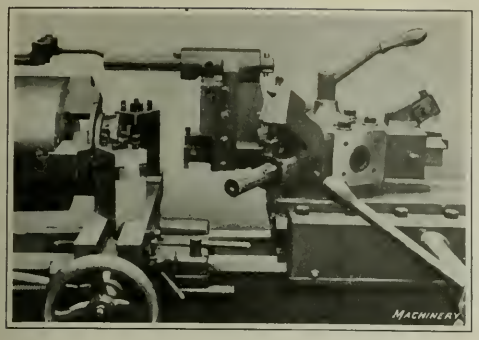


Fig. 3. Machine provided with Equipment for First Chucking on Differential Gear Case

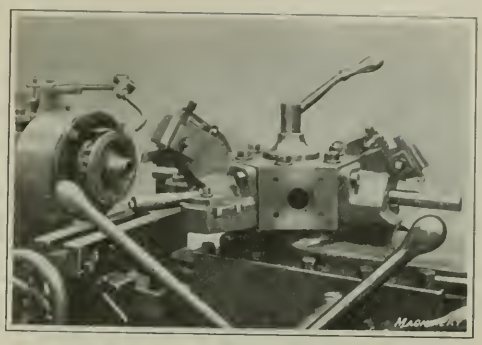


Fig. 4. Set-up of Machine employed for Second Chucking on Differential Gear Case

finished surfaces on the right-hand side of the casting, when viewing it in the position shown in Fig. 1. The various steps in machining these surfaces are taken in the following order: (1) The work is placed in a chuck equipped with jaws that grip it along the periphery of the flange. The headstock spindle is provided with a bushing which receives the pilots on the various tool-holders mounted in the turret, thus correctly locating the tools and producing concentricity of the work. (2) Hole *A* is reamed and surface *B* counterbored by the chucking reamer and counterbore held in the tool-holder in Face 1 of the turret. At the same time, rough cuts are taken on surfaces *H* and *I* with the tools held in tool-block *K*. (3) Surface *C* is rough-turned by the cutter mounted in the cutter-head held in Face 2 of the turret. (4) Surface *D* is rough-turned, another cut is taken on surface *C*, surface *E* is rough-faced and surface *J* is rough-bored by the tools mounted in the box-tool held in Face 3 of the turret. The tool which takes the cut on surface *D* is indicated by dot-and-dash lines, its normal position being on the upper side of the box-tool. (5) Hole *A* is reamed, another cut is taken on surface *B*, surface *E* is finish-faced, surface *F* is chamfered, and surface *G* is finish-faced by the tools mounted in the tool-holder held in Face 4 of the turret. At the same time, surfaces *H* and *I* are finish-faced by the tools mounted in tool-block *L*. (6) Surface *C* is finish-turned with the single-point tool mounted in Face 5 of the turret. This tool is indicated by dot-and-dash lines, its normal position being in a vertical plane which can be readily seen by referring to the view of the tooling equipment shown in Fig. 3. This view shows the machine just prior to the sixth step; however, at the time the photograph was taken, the tool-holder and tool used in Face 1 of the turret had been removed. (7) Surfaces *J* and *B* are reamed by the reamer mounted in the box-tool in Face 6 of the turret, and surface *D* is finish-turned by a tool held in the same box-tool. The tool used for reaming surface *J* and the tool used for finish-turning surface *D* are indicated by dot-and-dash lines. (8) the work is removed from the chuck.

The operations in the second chucking on the gear-case are performed in 2.2 minutes, and consist in finishing the surfaces on the left-hand side of the part. There is no diagram shown of the tools employed in this chucking, but a good idea of the equipment can be obtained by referring to the illustration, Fig. 4. The various steps in the second chucking are performed in the following sequence: (1) The work is secured in a special jaw chuck. (2) Surfaces *M*, *N*, and *O*, Fig. 1, are rough-turned and surfaces *P* and *Q* are rough-faced by tools mounted in a box-tool which is held in the turret. At the same time, surface *R* is rough-faced by a tool mounted in a toolpost on the cross-slide. (3) Surfaces *M*, *N*, and *O* are finish-turned, surfaces *P* and *Q* are finish-faced, and chamfer *S* is produced by tools mounted in a box-

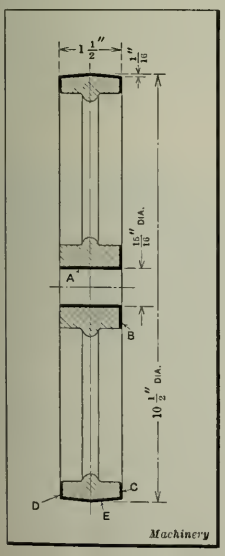


Fig. 5. Drawing of Pulley

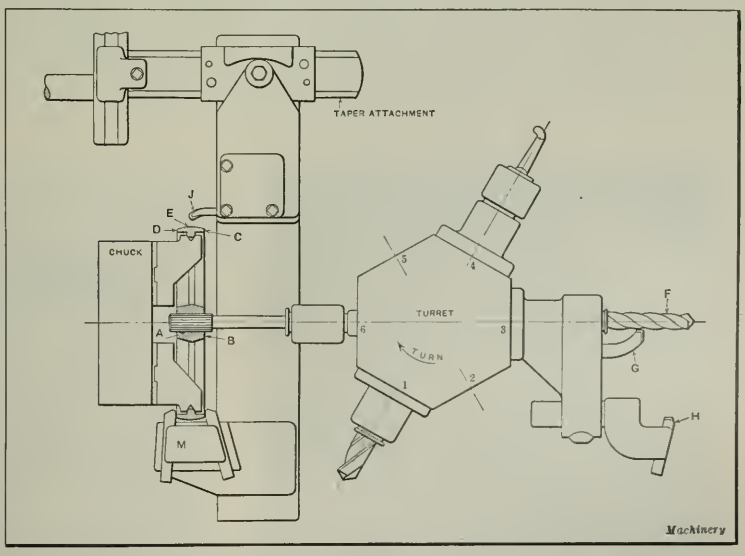


Fig. 6. Lay-out of Tooling Equipment used in machining Pulley shown in Fig. 5

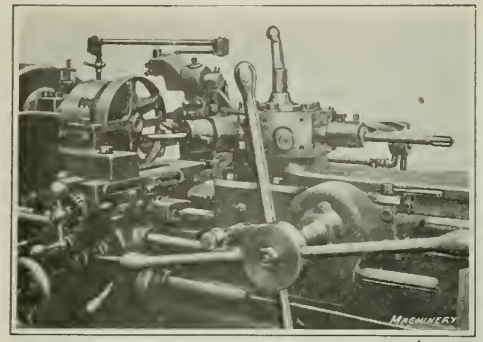


Fig. 7. Machine engaged in finishing Pulley shown in Fig. 5

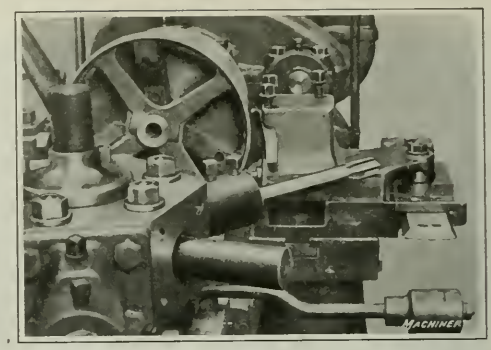


Fig. 8. Same Machine, showing Taper Attachment

tool held in the turret, while surface *R* is finish-faced by a tool mounted in a toolpost on the cross-slide. (4) The work is removed from the chuck.

Tool Lay-out for Finishing Pulleys

Cast-iron pulleys of the type shown in Fig. 5 are machined in one chucking on a No. 4 universal turret screw machine, which is provided with the tooling equipment illustrated in Fig. 6. The operations in this chucking consists of finishing hole *A* and surfaces *B*, *C*, *D*, and *E*, and are performed in 6½ minutes. The successive steps are as follows: (1) The work is placed in a chuck having jaws which grip it along the inside of the pulley rim. (2) A spot is drilled in the center of the face of hub *B* by the starting drill held in the tool-holder mounted in Face 1 of the turret, preparatory to drilling hole *A*. (3) Hole *A* is drilled by drill *F*, hub *B* is faced by cutter *G*, and surface *E* is rough-turned by cutter *H*, all of these tools being mounted in the multiple turning head in Face 3 of the turret. (4) Hole *A* is bored with the cutter held in the adjustable boring cutter holder in Face 4 of the turret. (5) Hole *A* is reamed by the reamer held in the floating tool-holder mounted in Face 6 of the turret. (6) Surfaces *C* and *D* are faced by the tools mounted in the tool-block *M*. (7) Surface *E* is rough-crowned by the cutter *J* mounted on a tool-block connected to the taper attachment. (8) The work is removed from the chuck. Fig. 7 shows a front view of the machine just after the third step in the series has been completed, while Fig. 8 shows a view from the turret end of the machine, taken just prior to the removal of the work from the chuck. The latter illustration gives a clear view of the taper attachment used in machining the crown on the pulley rim.

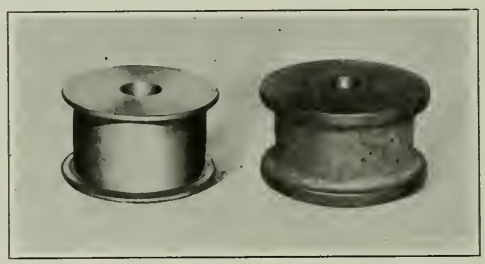


Fig. 9. Appearance of Double-flanged Pulley before and after being machined

Equipment for Machining Double-flanged Pulleys

Fig. 9 shows the appearance of a cast-iron double-flanged pulley before and after being machined on a No. 6 geared friction head turret screw machine. This part is machined in one chucking, the time required for performing the operations being 8 minutes. A dimensioned drawing of the pulley is shown in Fig. 10, while a lay-out of the tooling equipment used to machine this part is shown in Fig. 11. The different steps in this chucking are taken in the following procedure: (1) The work is held in a chuck having special jaws that expand and grip the work along the circumference of the large hole in one side of the pulley. (2) Surface *A* is cut into along surface *F* by cutter *L* and then is rough-turned by this tool,

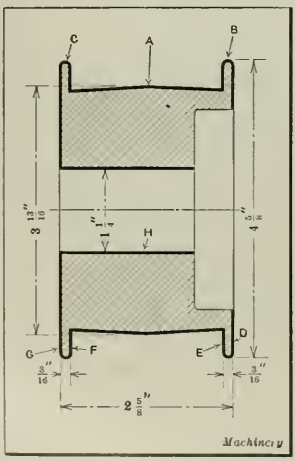


Fig. 10. Drawing of Double-flanged Pulley

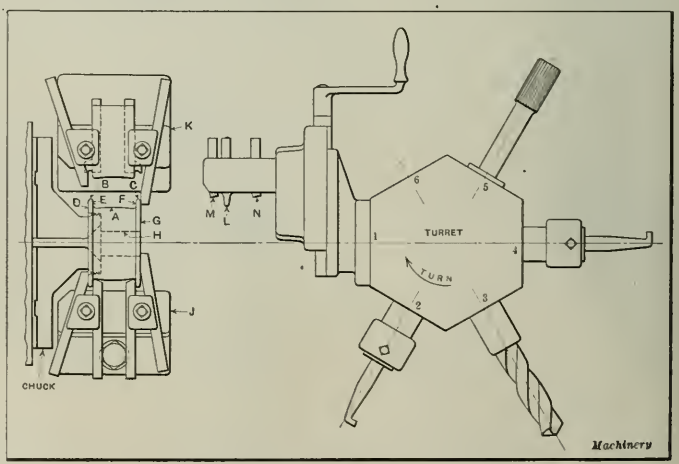


Fig. 11. Tooling Equipment used in finishing Pulley shown in Fig. 10

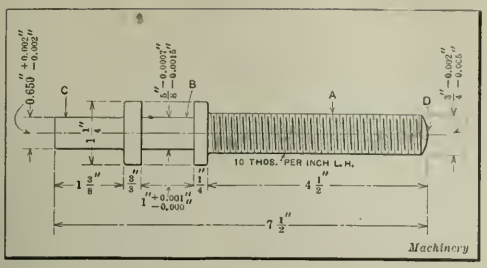


Fig. 12. Dimensioned Drawing of Special Screw

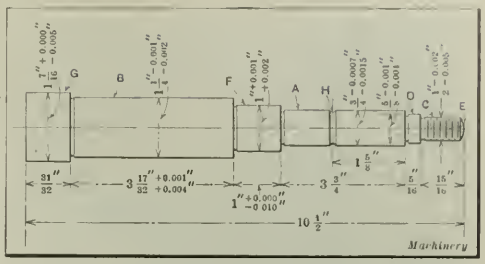


Fig. 13. Pinion-shaft produced from Bar Stock

while surfaces *B* and *C* are rough-turned by cutters *M* and *N*, all of these tools being mounted in the slide tool held in Face 1 of the turret. At the same time, surfaces *D*, *E*, *F*, and *G* are rough-faced with the tools mounted in tool-block *J*. (3) Hole *H* is rough-bored by the cutter held in the adjustable boring cutter holder mounted in Face 2 of the turret. (4) Hole *H* is drilled by a drill mounted in Face 3 of the turret. At the same time surfaces *D* and *G* are finish-faced, surfaces *B* and *C* are rounded, and surface *A* is crowned by

Producing Special Screws from Bar Stock

The special screw illustrated in Fig. 12 is produced from 1¼-inch round steel stock in 5½ minutes on a No. 4 universal turret screw machine. This part is 7½ inches in length over all and has a left-hand thread on one end, the outside diameter of which is ¾ inch. A lay-out of the tooling equipment used in the manufacture of this piece is shown in Fig. 14. The sequence of the various steps in the operation is as follows: (1) The stock is fed to the stop

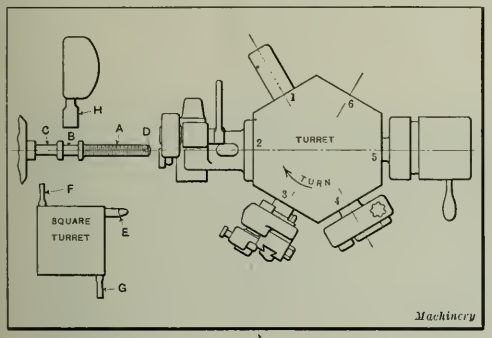


Fig. 14. Lay-out of Tooling Equipment for Special Screws

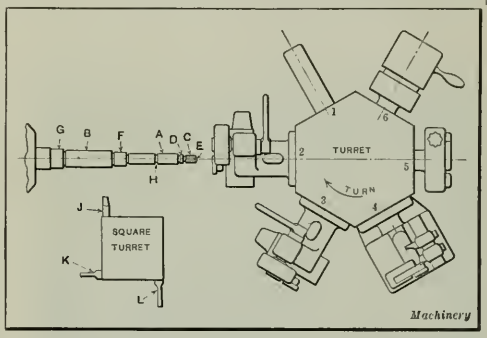


Fig. 15. Tooling Equipment employed in machining the Pinion-shaft

the tools mounted in the tool-block *K*. Fig. 18 shows the performance of this step. (5) Hole *H*, Fig. 11, is finish-bored by the cutter held in the adjustable boring cutter holder mounted in Face 4 of the turret. (6) Hole *H* is reamed by the reamer held in Face 5 of the turret. (7) The pulley is removed from the chuck. This finishes the operations on the pulley, leaving it in the condition shown to the left in Fig. 9..

in Face 1 of the turret. (2) Surface *A* is turned by the single cutter turner mounted in Face 2 of the turret. At the same time, surface *B* is formed by cutter *H* which is mounted in a tool-block, and the right-hand end of surface *C* is cut into by cutter *F* which is held in the square turret, preparatory to turning this surface. The square turret is then indexed 90 degrees and surface *C* turned by cutter *E*. (3) End *D* is rounded by the end forming tool held in Face 3 of

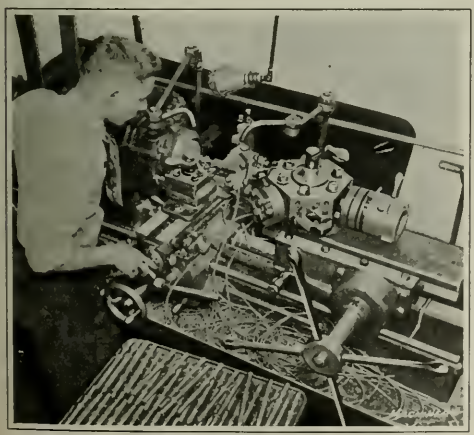


Fig. 16. Second Operation on the Special Screw shown in Fig. 12

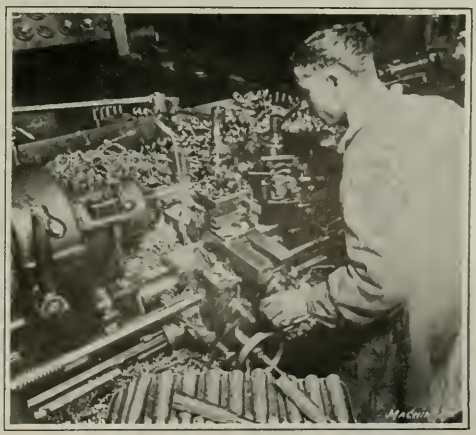


Fig. 17. Machine engaged in the Production of a Pinion-shaft

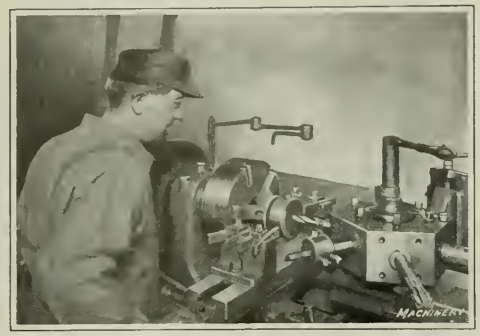


Fig. 18. Machine engaged in finishing Flanged Pulley

the turret. (4) A center is drilled in end *D* by the centering tool mounted in Face 4 of the turret. (5) Surface *A* is threaded with a set of chasers in the die-head mounted in Face 5 of the turret. (6) The completed piece is cut from the stock by cutter *G* which is held in the square turret. The machine shown in Fig. 16 is engaged in performing the second step in the series.

Tooling Equipment Used in Machining a Pinion-shaft

The pinion-shaft illustrated in Fig. 13 is produced from 1½ inch round steel stock in 10 minutes on a No. 4 universal turret screw machine. The over-all length of this piece is 10½ inches. A lay-out of the tooling equipment required in the production of this part is shown in Fig. 15. The order in which the series of steps in the operation is taken is as follows: (1) The stock is fed to the stop in Face 1 of the turret. (2) Surface *A* is turned and surfaces *C* and *D* are turned to the diameter of surface *A* by the single cutter turner mounted in Face 2 of the turret, while surfaces *B* and *G* are turned by cutter *J* which is held in the square turret. (3) Surface *C* is turned by the single cutter turner mounted in Face 3 of the turret. (4) Surface *D* is turned and end *E* rounded by the cutters held in the multiple cutter turner mounted in Face 4 of the turret. (5) Surface *F* is turned by cutter *J*, and a center is drilled in end *E* by the centering tool held in Face 5 of the turret. (6) The grooves at the various shoulders and oil-groove *H* are cut by cutter *K*, which is mounted in the square turret. (7) Surface *C* is threaded with chasers in the die-head held in Face 6 of the turret. (8) The finished piece is cut from the stock by cutter *L*, held in the square turret. Fig. 17 shows the machine engaged in performing one of the steps in this operation.

* * *

TURNING TOOL OF UNUSUAL DESIGN

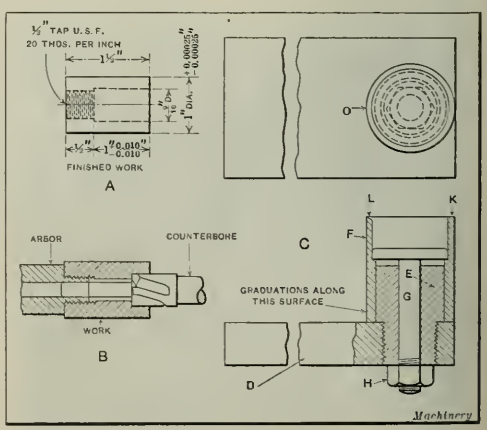
By W. D. FORBES

The writer once accepted a contract to manufacture a large quantity of small machine parts under the impression that the required accuracy could be easily obtained on an automatic screw machine. However, it developed later that greater accuracy than had been anticipated was required in tapping and counterboring the holes concentric with the circumference of the work. Because of these exacting requirements and the small tolerance on the outside diameter of the work, which is shown at *A* in the accompanying illustration, it was found impracticable to machine the pieces according to the original plan. In order to fulfill the terms of the contract without sustaining a loss, it was necessary to have the work produced by unskilled workmen, and this was accomplished by the methods to be described as follows:

The stock was an easy cutting material and was furnished 1/32 inch larger in diameter than the finished work. The hole was drilled and tapped in an automatic screw machine, the hole being drilled somewhat deeper than the length of one piece; then the end of the piece was faced, and the work cut off. The work was mounted on an arbor as shown at *B* for the final operation, which consisted of counterboring the hole and finish-turning the work in a lathe. The arbor was threaded, the threads being made to suit the tapped hole in the work. The arbor was held in the headstock spindle and was also provided with a longitudinal hole that served as a guide for the pilot of the counterbore. A collar was placed on the shank of the counterbore in order to gage the depth of the counterbored hole. The taper shank of the counterbore was held in the tailstock spindle.

The fixture and tool shown at *C* were designed for performing the turning operation. The support *D* was bolted to the compound slide of the lathe by means of T-bolts in the toolpost slot. The plug *E*, which steadies the circular cutting tool *F*, was screwed into this support as shown. The bolt *G* and nut *H* were provided for clamping the tool *F* so that any desired part of the cutting edge of the tool could be brought into contact with the work. The tool was graduated along its lower edge, the divisions being about 1/8 inch apart. One of these graduations was marked *O*, and when the fixture was set up on the machine the tool was turned until this graduation coincided with an index line *O* on the top of the support.

When a skilled machinist had set the tool to the proper height and located it so that the work would be turned to the required size, an apprentice could operate the machine. After the work was counterbored the circular cutting tool just described was fed across the work; then the operator stopped the machine, removed the piece by means of a special wrench, and ran the carriage back by hand, after which he was ready to repeat the operation. It was discovered that about 200 pieces of work could be finished before there was any noticeable wear on the tool. When this occurred, another keen cutting edge was obtained by loosening nut *H* and turning the tool until the next graduated line along its lower edge coincided with the index line on the support. It is apparent that as the locations of the axes of the tool and work remained unchanged during this adjustment, the size of the work finished by the readjusted tool would be the same as that of the work finished by the tool prior to the adjustment. Cutting tools of this type could be adapted for many turning jobs where it would not be required to work close to a shoulder. When used for cutting brass or similar metals, the edge of the tool can be left at right angles with the side as illustrated at *K*, but when used for cutting steel, the edge must be beveled on the inner side as shown at *L*.



(A) Detail of Work. (B) Method of mounting Work on Machine for Counterboring Operation. (C) Circular Tool and Fixture used for Different Metals

Patterns as Foundry Tools

By JABEZ NALL

IN designing patterns there are a number of essential factors requiring consideration that do not enter into the actual construction of the pattern. For instance, the action of the various metals and their contraction may affect various sections of the same casting differently, requiring special treatment of or allowances in these parts. The action of the metal contracting will affect some castings, in which the metal is of varying thickness, so as to warp or distort them. This distortion can sometimes be avoided in the foundry, or it may be prevented in the pattern shop by cambering the pattern. If, however, the arrangement of the pattern is such that this is impossible owing to the inaccessibility of the parts affected, the cause of the trouble may be attributed to a poorly designed pattern.

The action of the metal in making steel castings differs from the action of the metal in making gray iron castings, and the practice in the two types of foundries is therefore different. In molding gray iron, for instance, the molder can insure a solid casting by keeping the feeding head, or riser open by churning and by adding molten metal from time to time to fill the space caused by contraction as the metal congeals and the casting becomes set. When molding steel castings, the metal congeals so quickly that it is not possible to do this, and a sufficient head pressure must be provided to insure solidity and to furnish a body from which the casting can draw the metal required to fill the space caused by contraction. In steel castings this space is about double that in iron castings. If the metal is thin at the cope side of the casting, the feeding head, in order to be effective, must be of liberal proportions so that the metal will not congeal too quickly, or in shop parlance, "freeze." A sufficient thickness of metal must be added at this place to permit the feeding of the heavy metal below.

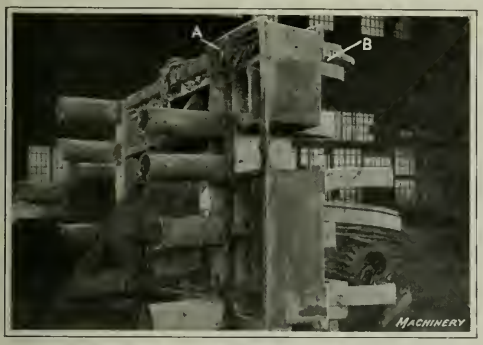


Fig. 1. Base of Bulldozer Frame Casting, showing Location of Feeding Heads

A case in point is illustrated in Fig. 1 which shows the base of a bulldozer frame casting, the metal of which is quite thin compared with that in the drag side of the casting. The head at *A* has been entirely removed by an electric arc, but all the metal below the head has been left so as to connect with the heavy metal in the bearing at *B*, where it is essential that the casting be solid. It will be noticed that the other heads have not as yet been removed. This illustration emphasizes the fact that a thorough knowledge of what is required in the foundry is essential in making patterns. To satisfy these requirements it may be necessary to depart from the non-essential details of the design.

How Different Metals Affect the Design of the Pattern

The simple form of pattern shown in Fig. 3 will serve to illustrate the fact that a pattern may be properly designed for use in producing castings of some one particular metal and at the same time be altogether unsuitable when used to produce castings from some other metal. The illustration represents a form of clamp, having three bosses, one at each end and one at the center. The central boss is for a clamping or binding screw. As a reinforcement, the top of the casting is arched as shown. According to common practice, most patternmakers, if given this pattern to make, would immediately plan on providing a split pattern, parted on the center line *CC*. This would be entirely proper if the casting were to be made of iron, but if it should be a steel casting, this method would not be the best one to follow. The reason for this is that in order to get a solid steel casting the molder must place feeding heads at each of the three high spots *A*. These heads must afterward be removed and the surfaces where they formerly joined the casting must be smoothed, thus adding considerably to the cost of finishing the casting.

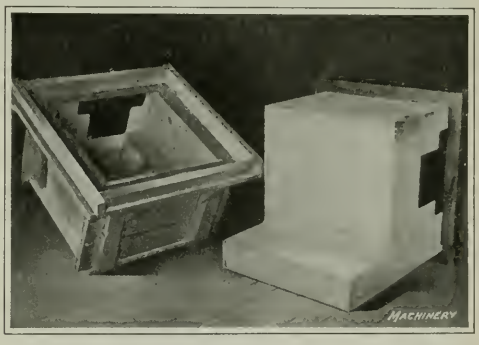


Fig. 2. Pattern and Core-box used in producing a Slide Casting from Cast Iron

If, however, this pattern were made in one piece and if it were molded in such a position that the crown of the arch would become the high point in the mold, one large head placed at point *B* would be sufficient to insure a solid casting. In such a case the head should be placed so that it may be conveniently and cleanly removed by the use of an oxy-acetylene flame. This makes a stronger pattern, with which a casting can be more quickly molded and which will produce a better job in every respect. If many castings are to be made, a sand-match or a follow-board should be provided. A pattern made to mold in this way may also be used in the same manner and with equal success when cast iron is used.

Another case which illustrates the fact that the construction of the pattern should be governed by the metal being molded is shown in Fig. 4. It will be noticed that the front walls are rather light compared with the metal in the rear part of the casting. These castings were originally made from cast iron, the pattern being arranged as indicated in Fig. 2 with an overhanging core-print for setting the core. This method gave excellent results both in molding and in the quality of the castings produced. The overhanging print allowed the core to act as a covering core, so that the cope half of the mold was not necessary, thus reducing the molding cost. The mold was made on a jarring machine.

This same pattern proved a failure when it was later used as a tool to produce steel castings owing to the fact that steel, when molten, congeals much more quickly than iron. Consequently, imperfect castings were produced, caused by feeding the heavy sections of metal through the lighter sections. When drilling the holes shown in the illustration of the casting, Fig. 4, the drill would invariably run into shrink holes, or into defective metal, thus making it difficult to obtain a perfect bore and often resulting in the breakage of drills. As the pattern was made to mold in the manner referred to, the most economical remedy seemed to be to change the pattern to allow it to be molded on the side as shown in Fig. 4, and to extend the core-print as shown in broken outline, so as to furnish a better guide and balance for the core in the mold. The molder was then able to place one or more feeding heads directly above the heavy parts of the casting, thus obtaining enough pressure and sufficient metal to draw upon to insure a solid casting throughout. This change eliminated the entire trouble.

Factors of Strength and Contraction in Pattern Construction

When considering how best to arrange a pattern for any given job, the patternmaker is confronted with the fact that there are usually several ways of doing the job, and the selection of the proper method depends upon his knowledge of foundry methods. In this connection, there are a number of factors to be considered, one of which is the construction of the pattern so that it will retain its shape and be strong enough to insure a long life under the hard usage which it is sure to receive in the foundry. This usage is particularly severe in steel foundries where the sand is rammed much harder than it is in iron foundries. It is also very important, particularly in molding large work, to provide means for withdrawing the pattern from the sand and also to make the pattern itself rigid enough to withstand the pulling power of a large crane.

The amount of pull that a heavy pattern must withstand is well brought out by a recent experience of the writer when making castings from a large pattern, approximately 17 feet long and 58 inches deep. This pattern was of a shape that made it difficult to build for strength, although it seemed strong enough when completed. Following the usual procedure, machine-steel lifting straps were employed to withdraw the pattern from the mold. These were made about 3 feet long and were hooked into and bolted to the inner framework of the pattern. The pattern was used successfully in making the first two castings, but in making the third mold, either the same care was not taken in starting the draw, or on account of the hot, damp sand of the foundry floor, or for some other unknown reason, the pattern stuck in the mold. The pull from the 50-ton crane used in removing patterns from the mold was so great that two of the lifting straps were pulled out and the parts of the frame to which they were bolted were torn away from the lower part of the frame. After much difficulty, the pattern was finally

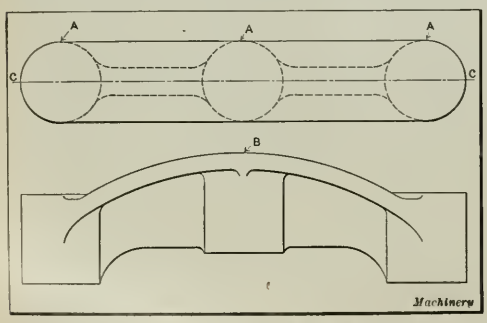


Fig. 3. Pattern used to illustrate Molding Methods for Different Metals

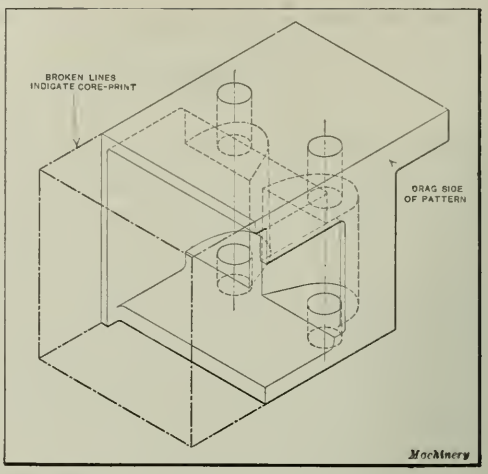


Fig. 4. Slide Casting made from Pattern illustrated in Fig. 2 showing Core-print as arranged to produce Steel Castings

removed—badly damaged—but the mold was not destroyed. The cause for this failure was that the amount of suction at the bottom of the mold was underestimated. Another considerable factor was that of friction on the sides of the pattern, although sufficient draft had been provided. The trouble was remedied by carrying the lifting straps to the full depth of the pattern, hooking and bolting them to the under side of the lower edge of the framework, so that it could not be pulled apart.

The difference in the allowance to be made for the contraction of various metals, as previously stated, is an important point to be considered. For castings of ordinary size and for small sized castings, this difference is not great and the standard shrinkage may be allowed with good results; but on account of the many and varied designs of castings, this factor of contraction affects various castings in different ways. It is not sufficient, for instance, to state definitely that the shrinkage allowance for steel castings should be 3/16 inch to the foot and apply that rule to all steel castings, because practical experience has taught that many castings do not contract uniformly and that some sections of the castings may contract less and certain other sections even more than the standard rule for the material of which the casting is made. Large sized steel castings which require many cores in molding will not contract the standard amount, and it is the experience of the writer that about one-half the accepted allowance, or 1/10 inch to the foot, is approximately correct for this material under these conditions

* * *

As the rolling stock on most European railroads is in a worn-out condition, and the demands on the plants in Europe building locomotives and railroad cars are heavier than the capacity available, it is evident that there must be an opportunity for a considerable export trade from the United States, especially in locomotives, but also in railway cars, if American builders could obtain large enough orders to warrant equipping for the type of railway cars used in Europe. The rapid revival of Belgian industry and trade make necessary additional railway facilities in that country, and as neither Germany nor France are able to meet their own requirements in the building of railway equipment, orders for locomotives have been placed in the United States and England. Freight cars, so far, have been bought chiefly from Great Britain. At the time of the armistice, 932 miles of Belgian railways had been destroyed, but practically all of these have now been replaced, which is a remarkable record, considering the difficulties to be overcome.

Carburizing and Casehardening

Methods of Treating Steel after Carburization, Tempering Practices, Packhardening, and Other Methods of Hardening—Third Installment of a Series

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THERE are really only four methods of treating work after it has been carburized; these are as follows: (1) Pot quenching, which consists of a single quench from the carburizing pot at or near the carburizing temperature. (2) Pot cooling and single quenching, consisting of cooling the carburized work in the pot and quenching slightly above the hardening or critical temperature of the case. (3) Pot quenching and single cooling, consisting of a single quench from the pot at or near the temperature of carburization, followed by a quenching from slightly above the hardening or critical temperature of the case. (4) Pot cooling and double quenching, which consists of cooling the carburized work in the pot, quenching slightly above the toughening or critical temperature of the core, and again quenching slightly above the hardening or critical temperature of the case.

First Method of Heat-treatment

Casehardening was first accomplished by wrapping pieces of steel, roughly cut into files and tools, in the skin of an animal, together with horn and bone. . This was laid in the fire and heated to a red heat after which the steel was removed and quenched, thus obtaining surface hardness. This method corresponds to the present direct quenching from the pot. When small parts such as screws and nuts are quenched from the pot they are usually dumped into a sieve so that the carburizing material can be screened off, after which the work is put into water or oil. As previously mentioned, sometimes the entire contents of the pot are dumped together into the water or oil, and the work is separated from the carburizing material. After this material is removed from the quenching bath it is dried for future use or perhaps thrown away. This method of heat-treatment leaves the case in a hard but extremely brittle condition, unrefined and coarsely crystalline, while the core is only partially refined and coarse in texture. The work in this condition has no great toughness or resistance to shock, and the best that can be said of it is that it is merely hard. Large pieces, such as wrenches, gages, etc., which due to riddling or rough handling may warp out of shape, are removed from the pot by wires attached to them or by tongs, and quenched separately. Hardness and strength conditions are not changed by this method, even with a drop in temperature before quenching, for the reason that the grain has been set by the highest temperature and the work must cool below the red stage and be reheated in order to cause appreciable diminution of the grain size. Further than this, a condition of liquation or enfoliation takes place, which is a lack of cohesion between the case and the core. On work hardened in this way which must withstand wear or shock there will be a tendency for the case to chip or flake from the core. This tendency commences with a certain degree of carburizing temperature and increases with higher temperatures.

Second Method of Heat-treatment

By cooling in the pot and rehardening at from 1400 to 1450 degrees F., the structure of the case will be refined, giving maximum hardness with maximum toughness. The core structure, however, will not be refined and in consequence the core will not have the maximum toughness of which it is capable. Danger of enfoliation will also be great. This method is widely used and gives excellent results for a multitude of parts such as bearings, camshafts, arbors, gages, etc. Parts treated in this way are less liable to warp, as the hardening treatment is given at a low temperature and the shock of coming in contact with the quenching medium is not so great as when quenched at higher temperatures.

Third Method of Heat-treatment

Quenching from the pot and again rehardening at a temperature of from 1400 to 1450 degrees F. will serve the purpose of refining the case to a great extent and will likewise bring out the natural qualities and toughness of the initial steel or core. The rehardening will not disturb the core conditions secured in the first quenching operation, but will refine the case and give maximum hardness with the toughness. This treatment causes the case and core to unite more and form a less abrupt line of transition so that enfoliation is only slightly in evidence.

Fourth Method of Heat-treatment

Cooling in the pot, rehardening at about the critical temperature of the core, and quenching (the critical temperature being from about 1550 to 1650 degrees F., depending upon the original carbon content of the steel), and rehardening at the critical temperature of the case (1400 to 1450 degrees F.) will serve to refine the core and case to the maximum extent. The result will be maximum toughness and grain refinement of core, and maximum toughness, grain refinement, and hardness of the case. The function of cooling in the pot is to allow the structure of the steel to come to rest, which helps to prevent warpage from internal strains. This

treatment tends to make more uniform work, especially with regard to the core, than pot quenched work, as the first quenching is apt to be controlled closer than a quenching from the pot. It also adds slightly to the depth of the carburization; saves carburizing material from exposure to the air; saves a slight scaling on the inside of the pot; and avoids subjecting the workman to excessive temperature. Such treatment also decreases the danger of enfoliation to a minimum.

Relative Qualities of Oil and Water for Quenching

Water or oil can be used for any of the quenchings. Screws, nuts, and other small uniformly shaped parts requiring more hardness are usually dumped into water. Intricate and delicate parts which are liable to warp or crack should be quenched in oil in order to obtain core refinement. Where the single pot quench only is desired, it will be found that there will be no appreciable loss in the hardness of the case by using oil instead of water. Extremely delicate parts may be floor-quenched, that is, laid on the floor to cool to obtain partial core refinement. In quenching to obtain case refinement, there is less danger of warpage due to a lower temperature; still certain shapes will warp excessively and sometimes fixtures must be used to hold the parts in shape. Oil-quenching will cause very little warpage, but it will be found that the hardness of the case will not be so great when oil is used as when water is used. The hardness will decrease as the cross-section of the work increases, approximately according to the following table, which gives the readings on the scleroscope:

Hardness Reading on Scleroscope

Area of Cross-section, Sq. Inches	Water-quenched	Oil-quenched
0.5	90	85
1	86	78
2	83	70

Owing to the difference in time required to cool the work by quenching in water and oil, it is necessary to start to quench in oil at a temperature about 25 degrees F. higher than is necessary when quenching in water, in order to approximate the same refinement of grain in the case. The chart shown in Fig. 10 depicts graphically the relation of the grain size of the original steel to the grain size of the case and core when treated according to the four treatments outlined.

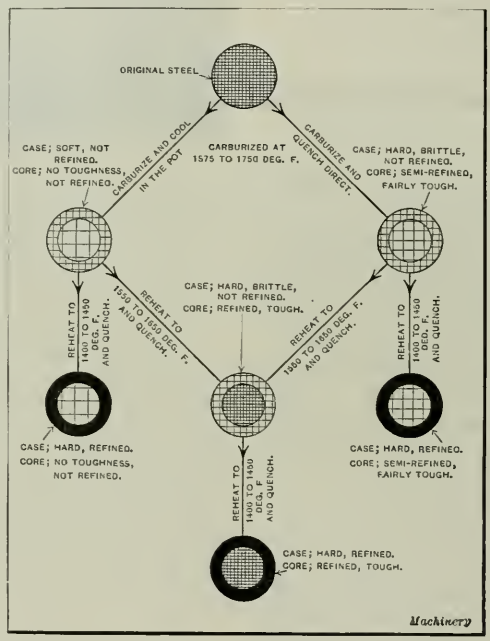


Fig. 10 Diagram showing Relative Grain Size of Work after Each Method of Heat-treatment

Tempering

Tempering, the process of drawing back or relieving strains, consists of simply reheating the hardened work to medium temperatures, and quenching, thus toughening the work and eliminating the danger of cracks and breakages at the expense of the initial hardness gained by quenching. There are three ways of determining when the work has reached the correct tempering temperature which are as follows; first, by maintaining the bath in which the work is immersed at the desired temperature; second, by sprinkling chemicals or metals on the work, the flash and melting points of which are known; and third, by heating the work and watching the colors.

Water can be used for tempering up to 212 degrees F. only, but by adding salts, such as calcium chloride, this temperature can be increased to some extent. Immersion of the work in oil baths is the most common form of tempering when the temperature does not exceed 600 degrees F., but there are a number of special and stock oils whose flash point is slightly over 600 degrees F., which may be used with absolute safety. For higher temperatures, niter baths, sometimes made of 50 per cent sodium nitrate and 50 per cent sodium nitrite are used. This mixture melts at about 500 degrees F. and can readily be used for temperatures as high as 1200 degrees F.

Open-fired furnaces of various designs are often used for tempering, and in this case, the work is piled up in the furnaces in racks or trays. The heat is controlled by a pyrometer system, and the work is allowed to remain in the furnace until entirely heated through. Such tempering is used on heavy railway springs, shells, gun barrels, etc. The tempering of articles by immersing them in oil of known flash and fire points and reheating until the oil starts to burn, is a method used on springs and small articles where no degree of precision is required. This method imparts a black finish to the article. On gun parts where it is desired to have this black finish uniform, sand and oil are used to temper the work by heating it over a flame in a hopper open at the top until the oil is burned off.

Some hardeners sprinkle salt, sawdust, lead filings, etc. on the work as they are heating it, to determine the degree of heat which it has reached. Tempering in a lead pot is a method often used, as lead has a wide range of temperature in the molten condition and its heating can be closely controlled. This method is used for springs requiring close control.

Color tempering consists of heating the work slowly and watching the colors as they appear on portions of the work previously polished. The tempering colors are a very good guide in determining the temperature of the work, provided the work is heated slowly so that there is no perceptible lag from the outside to the inside and the carbon content of the work does not vary more than 30 per cent. Mercury thermometers are in general use for temperatures up to 700 degrees F., but for higher temperatures, electric pyrometers are customarily used, although heat indicators based on the expansion of the metal are sometimes found satisfactory. Salt or niter baths leave a coating of the salt on the work, but immersion in water will remove this coating, after which the work can be dried in sawdust or air. The salts may be saved by evaporation of the water if it is thought expedient.

Removal of Oil from Work after Oil-tempering

Oil tempering baths, as a rule, cause considerable trouble because the heavy oil which is used for this purpose adheres to the work, especially in small holes, etc. Some users dip the oily work into kerosene to remove the heavy oil and then dump it in sawdust. The work may be dipped in a solu-

tion of sal soda, tri-sodium phosphate, or other prepared compounds, in order to remove the oil, after which it is given a final rinsing in water. A homemade oil-tempering furnace, and hot soda and water cleaning vats are shown in Fig. 11. Compressed air is used to stir the oil and keep it from charring in the bottom of the tank. The tilted runway is a drain to allow dripping oil to run back into the tempering tank. The two tanks seen at the right contain alkali cleanser and water. After tempering and draining the work, it is dipped into the alkali and then into the hot water, from which it emerges free from oil.

The flash point of heavy tempering oils is usually about 600 degrees F., while the majority of carburized work is tempered at from 300 to 450 degrees F. which leaves a large margin of safety. There are a number of thin body oils with flash points around 500 degrees F. which can be mixed with heavy tempering oils, thus producing an oil which will not stick to the work excessively and yet which will not have a dangerously low flash point. When dipping the work in the soda solution to remove the tempering oil, if the work is dipped quickly after the tempering and the solution is kept hot to the point of boiling, the work will not be hardened appreciably by this quenching effect, and the soda will remove the tempering oil very much quicker. Scum is eventually formed on the surface of the solution by the excessive tempering oil, and this scum should be removed by skimming with a board or by laying a newspaper on the surface, which acts as a blotter.

Table 5 shows, in scleroscope and Brinell units, the relative hardness of carburized steel, subjected to different tempering temperatures after the work had been hardened at a temperature of 1450 degrees F. by quenching in oil. This table cannot be relied upon absolutely, but it can be used as a basis on which to figure the depth of case and the percentage or concentration of carbon that will affect the depth of case. The steel from which this test was made showed 1.08 per cent carbon in a depth of 0.010 inch.



Fig. 11. Oil-tempering Furnace, and Soda and Water Cleaning Vats

In MACHINERY'S HANDBOOK, page 1139, there is a table which gives the color of the steel at various tempering temperatures, and also at high temperatures. By referring to this table, it will be noted that no change in color is visible for temperatures between 570 and 752 degrees F. Table 6 shows a list of the tempering colors and temperatures which are used by a certain concern for tempering various tools and parts. These temperatures can be used as a guide for all cases except where high-speed steel is used.

Pack-hardening

Pack-hardening as usually conducted is actually carburizing, the only departure from the process, in general, being that the temperatures of the heats are lower. Correctly speaking, pack-hardening is the process whereby high-carbon steels or steels that will harden without the aid of carbon added by carburizing may be protected from furnace gases and air. By packing in some carbonaceous material, the work is protected by the carbon gases given off, and in quenching from the pot, the work is clean and free from scale. A valuable point in favor of this operation is that the work is brought to the quenching temperature slowly and uniformly, and so dangers of cracking and warpage are reduced to a minimum. Any carburizer can be employed in packing, used material being the best, as the carbon strength of the gas is lower and there is less danger of carburizing the work. The danger of decarburizing is slight, provided the lowest temperature that can be used for hardening the work is employed. The length of time of the operation has a tendency to increase the grain size, which is augmented by high temperatures. It is dangerous to carburize the surface of high-carbon steel, because a line of demarcation between the case thus produced and the case of the original steel will shorten the life of the part. Minute surface cracks usually develop after hardening.

In a certain instance, trouble was experienced in securing a surface free from soft spots on gage disks of high-carbon steel, so a heat-treatment was used with no better results. The hardness test was very severe, as the tool-room foreman drew a diamond wheel dresser over the surface under severe pressure. Pack-hardening was attempted, and at first the gages were packed in fairly fresh carburizer and put in a furnace having a temperature of 1700 degrees F., with other low-carbon work being carburized. After quenching, the work was found to satisfy the hardness requirements and was then accepted for grinding and lapping. The grinding was done with utmost care on a wet wheel. During the lapping operation small cracks began to appear on all the work, causing it to be condemned. Success was eventually attained by heating the work at a temperature of about 1425 degrees F. Pack-hardening of low-carbon steel is a misnomer, because what is done is really carburizing.

Common hard wood charcoal perhaps answers best the requirements for pack-hardening, especially if it has had an initial heating to eliminate shrinkage and discharge its more impure gases. The work is packed as in carburizing and in the same type of receptacle. A wire attached to each piece and brought up in a loop to the under side of the cover allows the work to be removed easily. By carefully fastening these wires to the work, each piece can be quenched in relation to its axis so as to reduce quenching warpage to a minimum. Bone is often used for this work, but as it is so active in its carburizing properties at low heats, it is usually advisable to mix it with charcoal.

Work Coloring Process

Work is not colored so much now as formerly; however, certain classes of tools, nuts, and bolts are treated this way. Work so treated has been thought to be superior to other work and it has also been considered rustproof. The superiority of work treated in this manner is mainly in the pleasing effect that it gives, as no improved physical properties are attached to this method, and the work will rust nearly as readily as uncolored but hardened work. The



Fig. 12. Photomicrograph of 0.4 per cent Carbon Steel after being immersed in Cyanide and quenched in Oil. White Surface is Zone of High Carbon Content

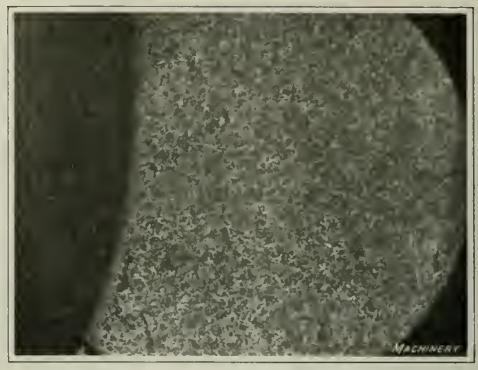


Fig. 13. Photomicrograph of 0.4 per cent Carbon Steel after being pack-hardened in Bone and Charcoal, cooled in the Pot, and rehardened in Lead

coloring is an indication that the work has received heat-treatment.

The method of coloring is to pack the work, which has previously been polished and cleaned so that there is no grease or finger marks on it, in charcoal, bone, or a mixture of the two; heat as in carburizing to from 1475 to 1550 degrees F.; hold at this temperature so that the desired depth of case is obtained; remove the pot from the furnace, throw off the cover, and hold the pot just above the water quenching tank; turn it over quickly and let the entire contents fall into the water. If a sieve has first been placed in the quenching tank, the packing medium will fall through it, but the work will be caught and there will be no danger of soft spots. The colors are heightened by having air bubbling up through the water tank. The colors obtained are merely air tempering colors resulting from oxidation on bright steel, and the same colors may be produced by slowly heating polished steel, but the beautiful mottled effect will be missing, as the surface oxidation is more uniform. The vividness of the colors can be enhanced by adding leather and cyanide to the bone and charcoal. After a little practice, beautiful results can be obtained. The colors can be brought out more vividly by rubbing the work with oil before it is cold.

Pack-hardening High-speed Steels

The pack-hardening of high-speed steels is extensively done. There are many tools which are so delicate and have such a variation in cross-section that only with extreme care can they be hardened in the open furnace and preserve the delicate edges and corners. Other high-speed tools which cannot be ground after hardening or economically lapped are successfully pack-hardened. The best method that the writer has used for this purpose is as follows: The iron pot of a lead pot furnace was replaced by a black-lead crucible, only about 2 inches larger in diameter than the largest dimension of the work to be hardened. The crucible was filled with finely ground hard wood charcoal and heated. As the charcoal shrunk, new material was added until the shrinkage was materially reduced. In the meantime, the work was wired for easy removal from the crucible and in some cases preheated to from 900 to 1000 degrees F. The furnace was then shut off and the charcoal removed from the crucible to within 2 inches of the bottom. The work was then placed in the crucible and a fire end attached to a pyrometer was placed next to it. The still hot charcoal was poured back into the pot and the furnace was started. The pyrometer was watched so that the rate of heating was uniform and when the temperature indicated was 2000 degrees F., the furnace fuel supply was reduced slightly. The indicated temperature increased to about 2200 degrees F. in from fifteen to twenty-five minutes. The wires to which the work was attached were then grasped with tongs, the work removed and quenched in oil.

Work handled in this manner has undoubtedly had the original surface carbon content increased. The core, however, has received the full benefit of the correct heat, which helps to eliminate this disadvantage. High-speed steels so treated make better finishing tools, and at the same time retain the heat-resisting qualities of high-speed steel. However, high-speed steel is not intended for use as a finishing steel but for heavy-duty work, and so it is advisable to heat in a muffle furnace when possible. The largest makers of high-speed tools do this and the cost of this steel warrants the greatest care in this operation.

There are several pack-hardening preparations on the market which sell because the average hardener is unfamiliar with the steel. One compound composed of non-shrinking petroleum, coke, and carbonaceous materials is used for packing the work. A heat of 1750 degrees F. is used, after which the work is either quenched direct or cooled in the pot, and rehardened at 1450 degrees F. The work becomes hard on the surface, but the core remains soft. High-speed steels do not depend on carbon for their hardening and heat-resisting power but on other elements, particularly tungsten. High-speed steel treated as described in the foregoing is no better than a good grade of tool steel and is little better than carburized low-carbon chromium steel. High-speed steel properly hardened should never be glass-hard, as toughness, and heat- and shock-resisting qualities are the properties required. It has been determined that from 1000 to 1150 degrees F. are the best tempering temperatures to use, depending on the chemical composition.

TABLE 5. RELATIVE HARDNESS, IN SCLEROSCOPE AND BRINELL UNITS, OF CARBURIZED STEEL TEMPERED AT VARIOUS TEMPERATURES

Tempering Temperatures		Instrument Readings	
Degrees Fahrenheit	Degrees Centigrade	Scleroscope	Brinell
0	0	86	675
300	148.9	86	675
400	204.4	85	650
500	260.0	83	580
600	315.6	79	530
700	371.1	75	480
800	426.7	71	430
900	482.2	67	360
1000	537.8	60	290

Machinery

Cyanide Hardening

The use of cyanide for hardening is not a casehardening or carburizing process, but it is, in a way, analogous to pack-hardening. When work is immersed in heated cyanide, it is protected from air oxidation, and the cyanide imparts carbon to the surface. Cyanide hardening is used for several purposes, some of which are as follows: to harden low-carbon steel by giving it a

hard surface, which is applicable to set-screws, and light snap and plug gages where depth of hardness is not of great importance but where a very shallow or surface hardness is required; to harden medium carbon steel, when the parts made from it must combine the available toughness of this class of steel and a surface hardness; to harden tool steel to prevent finished ground parts from scaling and to diminish the danger of soft spots; and to harden carburized work, which through previous hardening by other methods, has developed soft surface spots.

This shallow hardened surface is found to be extremely high in carbon, being much higher than is obtained by the carburizing process under ordinary commercial conditions. For this reason it is possible to use low temperatures and obtain the desired surface hardness. By the use of too low a temperature in hardening tool steel, it may be found with a test file that the work is hard but the steel directly underneath the surface will be soft; this applies to carburized work. By the use of too low a temperature with a medium-carbon steel, the steel under the hard surface may not have obtained the required or possible physical qualities. By the use of a low temperature on low-carbon steels, no harm results, provided the surface hardness conditions are met. It is therefore desirable to heat the steel at a temperature called for by the steel itself and ignore the hardening temperature of the cyanide case. This, however, does not apply to low-carbon steels as a general rule, for the reason that the critical temperatures of such steels are high and at such temperatures cyanide boils, gasifies or volatilizes rapidly and in consequence is very wasteful. Temperatures of over 1500 degrees F. are seldom used for cyanide.

The surface hardness depth obtained with cyanide is never great, being rarely over 0.015 inch. The carbon absorption by the surface is unlike that when using the solid carburizing material in that its initial depth of carbon is given to the steel in a very short space of time, and this initial depth immediately chokes off further penetration. Longer exposures to cyanide will only deepen the case a little. Long exposure to the cyanide will also cause the carbon to intensify on the surface to the extreme, thus leaving the work in a condition of intense surface hardness and brittleness with an abrupt line of demarcation between this case and the original steel. This condition often impairs the results desired because surface cracks start easily and erratic shock-resisting qualities are obtained. Cyanide furnaces are merely lead pot furnaces where the lead is replaced by cyanide salts.

Properties of Cyanide

Cyanide is a deadly poison, and where large quantities are used it is best to have a hood over the furnaces to carry off the fumes. When the furnace is used for only a short time, there is little or no danger to the workman unless he is careless and deliberately breathes the fumes. The fumes of cyanide cause sneezing, and in this way the workman is warned of their presence. Care should be taken not to get it under the finger nails, as the fingers may be put in the mouth, and care should also be taken to expectorate if the cyanide spatters and gets on the tongue. Cases where men have been killed or injured by the poisonous effects of cyanide when used for heat-treating steel are extremely rare.

Cyanide, for hardening purposes, is in the form of cyanogen gas held in solution by a salt, either potassium cyanide or sodium cyanide. The former is very expensive and at present is not always available. A great many surface hardening salts are on the market intended to replace cyanide, but they are merely dilutions of cyanide salts with barium, saltpeter, common salt, etc. They sometimes have the advantage

TABLE 6. TEMPERING TEMPERATURE FOR VARIOUS TOOLS AND PARTS, AND COLOR OF METAL AT DIFFERENT TEMPERATURES

Tool	Color of Metal	Temperature in Deg. F.	Tool	Color of Metal	Temperature in Deg. F.
Augers	Light purple	530	Gimlets	Dark purple	550
Axes	Dark purple	550	Hacksaws	Dark purple	550
Bits, half round	Straw yellow	460	Hammers and drop-forge dies	Spotted red brown	510
Bone, cutting tools	Very pale yellow	430	Hammer faces	Very pale yellow	430
Boring-cutters	Straw yellow	460	Hand plane irons	Brown yellow	500
Butt-mills for brass	Very light yellow	420	Hand reamers	Straw yellow	460
Cams with sharp corners	Very dark blue	601	Hand springs	Purple blue	530
Chasers	Straw yellow	460	Hand taps and dies	Straw yellow	460
Chisels, cold, for cast iron	Dark purple	550	Hand tools	Light yellow	440
Chisels, cold for steel	Light purple	530	Ivory cutting tools	Very pale yellow	530
Chisels, cold for wrought iron	Light purple	530	Jaw pieces	Purple blue	530
Chisels, firmer	Dark purple	550	Lathe tools for brass	Very light yellow	420
Chisels for wood	Very dark blue	601	Mandrels, drawing	Very light yellow	420
Chuck jaws	Spotted red brown	510	Milling cutters	Straw yellow	460
Clutch bolts	Very dark blue	601	Milling cutters for brass	Very light yellow	420
Clutch springs	Blue	549	Milling cutters, small	Straw yellow	460
Collets	Dark yellow	490	Molding and planing tools	Dark purple	550
Coppersmiths' Tools	Light purple	530	Needles	Dark purple	550
Cutters, edging	Light purple	530	Paper cutters	Very pale yellow	430
Cutting tools for iron	Light yellow	440	Parts subject to shock	Very dark blue	601
Cutting tools for soft materials	Very light yellow	420	Penknives	Straw yellow	460
Dental and surgical instruments	Light purple	530	Percussion tools for metals	Blue	549
Dies, bending and forming	Dark yellow	490	Planer tools for iron	Straw yellow	460
Dies, embossing	Light yellow	440	Planer tools for steel	Very pale yellow	430
Dies, large cutting	Straw yellow	460	Reamers	Straw yellow	460
Dies, large, forging, for presses	Dark yellow	490	Saws, bone and ivory	Dark purple	550
Dies, leather cutting	Straw yellow	460	Saws, circular for metal	Light purple	539
Dies, press, for brass	Light purple	530	Saw teeth, inserted	Straw yellow	460
Dies, press, for cold-rolled stock	Brown yellow	500	Saws, wood	Dark blue	570
Dies, press for leather	Straw yellow	460	Scrapers	Very light yellow	420
Dies, press, for paper	Dark blue	570	Scrapers for brass	Very pale yellow	430
Dies, screw-cutting	Straw yellow	460	Shear blades	Dark yellow	490
Dies, press, for sheet steel	Straw yellow	460	Shell reamers	Brown yellow	500
Dies, threading	Light yellow	440	Springs	Dark purple	550
Dies, wire-drawing	Straw yellow	460	Steel engravers' tools	Very pale yellow	430
Drifts	Brown yellow	500	Stone-cutting tools	Brown yellow	500
Drills, flat, for brass	Brown yellow	500	Taps	Straw yellow	460
Drills, flat, for iron and steel	Straw yellow	460	Tools, wood, not to be filed	Spotted red brown	510
Drills for brass	Straw yellow	460	Tools, wood, to be filed	Purple blue	530
Drills, rock	Straw yellow	460	Turning tools	Very pale yellow	430
Drills, twist	Brown yellow	500	Wood boring cutters	Brown yellow	500
Gages	Brown yellow	500	Wood engraving tools	Very pale yellow	430

Machinery

that by proper mixture, higher temperatures can be attained at a minimum of escaping gas or volatilization.

Cyanide Hardening Harmful to Steel

The following experience shows that the use of cyanide baths for hardening is often harmful to the steel, due to the extremely high carbon case, brittleness, and sharp line of demarcation. During the war there were two concerns engaged in the manufacture of a machine gun which used steel having the same specifications, or 0.45 to 0.55 per cent carbon. One concern, however, cyanide-hardened practically all the parts of the gun, which required a hard surface for wearing purposes. The other concern pack-hardened the gun parts in bone and charcoal, and finally hardened in a lead bath. The first concern was able to obtain a very high production in its hardening shop at a very low expense, because the large floor space necessitated for the regular pack-hardening process and the cleaning of the parts were not required. However, a number of the gun parts which were subjected to extreme shock conditions on the firing of the guns broke, and a thorough investigation of the trouble was made. A number of samples of cyanide-hardened work and pack- and lead-hardened work of parts picked at random were selected with samples furnished by the firm which used the pack- and lead-hardening process. This investigation was conducted at one of the government arsenals, a Charpy hardness testing machine being fitted up to strike the parts and thus affect them in the same way as the force of the explosion of the gun. It was interesting to note that about 20 per cent of the cyanide-treated parts broke readily, while the remaining cyanide-treated parts stood up and could not be broken, but none of the pack- and lead-hardened parts were broken. It might be thought that the steel from which the broken parts were made was faulty, but microscopic examination of the fractures failed to disclose such a condition or an extreme size of grain in the core. Everything seemed to point to the fact that the cyanide-hardened work was unstable and could not be depended upon under shock conditions. The photomicrographs, shown in Figs. 12 and 13 show the differences in effect on the steel of cyanide-hardening and pack-hardening. Fig. 12 shows a piece of 0.4 per cent carbon steel which was immersed in cyanide at a temperature of 1500 degrees F. for twenty minutes and quenched in oil. Fig. 13 shows a piece of the same steel after it had been pack-hardened in bone and charcoal, cooled in the pot, and rehardened in lead at a temperature of 1500 degrees F. Both samples were carefully annealed at the same time before polishing. The white surface seen in Fig. 12 is not decarburization, but is the zone of the high carbon content. Its resistance to the needle scratch can readily be seen. Note the lines of demarcation of case and core in both of the illustrations.

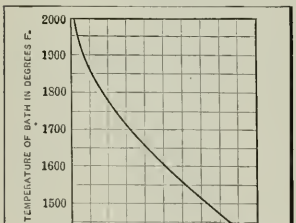


Fig. 14. Economical Percentages of Salts of Barium Chloride and Potassium Chloride to use for Various Temperatures

Sometimes cyanide is sprinkled on the work in powdered form as a quick means of obtaining surface hardness. The action is exactly the same as when the work is immersed, except that poorer results are obtained because the work is not exposed to the action of cyanide long enough to get the full benefit. Cyanide is often used for coloring work; if the work is removed from the cyanide pot and passed through a water spray into the water quenching bath, beautiful colors are given to the steel. The cleaner and smoother the surface of the metal, the better the colors will appear.

Use of Salt Baths in Hardening

Various salts may be used for hardening in place of cyanide salts. In this case no surface hardening is obtained, as the salts are heated and used as a bath in which to heat the work and to protect it against oxidation. Various salts are used, such as barium chloride, sodium chloride, potassium chloride, etc. The mixture of these salts to prevent too much waste from volatilization is an important consideration. The diagram Fig. 14, shows the percentages of the salts of barium chloride and potassium chloride which give the most economical condition of volatilization for the temperatures indicated.

Lead Baths

Lead baths are used more than salt baths for hardening, as there is less waste due to volatilization and sticking to the work, and owing to the weight of the bath there is less fluctuation in temperature when the temperature is high. Furthermore, work immersed in a lead bath heats quicker than when placed in a salt bath due to the better heat-conducting qualities of the lead, and oxidation is also prevented. Lead oxidizes on the surface as it melts and causes globules of lead to stick to the work, especially to threads on the work, etc., which causes inconvenience in cleaning. If the work is tempered after hardening, at temperatures exceeding the melting point of the lead, as in niter baths, the lead will in most cases be removed. The best method of preventing the lead from adhering to the work is to use a good grade of lead containing no tin; keep the molten lead surface covered with cyanide or other salts, or lumps of charcoal; skim the dross off the surface occasionally; and pour a little oil on the lead before adding new salts or charcoal. The cleaner and smoother the work is before immersion, the less the lead will stick.

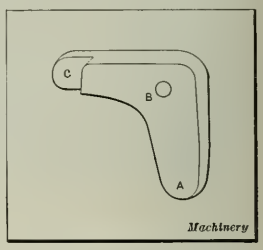


Fig. 15. Work having Different Degrees of Hardness at A, B, and C

The foregoing types of immersion baths are particularly adapted to work which does not require hardening all over, such as punches, drills, etc. They are further adapted to selective hardening, as on the piece shown in Fig. 15. This part was made from a piece of 0.25 per cent carbon steel and carhurized. It was required to show a scleroscope hardness of 70 at *A*, 50 at *B*, and 85 to 90, or glass-hardness, at *C*.

The process, after carburizing, was to harden in an open furnace, draw in a niter bath to 700 degrees F., reharden end *A* in a lead or salt bath, draw the entire piece at 500 degrees F., and reharden end *C* in a cyanide bath.

* * *

There are two kinds of carborundum brick furnace linings: one, the recrystallized or refrax, and the other the clay-bonded, or carbofrax. In the first type, by heating the material in an electric furnace at a temperature of 2000 degrees C., a brick is formed which is well bonded and which has a tensile strength of from 1500 to 2000 pounds per square inch. Carbofrax bricks are made by bonding carborundum with a small percentage of clay and burning at high temperatures. The result is a hard stiff brick, very resistant to abrasion and capable of withstanding high heat. The fact that carborundum has such a low coefficient of expansion readily reduces breaking off and chipping when the brick is subjected to sudden temperature changes; consequently the life of the brick is greatly prolonged. Carborundum bricks retain their mechanical strength even at high temperatures and in this respect differ from most refractories. Carborundum is unaffected by acid or by burning oil. It will not stand the action of molten iron or steel, however, and is also decomposed by alkali at high temperatures.

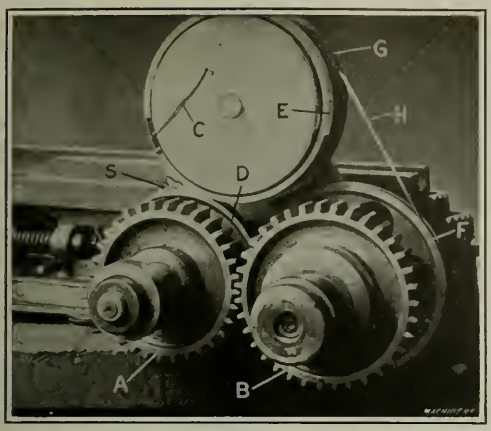


Fig. 1. Top View of Gear-testing Machine

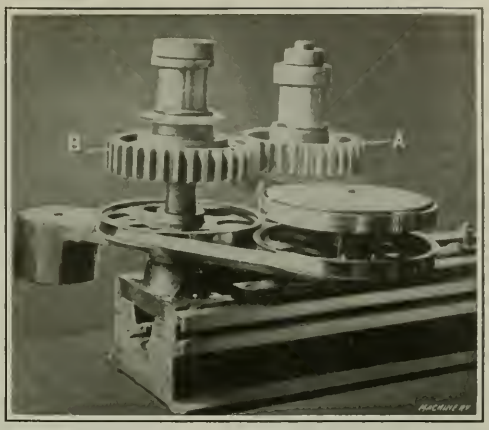


Fig. 2. Rear View of Gear-testing Machine

Gear-Testing Machine

A Machine Designed to Test Spur Gears for Accuracy of Tooth Profile and Concentricity

By G. WIRRER, Mechanical Engineer, International Motor Co., Plainfield, N. J.

BEFORE considering the construction and operation of the gear-testing machine shown in the accompanying illustrations it may be well to review briefly the principal reasons for developing a machine of this type. The quantity production of gears having the extreme accuracy required to insure long wearing qualities has been one of the most difficult problems encountered in the manufacture of engines and transmission gearing for automobiles. While modern gear-cutting machines are capable of maintaining a high degree of accuracy it is necessary that their tool equipment and adjustment be kept as nearly perfect as possible when employed for the quantity production of automobile gearing and gears used for similar classes of work.

Any slight error in the form of the cutter which produces the tooth profile, or any slight misadjustment of the gear-cutting machine will cause inaccuracies in the gear. In many cases it may be impossible to detect these inaccuracies by the usual inspection methods or with the instruments ordinarily available in machine shops. These minute defects may nevertheless be sufficient to cause premature breakage or undue wear, or they may cause slight but objectionable irregularities in the rolling motion imparted to a mating gear. From these brief considerations it is evident that the desired accuracy can be obtained and maintained only by providing means of testing the gears in such a way that these minute defects will not only be revealed, but their cause will also be readily determined.

The gear-testing machine shown in Figs. 1, 2, and 5 is the patented invention of the writer, and was designed primarily to record graphically any imperfections or inaccuracies in a pair of intermeshing gears (particularly in the involute of each tooth) as they come from the gear-cutting machine, so that any error or defect in the gear-cutter, or misadjustment of the gear-cutting machine could be detected and remedied. However, the machine has proved of great value not only in checking and recording the performance of cutters and gear-cutting machines, but also in recording the accuracy of the product after various subsequent opera-

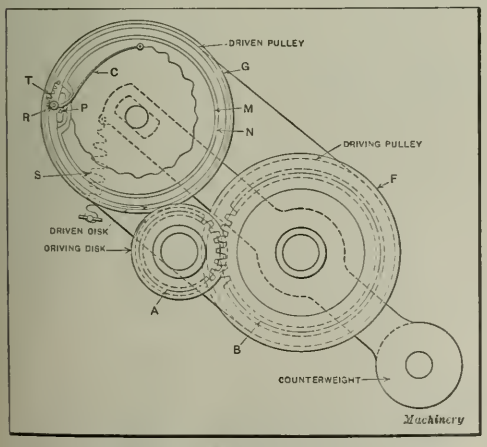


Fig. 3. Diagram illustrating Method of comparing the Rolling Action of Two Gears with the Rolling Action of Two Accurate Disks

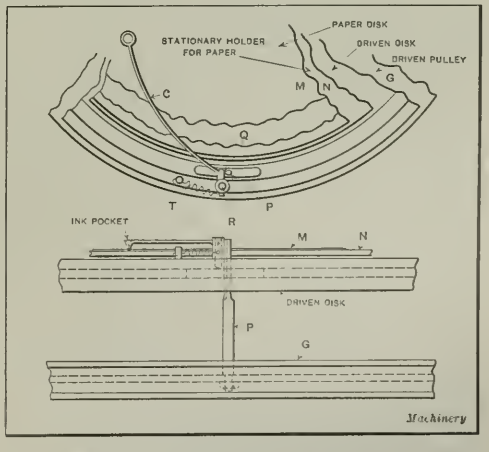


Fig. 4. Mechanism employed to record any Variation of the Rolling Action of Two Gears from that of Two Accurate Disks

tions, such as hardening and grinding. A machine with capacity for testing pairs of gears from 2 to 12 inches between centers is now being used in a large automobile plant.

The principle on which the gear-testing machine operates is the comparison of the rolling action of the pair of gears under test with the rolling action of two circular disks. The result of this comparison is graphically recorded by the testing machine on a chart, thus producing a permanent record. A careful inspection of the chart or diagram will generally reveal at once the nature of any defects detected and the cause of such defects. Briefly stated, the machine consists of a suitable mechanism for comparing the rolling action of the pair of intermeshing gears with the rolling action of two accurate disks.

The comparison is ordinarily made by mounting the pair of gears to be tested on the testing machine, which is shown in its normal position in Fig. 2. The machine may also be employed as shown in Fig. 5 for testing gears under load. Fig. 1 is a top or plan view of the machine. If only one gear is to be tested it must be mounted with a mating gear which has been previously tested and found accurate. When making the test, the shaft carrying pinion *A* is rotated by hand. This action may transmit motion in two different ways to arm *C*, which is provided with a suitable stylus for drawing the diagram: first, by means of disks *D* and *E* which are in rolling contact and have the same ratio as the gears being tested; and second, by means of pulley *G*, driven by belt *H* from pulley *F*. When the driven pulley revolves at exactly the same speed as the driven disk, carrying the recording arm, the pencil or stylus at the end of the arm will trace a concentric circle; but when the driven pulley either lags behind or rotates faster than the driven disk, the pencil arm is moved in or out and traces a spiral.

In either case the line traced will be practically smooth and continuous, that is, it will not have a jagged or broken appearance if the rolling action of the gears is perfect; but if the profile of any tooth is not correct in form, the line will be jagged (see Fig. 6). The nature of these irregularities enables any defect in the gear to be readily detected.

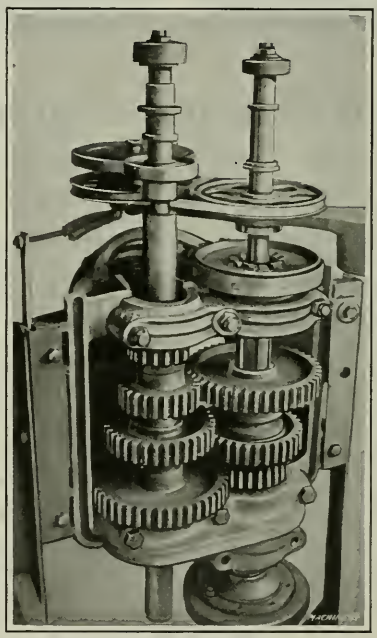


Fig. 5. Testing Gear under Load

The diagram Fig. 3, while not showing complete construction details, illustrates the general arrangement and function of the principal members which constitute the gear-testing machine. In this illustration, *A* and *B* represent the pinion and gear to be tested. As pinion *A* and the driving disk are secured to the same sleeve it is evident that the driven gear and driven disk will rotate or revolve at exactly the same speed. Then, as gear *B* and pulley *F* are secured to the same sleeve and the loose pulley *G* is mounted on a stationary bushing which is concentric with the driven disk, it is evident that both the driven disk and pulley *G* will be driven at the same speed when the shaft carrying pinion *A* is rotated, provided the rolling action of gears *A* and *B* is as perfect as that of the disks, which are held in rolling contact by spring *S*. To accomplish this, the diameters of pulleys *F* and *G* must be exactly the same. If there is the slightest irregularity in the rolling action of the meshing gears it is evident that pulley *G* will momentarily rotate faster or slower than the driven disk according to the nature of the defect in the gear or gears. The stylus arm *C* records these minute irregularities on the chart sheet *M*, placed on the stationary chart-holder *N*. The method of accomplishing this may be readily understood by referring to both Figs. 3 and 4. The fulcrum pin *R* on which the arm *C* pivots is firmly set in the rim of the driven disk, as shown in Fig. 4. Pin *P* is located in the pulley *G*, and contact is maintained between this pin and arm *C* at point *Q* by means of spring *T*. It is therefore evident that any irregularity between the motion of the driven disk and pulley *G* will cause the stylus to move either toward or away from the center of the disk in addition to the rotary motion produced by the revolving disk.

For purposes of comparison, it is possible to use not merely disks with diameters which correspond to the diameters of the gears to be tested but disks which correspond in ratio to the ratio of the gears tested, so that within certain limits gears of different pitch diameters but of the same ratio may be tested without requiring the disks which furnish the standard of comparison to be changed.

From the foregoing description it will be seen that if both gears are perfect, the path traced by the stylus upon the record sheet will be smooth and continuous, being circular if the speed of the driven disk is the same as that of the driven pulley, and spiral if the speed of these rotating bodies is not precisely the same. Any imperfection of any tooth, of either intermeshing gear, will obviously cause a temporary variation in speed of the two rotating bodies, one of which is driven in harmony with one of the intermeshing gears, while the speed of the other is dependent upon the action of the two intermeshing gears. Such temporary variation in speed of the two rotating bodies, one of which influences the stylus-supporting arm which is carried by the other, will produce a temporary departure of the stylus from the smooth continuous line, and the character and location of such temporary departure, as recorded by the stylus upon the record sheet, will indicate the character and the location of the defect in the gears.

Diagrams Indicating Typical Defects in Gears

In Fig. 6 is shown a diagram of an actual record which indicates imperfect rolling action and eccentricity. The size of the original diagram, however, is about twice that shown in the illustration. The actual outside diameter of a complete diagram is 6¾ inches. In Figs. 7 and 8 small sections of typical diagrams are shown to illustrate how the most common defects in gears are indicated by the diagrams and how the diagrams are employed to determine the cause of existing inaccuracies. At *A*, Fig. 7, is shown a section of a diagram produced when testing the accuracy of the gear-testing machine. In making this test, friction wheels were employed in place of the gears shown at *A* and *B*, Fig. 1 The smooth continuous lines resulting from this test indicate that the rolling action between the driving and driven disks of the machine and between the friction wheels employed to check the gear-testing machine is almost perfect.

The diagram shown at *B* was produced in testing a pair of gears as they came from the gear-cutting machine. This diagram shows that the gears were properly cut, the slight departure from a true curve being caused by tool marks. At *C* and *D* are shown the diagrams resulting from tests made on two pairs of gears which were cut with the same cutter but in two different machines. The purpose of these tests

was to check the accuracy of the gear-cutting machines. It will be noted that only slight departures from a smooth curve resulted from the first test. This indicates that the cutter employed was correct in form and that the gear-cutting machine was correctly adjusted. In the second test, the diagram *D* shows that the gear-cutting machine was either worn or improperly adjusted. This example illustrates quite clearly the method of employing the gear-testing machine to check the accuracy of gear-cutting machines.

The diagrams *E* and *F* were made in testing or checking the accuracy of two gear-cutters. In carrying out this test, the first cutter was employed to cut a pair of gears on a gear-cutting machine which had previously been tested and found accurate. These gears were then mounted on the gear-testing machine, and the diagram shown at *E* indicates the result of the test. The slight departure from a smooth circular line indicates that the cutter is very nearly perfect in form. After testing the accuracy of the first pair of gears, another cutter was mounted on the same gear-cutting machine and another pair of gears cut. In testing these gears, the diagram shown at *F* was produced. It will be noted that the line traced by the stylus in this diagram has a toothed appearance, which indicates that the contour of the cutter is defective. The two diagrams *G* and *H*, Fig. 8, resulted from tests made upon gears after they had been subjected to heat-treatment. In these cases the imperfect rolling action due to distortion in hardening is illustrated by the jagged appearance of the lines.

Diagrams *I* and *J* were made in testing a pair of hardened gears before and after lapping. Diagram *I*, while indicating that the rolling action was fairly good, shows the effect of tool marks by the large number of very slight irregularities in the lines. Diagram *J*, which shows the result of a test made after lapping the gears, indicates that the tool marks have been removed but that the true shape of the tooth has been destroyed. Diagram *K* illustrates the result of a test made upon a pair of very noisy gears, while diagram *L* indicates excessive eccentricity in a pair of noisy gears.

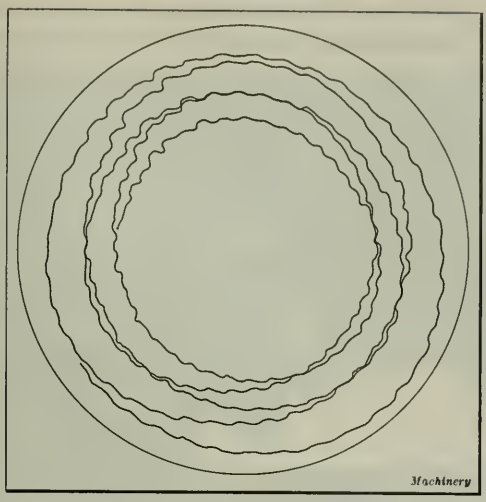


Fig. 6. Diagram indicating Imperfect Rolling Action and Eccentricity of Gears

* * *

The Westinghouse Electric & Mfg. Co., East Pittsburg, Pa., recently transferred seventy-five of its engineers from the Pittsburg works to the South Philadelphia works in a very interesting manner. Contrary to the old system of having every man look out for a home for himself and his family, the company built a large number of houses at Lester, a suburban development within ten minutes' walk of the South Philadelphia works. Photographs were taken of the houses and sent to East Pittsburg, together with blueprints and plans. The engineers' families then selected from the drawings and photographs their choice of a home. Each man was given a blueprint plan of the house in which he was to live, showing the size and number of rooms. He then tagged all his furniture, numbered the tags, and indicated by the same numbers on the blueprints where each piece of furniture should be placed. The packing, crating and shipping of the furniture was then taken care of entirely by the Westinghouse company, which engaged transfer and storage companies in Pittsburg to take charge of this work. The entire household effects of the seventy-five families were then taken to Philadelphia and unpacked by the transfer companies in the new house, so that when the families arrived in Philadelphia, they found their homes ready to move into, with all the furniture in place.

* * *

In mending belting wherever belts are exposed to steam, it is not advisable to use glue. The steam will dissolve it and the joint will soon break. The only adhesive that will hold under these conditions is a pyroxylin cement which, being waterproof, will withstand the steam and moisture.

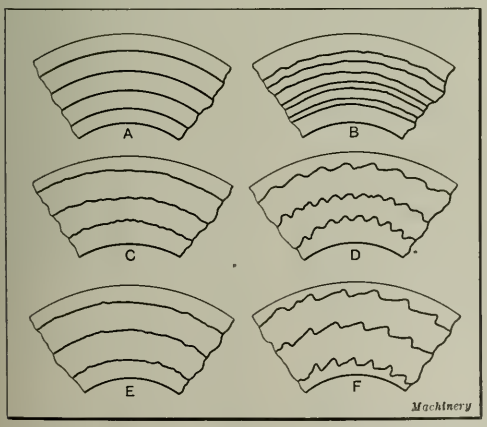


Fig. 7. (A) Section of Diagram indicating Perfect Rolling Action. (B) Properly Cut Gears. (C) and (D) Diagrams from Two Pairs of Gears cut with the Same Cutter but on Different Machines. (E) and (F) Diagrams from Two Pairs of Gears that were cut in the Same Machine but by the Use of Different Cutters

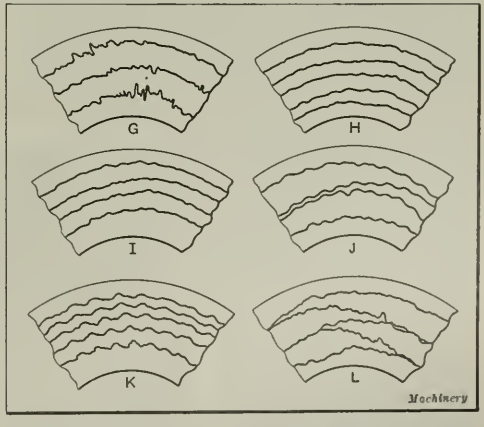


Fig. 8. (G) and (H) Wavy Lines indicate Imperfect Rolling Action due to Distortion in hardening. (I) and (J) Diagrams made before and after lapping Hardened Gears, indicating that Shape of Tooth has been destroyed by lapping. (K) Example of Noisy Gears. (L) Noisy and Excessively Eccentric Gears



Economical Interchangeable Manufacturing Practice

By EARLE BUCKINGHAM, Engineer, Pratt & Whitney Co., Hartford, Conn.

Specifications and their Use in Interchangeable Manufacture—Use of General and Specific Production Data—Factors Entering into Production Costs

THERE are three principal elements in the economical and successful production of a commodity. Stated briefly, they are as follows: (1) A thorough knowledge of the object (function) of the article and of all the conditions essential in attaining it. (2) The development of manufacturing methods and facilities that will most economically produce a satisfactory product. (3) The development of testing methods and apparatus to determine in an economical manner, at any stage, whether or not the desired results are being achieved.

Duplication of work never results in economy. Therefore, a record should be made of any solution reached in regard to these questions. Almost every problem has more than one satisfactory method of solution. The multiplication of solutions, however, particularly in manufacturing, is a hindrance to teamwork. For example, if the foreman of one department uses one solution of a problem, while the foreman of another department who performs succeeding operations on the same or companion parts arrives independently at another solution and uses it, the final results may be chaos; whereas, if each solution is recorded, whenever or wherever made, an opportunity is created to check these solutions against each other, thus making possible the elimination of inconsistencies at an early stage of the work. This practice will aid greatly in promoting teamwork, and thereby eliminate many misunderstandings.

Whenever any important decision is made, it should be recorded in the specifications together with the reasons therefor. This practice tends to eliminate many expensive, unnecessary refinements which are often specified arbitrarily. Instead of baldly specifying the various requirements, this practice requires the addition of sufficient reason for such requirements. This in turn, demands a careful analysis of the mechanism and its purpose; and a careful analysis of almost any mechanism will soon make it apparent that only a small proportion of the detailed dimensions and other requirements are exacting. Attention is called, in this respect, to the preceding articles, "Practice in Making Component Drawings," published in the January and February numbers of MACHINERY.

Specifications, in their broadest sense, include the solutions of all the three problems mentioned. This information may be compiled and recorded in one place or it may be scattered throughout the plant. In general, if the entire control of the design and manufacture of a commodity is held in one plant, the compiling and assembling of much of this information may be of doubtful value. As long as it is on record somewhere and available when needed, that is sufficient. On the other hand, if the control of the the design rests with one organization, the control of the production with another, while the control of the final inspection is distinct from either of the two foregoing establishments, reasonably complete specifications are imperative if economical and expeditious production is to be obtained.

Specifications, thus defined, include component drawings. For purposes of discussion, however, we will consider component drawings and specifications as distinct. In this case the specifications are supplementary to the component drawings and include all information which is not given on these drawings.

When certain manufacturing methods are to be decided upon, the decision made in this connection should be recorded, together with the reasons for it. This practice tends to eliminate many expensive, unnecessary refinements which are often arbitrarily specified, because, instead of baldly specifying the various requirements, the necessity for adding sufficient reasons therefor demands a careful analysis of the mechanism and its purpose; and a careful analysis of almost any mechanism will soon make it apparent that only a small proportion of the dimensions and other requirements are exacting. This and many other subjects bearing upon the attainment of economical practice in interchangeable manufacturing are dealt with by Mr. Buckingham in the present article.

Function and Essential Requirements of Product

The component drawings consist of pictures of the parts, statements of the physical dimensions required, and usually, specifications of the material to be employed. By themselves, they only partially solve the first of the major problems noted previously. They tell little or nothing of the object of the commodity. They state requirements, but give no reasons therefor. Thus, the first function of the specifications is to state briefly the purpose of the mechanism and its functional requirements. The articles "Practice in Making Component Drawings," published in the January and February numbers indicate the lines which specifications should follow.

A second function of the specifications is to indicate the quality of workmanship desired. The extent of the tolerances given on the drawings indicates, to a certain degree, the proper character of the finished surfaces. The specifications should supplement this information by stating not only desired results, but also reasons therefor. The preceding articles previously referred to, illustrate this practice. To a certain extent, perhaps, many of the conditions discussed there are so obvious as to need no mention, yet no harm is done by being explicit.

Another subject to be included in the specifications is the matter of the materials to be employed, and their nature, composition, and ultimate use. When standardized material is used, this can be called for directly on the component drawing, together with the proper heat-treatment. It is of interest to note that the Society of Automotive Engineers has done much valuable work in establishing standard specifications and methods of heat-treatment for nearly every kind of material used in automobile construction. The adoption of such standards greatly simplifies the provision of proper component drawings and specifications. In those cases where standardized material cannot be used, the specifications should give all pertinent information to enable the proper material to be secured. Whenever preservative finishes are required, the drawings or specifications should give complete information as to their nature, need, and use.

The first function of specifications is to state briefly the purpose of the mechanism and its functional requirements. The second function is to indicate the quality of workmanship desired. The tolerances given on the drawings indicate to a certain degree the character of the finished surfaces. The specifications should supplement this information by stating not only the desired results, but also the reasons therefor. The third function of the specifications is to give the materials to be employed, their nature, composition, and treatment. The adoption of standard specifications for materials and standard methods of heat-treatment greatly simplifies the method of specifying materials and treatment on drawings and in specifications. Whenever preservative finishes are required, the drawings or specifications should give complete information as to their use. If these simple rules are followed, much time and expense are saved in the manufacturing processes.

When the component drawings have been completed and the specifications have reached this stage, the first chief elements of the work are established. Until this is accomplished, those responsible for the manufacturing design have not done all in their power to secure the economical production of duplicate mechanisms in large quantities. Undoubtedly, many minor revisions will be required before the proper solutions of the succeeding problems will be found. But without the foregoing information, such revisions cannot be made intelligently. Furthermore, this information, in most cases, will point the way to a simple and direct solution of the succeeding problems. "Well begun is half done" was never nearer the truth than in connection with interchangeable manufacturing.

Specific Manufacturing Data

We will now consider the solution of the second major problem—the development of suitable manufacturing methods and facilities. The first step to be taken is to make up the operation lists for every component, noting in detail the type of machine, fixture, and tool required. It is of great assistance in many cases to develop concurrently the operation drawings, indicating on them the work to be performed at each operation. In addition, it is a good plan to include in this part of the work an estimate of the production time on each operation. This information is necessary to establish the amount of equipment required and also to make a comparison, when desired, of the economy of several methods.

This information should be revised and kept up-to-date after production is under way. This furnishes valuable data for estimating on new commodities and facilities comparison between the costs of different methods of manufacturing. Such information is invaluable when it becomes necessary to call on outside plants to assist in obtaining greater production. It need not be bound together with other parts of the specifications, but it should be in such shape that it can be quickly found and readily applied. The foregoing information serves as the basis for designing the special manufacturing equipment necessary as well as for arranging the manufacturing departments so that the component parts can be produced rapidly and efficiently.

This second problem is seldom or never fully solved. Improved methods are being devised constantly, and these introduce new factors into old problems. Even greater care must be exercised in adopting a new method on work already in process of production than is required in adopting the original methods, because in these cases, ultimate economy requires that such changes result in a saving which will pay for the discarded equipment as well as for the new. The effect of a possible interruption in production must also be carefully considered.

The production records of the manufacturing equipment should be so kept that it will be always possible to trace back through every change in equipment and make direct comparisons between the results obtained by each method. At the same time, these records should be so simple as not to entail unnecessary clerical expense. Whenever a change is made, the reason for making it should be on record. All these data furnish information which cannot be secured in any other way. As a matter of fact, many plants keep a complete record of changes, but do not provide this class of information when the production of an entirely new mechanism is undertaken.

General Manufacturing Data

In addition to the specific information required for each individual part and each assembled mechanism, there is a vast amount of general data which must be had before decisions as to the economy of different methods of manufacture can be made with certainty. Much of this information should be available from the cost department records, but, in most cases, these records are kept merely for accounting purposes and their use as engineering data often gives incorrect results.

Factory Cost of Production

It is not the purpose to outline here a new system of cost-accounting. A discussion of some of the factors entering into the factory costs of production, however, is necessary to indicate the character of the information needed to promote economical production. For the purpose of simpler accounting, it is often customary to prorate the entire amount of indirect or overhead charges against the total output of the plant, distributing them according to the direct labor costs.

From the accountants' viewpoint, this method is correct. If the product of the plant consists of one simple specialized article, such a method of accounting undoubtedly gives sufficient data for general engineering purposes. On the other hand, if the products are varied, or if the productive operations are sub-divided into elementary operations, performed in various departments, the data so collected are incomplete and misleading for engineering purposes, because the direct labor cost alone will be the determining factor in selecting the apparent economical methods of production. As a matter of fact, this direct labor cost is but a small percentage of the total cost of production. It seldom amounts to 25 per cent. Furthermore, as the volume of business increases, the percentage of direct labor charges decreases. Thus, as the quantity of production increases, the data so obtained become more and more unreliable.

Another method of distributing the indirect expense consists in establishing overhead rates for each department, prorating these charges in proportion to the direct labor cost as before. If the departments are arranged to contain only one type of equipment, and to perform similar operations, the data so obtained are valuable, but such an arrangement of machines and operations is seldom possible or desirable. Different types of work creep into a department. When this condition exists, the information obtained from the use of a departmental overhead will again lead to false conclusions, causing the acceptance of manufacturing methods that are not economical.

Certain types of equipment are always duplicated to some extent in several departments. All other things being equal, the cost of duplicate operations on duplicate equipment is identical regardless of the physical location in the plant. But with the use of departmental overhead charges, the book costs will show otherwise. For example, in one plant a sheet-metal part required a foot-press operation between two power-press operations. Foot presses were available in two departments: the power-press department with an overhead charge of 150 per cent, and a sub-assembly department in a distant part of the factory with an overhead charge of only 50 per cent. The original operation list assigned all three operations to the power-press department to eliminate unnecessary trucking and transfer. This was changed so that the second operation would be performed in the other department because of the lower overhead there. Actually, this last method cost more than the first because of the trucking and transfers back and forth, but because the book records showed a higher cost for the first method, it was disapproved despite all arguments. This is not an extreme case. Similar conditions exist in the majority of manufacturing plants.

It is realized that book costs and actual costs are not identical. To obtain such accuracy would entail a system so complex and elaborate that its cost alone would overbalance all other expenses. Yet some simple way must be found to give more nearly true costs of production in order to promote true economy of manufacture. The direct labor and direct material costs are readily obtained. Most accounting methods apply these charges directly against the individual parts, which is the proper distribution. But this, in most cases, disposes of less than half of the total cost of production. Indirect expenses are not only the most difficult to distribute equally, but also involve the larger amount of the costs. The total amount of these charges can be easily determined. This is purely a matter of bookkeeping. Their equitable distribution, however, is more an engineering than an accounting problem.

It is not an easy matter to properly distribute the indirect expenses that should be added to the direct labor cost. One charge against labor is the cost of supervision, as represented by the salaries of foremen and their assistants. This charge is often divided equally among the number of men employed, but this method is somewhat erroneous, because higher-priced men require proportionately less supervision. It would be more correct and logical to proportion this charge in an inverse ratio to the wages of the men, but the clerical work necessary to do this would cost more than the information would be worth. The cost of time-keeping and the making up of the payroll should logically be distributed equally between the men employed, as it costs practically as much to keep the time and make up the payroll for a man earning $15 a week as it does for one earning $30. Matters of this kind are, however, of great importance in determining actual costs of manufacture.

Distribution of Indirect Factory Expenses

There are three main factors to which most of these indirect expenses can be logically applied: First, the direct labor; second, the general productive equipment; third, the component parts themselves. There are also a number of other indirect expenses which must be charged to the general factory expense. As these are relatively few, they can be arbitrarily distributed over the entire product without affecting the value of the data sought. Eventually, of course, the product must carry them all. The great problem is to distribute them simply and properly.

If the attempt is made to apply all indirect charges to any one of the above factors, many economic errors will result. Attempts have been made to carry them all on the direct labor factor with far from satisfactory results. Neither can they all be applied to the equipment factor with any better results. Each factor must bear only its own indirect expenses. In order to determine where each indirect expense belongs, a process of elimination should be adopted. Without such a factor, would this expense exist? If the expense remains after direct labor, general productive equipment, and individual components are eliminated, it belongs to the general factory expenses or factory management.

Direct Labor

Let us first consider the indirect expenses due to direct labor. Hereafter, for the sake of brevity, direct labor will be referred to as labor. One charge against labor is the cost of supervision as represented by the salary of the foremen and their assistants. The number of these depends chiefly on the number of men to be controlled. This charge could be prorated against the number of men employed. Such a method might, in extreme cases, be erroneous because the higher-priced men should require less supervision. Although, in such cases, it might be more logical to proportion this charge in an inverse ratio to the wages of the men, the clerical work necessary to accomplish this would cost more than the information would be worth.

The cost of time-keeping and making up the payroll logically belongs to the labor factor. Eliminate labor and you have no payroll to make up. This should also be distributed on the basis of the number of men employed, as it costs as much to make up the pay account of a man getting fifteen dollars a week as it does to make up the pay account of a man getting thirty dollars. Here again, the indirect expense of high-priced labor is proportionately less than that of lower-priced labor.

The cost of the employment department also belongs to the labor factor. Eliminate labor and you have no further need of an employment bureau. These charges should also be distributed on the basis of the number of men employed, for it costs as much to hire one man as another. In many cases the higher-priced men are the most reliable—not always, of course, as so many other conditions enter into this—and thus it is possible that a closer result would be obtained by distributing the cost in an inverse proportion to the wages of the men.

Wherever personnel or educational departments are established or other similar departments whose objects are to promote cooperation between the employer and employe to their mutual advantage, all expense incurred should be charged against labor. It is extremely difficult to analyze such charges accurately—so much depends upon the nature of the activities of such departments and upon the character of the persons with whom they deal. Therefore it might be best to distribute these charges also on the basis of the number of men employed so as to simplify the accounting by prorating all labor charges in a uniform manner.

All charges for installing safety devices, fire escapes, improved sanitary equipment, for heating and lighting, and other similar expenses necessary for maintaining the health and safety of the employes as required by law or promoted by the dictates of humanity, belong to the labor factor. However, some of these expenses might be included in other general items—fire escapes may be included in the cost of the buildings, for example—and it may not be possible or feasible to isolate them. Those few cases where it is not practicable to apply expenses directly where they logically belong will not affect appreciably the values of the final data.

It should offer no great accounting difficulties to isolate the majority of the expenses enumerated and all other kindred items. This is all that the accountant would necessarily do. The total amount so determined could be prorated on the basis of the average number of men engaged in actual production, and thus give the labor overhead. This would be used as a constant for a predetermined period in a similar manner to the usual overhead charges, and would be close enough for all practical purposes. Of course, it is evident that this labor overhead fluctuates constantly, but as these data are for the use of engineers and not accountants, an exact balance is not essential. As a matter of fact, the use of a general overhead burden does not give an exact balance. A comparison between estimated results and the accountants' records will show how wise a use has been made of this information. This direct labor overhead is a valuable factor in determining economical methods of production. If the general type of labor employed differed to any great extent in the various departments, a separate labor overhead could be established for each department.

Machine-hour Rate

We will next consider the indirect charges that belong to the general productive equipment which, prorated on an hourly basis, we will call the machine-hour rate. The first items are the interest on the investment, depreciation, and insurance. These are relatively simple to determine. Their maintenance charges belong here also. When possible, these should be applied to the particular types of machines. The many petty items would be distributed over the entire equipment. Having the machinery, we must have a place to put it. The majority of the factory space is utilized by productive equipment. It would seem, therefore, that all our fixed plant charges would be best distributed here. This could be done proportionately to the average floor space required for operating each type of machine.

The power charges would also be included in the machine-hour rate. One cannot go into the exact distribution of this factor without incurring great expense in power tests—tests that become valueless as the machining cuts vary from light to heavy, short to long. An approximation could be made which would determine the value of this factor close enough for practical purposes. A few power tests could be made to advantage for the purpose of securing data to assist in the proper distribution of all power costs. The cost of belting and lubricating oils, etc., could also be included in the total power charges. Such a plan would insure an equitable and simple method of distributing these.

There is always a certain amount of idle time for any machine, no matter how well the work is planned. The amount of this normal non-productive time varies for different types of machines. For example, an automatic screw machine—as efficient a productive machine as we have—is idle on an average of one hour in five. This idle time is caused by the necessity of adjusting tools, oiling, changing bars, etc. Therefore, the actual productive time of this machine is 80 per cent of its total operating time. In the printing trades, where a complete system of machine-hour costs has been developed, 65 per cent is considered as a normal average of productive time. The normal percentage of non-productive time should be estimated as closely as possible and included in the machine-hour rate.

There is, however, another source of idle time to be considered. This may be lack of work or lack of labor. If it is lack of labor, it should logically be charged against the employment department. Lack of work may, of course, be due to one of several causes. If due to lack of business, it could be charged against the sales department, while if due to poor planning, it belongs to the general factory expense. For simpler accounting, abnormal idle time might best be included in the general factory expense.

The shop office carries records of the machinery, such as inventory lists giving the original value, depreciation, locations, etc. The results of using machine-hour rates would be, to all intents and purposes, the creation of a payroll for the various machines. All this would require a certain amount of clerical work, the cost of which should be prorated against the machines.

The accountant would carry accounts showing only the total amounts spent for power, belts, lubricating oil, fixed plant charges, fixed charges on general manufacturing equipment, labor costs for machine records, etc. These totals would be prorated as discussed above to establish a constant machine-hour rate for each type of equipment, which would be simple to apply. Such values would be adjusted periodically as required. Here, again, the successive reports of the accountant would make apparent how wise a use had been made of the information so gathered.

We, in the mechanical manufacturing industries, would find it well worth our while to follow, in one respect at least, the

The items that make up the machine-hour rate are interest on investment, depreciation, and insurance. Next in order come maintenance charges, which, as well as the first items mentioned, can be distributed to particular types of machines. There are many minor items, however, which have to be distributed over the entire equipment. The cost of the space occupied by the entire factory should be distributed over all the machines, proportionately to the average amount of floor space that is required for setting and operating each type of machine. Power charges also must be included in establishing the machine-hour rate.

There is a certain amount of idle time for any machine, no matter how well the work is planned. The amount of this non-productive time varies for different types of machines. For example, an automatic screw machine—as efficient a productive machine as could be used for an illustration—is idle on an average of one hour in five. This idle time is caused by the necessity of adjusting tools, oiling, changing bars, etc. Therefore, the actual productive time of this machine is eighty per cent of its total operating time. The percentage of non-productive time should be estimated as closely as possible and included in the machine-hour rate; otherwise the cost of manufacture, based on the machine-hour rate, will be erroneously estimated.

example of the printing trades. The problem of the actual cost of production has been studied by them on a cooperative basis. For several years, one of their trade journals has been collecting cost data from many plants throughout the country. The information so willingly given has been compiled and analyzed for the benefit of all. As a result, a complete series of average machine-hour costs has been developed, the use of which gives results very close to the actual balances of the accountants. This data is kept up-to-date and corrected values are distributed periodically. This information is invaluable for estimating and other planning purposes.

Improved methods are constantly being devised and new factors are thereby introduced into old problems. While great care must be exercised in adopting any method for performing work for interchangeable manufacture, still greater care must be exercised in adopting a new method on work already in process of production, because in these cases ultimate economy requires that the changes should result in a saving which will pay for the discarded equipment as well as for the new. The effect of a possible interruption in production while the change takes place should also be carefully considered before a new method is instituted.

Product Overhead

We will now consider the indirect expenses due to the product itself. The following method of distributing indirect costs is a radical departure from any established practice, yet their logical distribution leaves no other path open. There are two classes of these charges; those which can be applied to specific component parts and those which apply to the whole product in general. For the sake of brevity, we will call those of the first type, specific product charges and those of the second, general product charges.

The most important specific product charge and the one most readily isolated is that for jigs, fixtures, special tools, and gages. These certainly belong to specific parts. The adoption of this practice will soon develop a valuable record. It will then be possible to obtain—and apply directly where it belongs—the cost of making changes in the design and methods of manufacturing of the various parts. Then only will it be possible to determine whether or not such changes result in an economic gain. The writer believes that frequent changes of this sort are altogether too common in American manufacturing practice. Judging from personal experience during the past ten years, the majority of such changes are the results of mental laziness. When the first important difficulty appears, we avoid the issue instead of carrying it through to its logical conclusion. It is the easiest thing in the world to try to make a part in a different way from the one originally planned; but by so doing, we merely substitute one set of difficulties with which we are somewhat familiar for others with which we have had no previous experience, and, in the end, we find ourselves at the same place from which we started. The writer feels safe in stating that not less than seventy-five per cent of the changes made are attempts to avoid trouble which is not eventually escaped, and that this percentage of the cost of changes represents a total economic loss. A method of distributing indirect expenses along the lines indicated above will expose such conditions as nothing else will.

Another specific product charge is the cost of constructing special machines for specific parts. This is logically included in the jig and fixture costs. When the special machine is used on several parts, these expenses, of course, will be classified with other general machinery items. Its normal non-productive time, however, is usually large.

The loss resulting from scrapped work is another specific product charge. Some parts are delicate and difficult to machine and this results in a high percentage of scrap. Others are simple and more rapidly produced with little or no scrap. It is manifestly unfair to distribute this item of expense over the product as a whole because this will give an entirely wrong idea in regard to the economy of the simpler and sturdier designs. Often, when the design is changed, a large number of finished parts are scrapped or reworked. All such expenses should be charged to specific pieces when possible. There will, of course, be some credit items, due to salvage. If it should be difficult and expensive to distribute these salvage credits specifically, they could be credited to a general scrap account and applied proportionately to the cost of the scrap charged against each part. Any inaccuracy resulting from this procedure would have little effect on the value of the final result.

Most of the other expenses incurred by the product are general product charges. Among them would be the cost of trucking, including the interest on the investment of the trucks, elevators, etc., depreciation, and their maintenance costs. The expenses of shop rearrangements also belong with the general product charges, as these alterations are made to facilitate production. If, however, they can be charged directly to specific component parts, they should be so distributed. The majority of the factory office expenses would be included in the general product charges. This would include the cost-keeping, production records, engineering and experimental work, etc. All these general product charges could be distributed in conjunction with the general factory expenses. This method would be as equitable as any.

Let us now consider the clerical and accounting work which such a procedure would entail. First, the accountant must arrange his books so as to separate all expenses due to direct labor. This would only be a single account. Next he would open another account to carry all the expenses making up the machine-hour rate of the general productive equipment. Another account would be opened for the indirect charges due to the product. The indirect charges caused by the purchase and handling of the material have not been previously mentioned. These would be handled in the same manner as the other indirect expenses, and distributed over the direct material. The accountant would carry this account, and one to cover the general factory expenses which are not distributed elsewhere. These would be all of the indirect factory expense accounts which he would require. He would also carry direct labor and material accounts. The sum of these accounts would represent the factory cost of production of the work produced during a given period. This, balanced against the value of the output would represent the gain or loss during the specified period. This is the essential information in which the stockholders and directors of a plant are interested.

The production records relating to manufacturing equipment should be so kept that it may always be possible to trace back the effect of every change in equipment and make direct comparison between the results obtained by the use of different methods. At the same time, these records should be kept in so simple a form as not to require unnecessary clerical expense. Emphasis should be placed on the point that whenever changes are made, the reason for making the change should be recorded; otherwise, there may arise conditions in the future when a change back to the original methods may be decided upon without any actual knowledge of the reasons why they were abandoned.

The factory cost department would carry independent accounts along entirely different lines. These should give detailed information in regard to the cost of each component. They need not necessarily check exactly with the accountants' records. The constants which are used by the factory should be so estab-

lished as to make the total of these records a small percentage higher than the accountants'. A factor of safety of, say, 5 per cent, should be included in the various constants. The direct labor and material charges are the only ones which should check absolutely in both sets of records, while all the others need check only within the limits of the factor of safety established. The various constants would, necessarily, be adjusted from time to time to bring this result.

The factory cost department would carry an account for each separate component, including sub-assemblies and complete mechanisms. Records must be kept on each of these accounts, showing the direct labor, direct material, machine-hours, special equipment, and scrap charges. To this would be added the proper direct labor overhead, direct material overhead, machine-hour rates, general product overheads and general factory expense. These last would be specified constants. The comparison of these shop records with the accountants' records would prove, first, the relative accuracy of the established constants, and, second, how effective a use had been made of the data that was so collected.

If it were possible for several manufacturing concerns to adopt a method of factory cost-keeping along these lines and to compare, from time to time, not the details but certain of the resultant factors, much valuable information would be secured—information which would not in the least reveal any of the confidential facts of the business but would uncover many economic truths as yet undiscovered. For example, it is of the utmost value to determine what the normal direct labor burden should be. The different plants involved in such an undertaking need not be engaged in the production of the same commodities, and their methods of manufacturing might differ in many particulars, yet from data so obtained the normal cost of this factor could be determined very closely. These plants would thus establish a standard with which to compare their costs, giving them either the gratifying knowledge that their labor burden was normal or else a warning of conditions that should be corrected. The same is true in regard to the machine-hour rates. With cooperation between a large number of plants, an accurate series of values could be established for these rates. Accuracy or precision in manufacturing requires established standards. Why should not the same principle be applied to our other problems? If we establish relative standards for machine-hour rates and direct labor overhead, for example, we are justified in looking forward to the same progress in these respects as we have made in our mechanical work since the establishment of physical standards. It may be a long and slow process, but we shall be conscious and certain of improvement during its development. The product factors would be of little value for general comparisons. Their nature prevents their economic use for this purpose.

If it were possible for several manufacturing concerns to adopt a method of factory cost-keeping along the lines outlined in this article and to compare, from time to time, not the details, but certain of the resultant factors, much valuable information would be secured—information which would not in the least reveal any of the confidential data of the business, but would uncover many economic truths as yet undiscovered. For example, it is of the utmost value to determine what the normal direct labor burden should be. The different plants involved in such an undertaking need not be engaged in the production of the same commodities, and their methods of manufacture might differ in many particulars, yet from data so obtained the normal cost of this factor could be determined very closely. These plants would thus establish a standard with which to compare their costs. The same is true in regard to the machine-hour rates. With cooperation between a large number of plants, an accurate series of values could be established for these rates.

Inspection and Testing

The third major problem—the development of inspection methods and facilities—should be solved to a great extent in conjunction with the development of the other manufacturing equipment. The inspection operations and necessary gages should appear in their proper place on the operation lists. In some cases, these lists should be supplemented by a more detailed description of the methods of inspection. This is unnecessary for limit gages measuring elementary surfaces. It is required, however, in connection with the use of functional and other gages for many composite surfaces. Such information should be included in the specifications as an integral part of the description and requirements of each component part.

Specific and General Information

It is obvious, then, that specifications may be divided into two main divisions. The first division contains the specific information required in the production of particular commodities. The preceding articles "Practice in Making Component Drawings," published in the January and February numbers give a good illustration, as far as the requirements of dimensions and surfaces are concerned, of the nature of specifications of this class. Operation lists, material specifications, inspection requirements, etc., are needed to make them complete. In this way, the efforts of all will be directed along similar lines, the exacting requirements will receive the greatest attention—and this they should always receive—while those of lesser importance will be treated accordingly.

The second division consists of that vast amount of general information that is derived from our cost and production records, "traditions of the shop," and all other general data gleaned from every possible source which applies equally to every commodity. This should not be duplicated in the written specifications of every individual commodity, but should be gathered independently in usable form.

The next article on this subject, which will be published in the April number of MACHINERY, will discuss equipment for interchangeable manufacturing, laying down the principles involved in the selection of machine tools and in the proper designing of jigs, fixtures, and cutting tools.

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BRITISH WROUGHT IRON INDUSTRY

The wrought iron industry in England has been considerably hampered during the last few years due to lack of men, particularly puddlers. Staffordshire is the principal seat of the wrought iron industry, there being from 600 to 700 puddling furnaces in that district, all operated by hand. These furnaces have a total capacity of over half a million tons of puddled bars per year, and in the past used to employ 10,000 men; but even before the war, there was the difficulty of obtaining the required number of men. When the war began, this shortage was accentuated by the rush of the men to the colors and by the unfortunate delay in stopping the outflow of experienced puddlers who could not be replaced. Experiments in mechanical puddling have never been viewed with much favor in England and the results achieved have been unable to overcome the prejudice against it. It has become necessary, however, during the past year, to experiment with a new system of mechanical puddling in order to overcome the condition existing due to lack of experienced puddlers. As England has furnished the world with its principal supply of high-grade wrought iron, any curtailment of this industry would be serious, both from the British point of view and from that of other nations who have obtained the wrought iron now used mainly from British or Swedish sources.

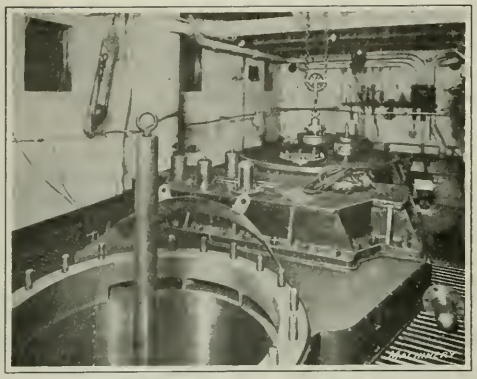


Fig. 1. General View of Engine Room and Cylinder undergoing Repair

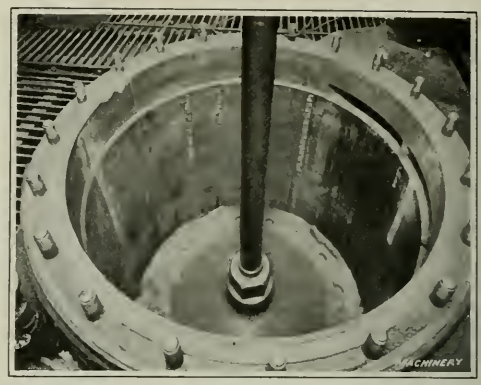


Fig. 2. Interior of Cylinder showing Two Welds Ready for Grinding

Welding the Interior Surface of a Cast-Iron Cylinder

By OTIS ALLEN KENYON

ALTHOUGH skilled workmen have been welding cast iron by means of the arc-welding process for many years, there are no fixed rules which can be followed in the employment of this process for repair work. Each job is a problem in itself, and in many cases considerable study and ingenuity on the workman's part is required to make a satisfactory weld. Arc-welding outfits have been greatly improved in recent years, but up to the present time much more depends on the welder's skill than on the welding outfit, provided the system will supply the necessary current and voltage. As the conditions which must obtain in order to produce a satisfactory weld are not generally understood, the writer has taken this opportunity to preface the present article with a brief analysis of the difficulties encountered in making cast-iron welds.

For the purpose of analysis, it is possible to separate the difficulties encountered in welding cast iron into three general classes:

1. The production of extremely hard and brittle metal at the fusion line between the casting and the deposited metal.
2. Failure due to shrinkage strains in the weld.
3. Failure or distortion due to temperature stresses in the casting.

The layer of glass-hard metal at the fusion line is due to the absorption of carbon from the cast iron by the freshly deposited metal; after this occurs, the sudden chilling action of the massive casting produces the hardest kind of high-carbon steel. The only way to avoid the effect of this carbon absorption is to remove the carbon from the weld. Up to the present time the success of every process known to the writer, which is employed to remove this carbon depends entirely upon the skill of the welder in carrying out the process. There are two general methods of removing the carbon: (1) Flowing iron on the casting and then so manipulating the arc that the newly deposited metal will be flowed out of the weld again, carrying with it the excess carbon; (2) Using a flux that will combine with carbon and then manipulating the arc so as to flow the flux out of the weld.

The avoidance of shrinkage strains in the weld is purely a matter of welding technique. It consists in preparing the joint and depositing the metal in such a way that a string of metal is never fused to cold metal on more than one side. Wherever the string fuses to cold metal on two opposing sides shrinkage strains must result, whether actual rupture occurs or not. Comparatively little trouble results from temperature strains when the arc-welding process is employed on account of the extreme concentration of the heat.



Fig 3. Chipped-out and Studded Grooves Ready for Welding

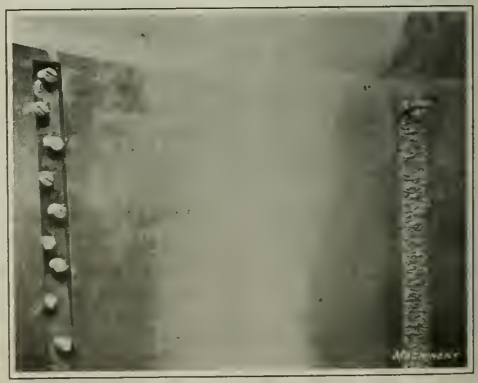


Fig. 4. Groove Ready for Welding and One Completed Weld

A great many cast-iron welds can be made successfully without preheating, but where there is a large amount of welding to be done in a comparatively small area, preheating cannot be avoided if the best results are desired. Those who are familiar with preheating for oxy-acetylene welding should carefully note that preheating for an arc-welding job is different in that it does not require nearly as much heating. For arc welding it is generally sufficient to warm the casting all over so that it is not too hot to touch with the hand. The heating, however, is not anywhere nearly as important as the cooling, and here the greatest care must be exercised.

Having pointed out a few of the difficulties attending cast-iron welding, the best way to visualize them is to take a specific case. For this purpose, a cast-iron job has been selected that is generally considered impossible of successful accomplishment, namely, the welding of the interior surface of a finished engine cylinder. The job here described was done on board a large ship by the Electric Welding Co. of America. No special welding generator or automatic controller was employed. The generator was simply a compound-wound constant-potential 80-volt machine and the control was accomplished by a simple ballast resistor arranged for convenient adjustment of the current. The repairs were made on the second intermediate cylinder of a quadruple expansion engine, which develops 4500 horsepower with a steam pressure of 220 pounds per square inch at normal speed. The cylinder in question, which is shown in Fig. 1, is 56 inches in diameter and approximately 50 inches long. The damage consisted of a number of deep scores and cracks.

Preparing Cylinder for Weld

Preparatory to welding, the scores and cracks were all opened up with a pneumatic chipping hammer so as to expose the full extent of the damage and provide ample space for the deposit of metal. Irregularly spaced holes were then drilled in the surface of the grooves. The portable drill used for this purpose is shown in Fig. 1 on top of the low-pressure cylinder. The holes were next tapped and tap bolts screwed into place. The heads of the bolts were then removed so as to permit the welding pencil or electrode to touch all parts of the work. Several of the parts that were to be repaired are shown in Figs. 2, 3, and 4, studded and ready for welding. The joint and the surrounding metal were slightly warmed with a small blow-torch (seen on the low-pressure cylinder at the left in Fig. 1) before welding.

The welding leads as well as the compressed air pipe were brought on board from the welding company's floating plant, which consists of a power plant to supply electric energy suitable for welding purposes and compressed air for operating air tools such as hammers and drills.

Making the Weld

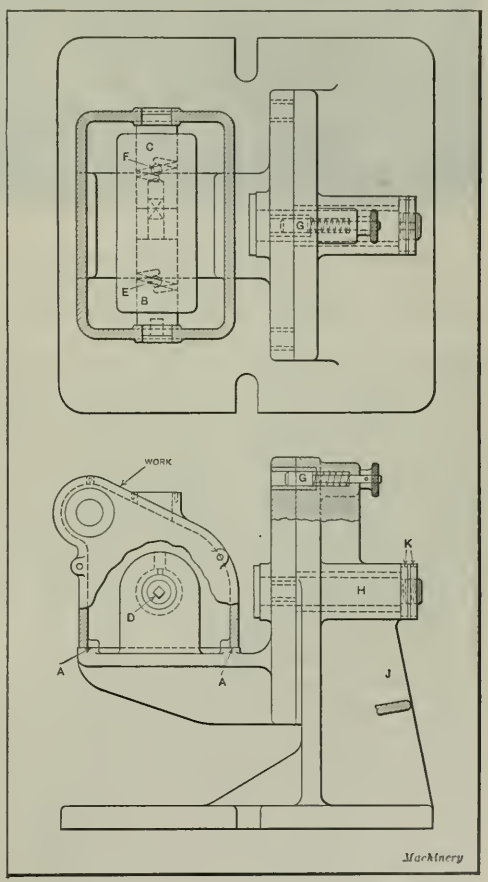
The welding itself was done with a special coated electrode made in the company's laboratories. After the welding patch was completed, as shown at the right in Fig. 4, it was ground to a true contour by means of a portable grinder and a special gage. While using the arc, the valve ports were protected from injury by a metal screen that was hung over two of the cylinder studs.

* * *

INDEXING TAPPING FIXTURE

The indexing fixture here illustrated is intended for use on a radial drilling machine when tapping holes in a casing such as shown mounted in position on the fixture in the illustration. The work is seated on two finished surfaces *A* of the revolvable member of the fixture. A rather interesting method is employed to secure the casing in position. Two plugs *B* and *C* are mounted in a bearing on this revolvable casting, in each of which opposite-hand helical grooves are milled. Holes are drilled in the bearing which supports these plugs, in which the pins *E* and *F* are assembled in such a manner as to engage the opposite-hand grooves. The inner end of one of the plugs has a square stem which fits into a similar square hole in the other plug so that when a socket wrench is fitted into hole *D* and turned, the plugs may be operated simultaneously in opposite directions. By this means the ends of the plugs enter holes in the casing and the shoulders on the plugs are forced against bosses, thus securely holding the work in place.

Another feature of this fixture is the provision for indexing the work. After all the holes have been tapped in the upper side of the work, the fixture is indexed through 90 degrees by withdrawing the spring plunger *G* and turning the revolvable member of the fixture on the center stud *H* which is supported in the base casting *J*. The index holes



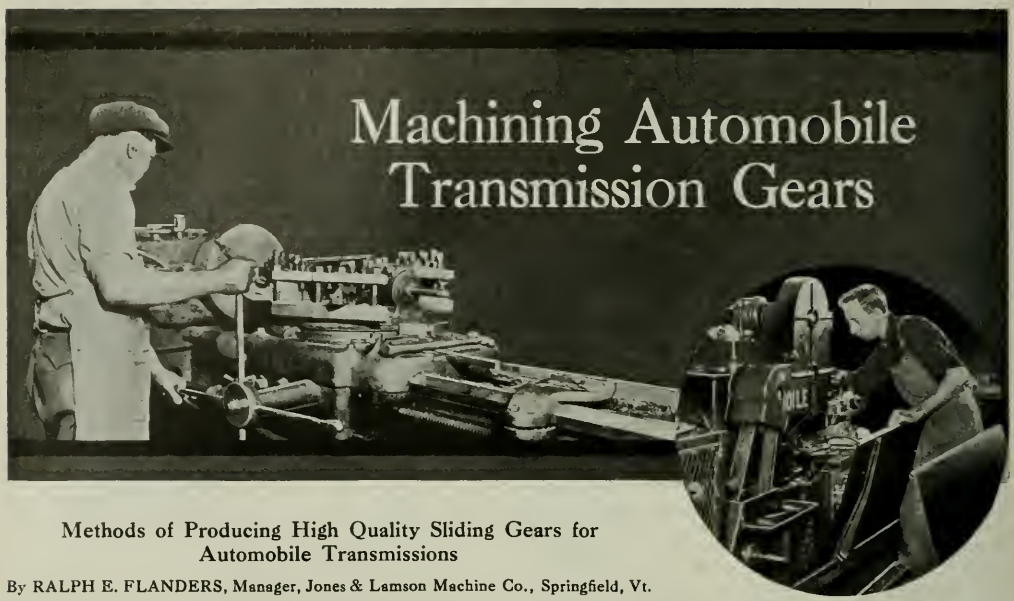
Indexing Fixture used on a Radial Drilling Machine

in which the spring plunger operates are equipped with bushings, as is also the center stud *H*. Two check-nuts *K* are threaded to the center stud, and besides holding the two principal parts of the fixture together, provide means of adjustment for the revolvable member.

This fixture works very successfully when the holes to be tapped are small. Advantage is taken of the radial feature of the machine to reach the various holes. It is understood that a tapping attachment must be employed on the machine and that the fixture is secured to the platen in the regular manner. F. H. M.

* * *

According to a statement issued by the Director General of Railroads, more than $111,000,000 was lost by the railroad administration during November and December on account of the strike of soft-coal miners.



Methods of Producing High Quality Sliding Gears for Automobile Transmissions

By RALPH E. FLANDERS, Manager, Jones & Lamson Machine Co., Springfield, Vt.

THE sliding transmission gears used in most types of automobiles are generally of a simple design; however, as is the case with many other equally simple parts, certain difficulties are presented in their manufacture when it is desired to produce them in large quantities at a low cost and still maintain high quality. The principal difficulties experienced lie in facing the hub and rim true with the broached hole. This condition is essential, as otherwise it is impossible to cut the teeth accurately by means of a gear-cutting machine, because the untrue faces of the gear blanks will cause the arbor of the machine to be sprung when a number of blanks are clamped on it. The purpose of this article is to describe how gears of this nature are produced in an economical and efficient manner.

Types of Holes Generally Used in Transmission Gears

The holes in automobile transmission gears are usually of one of the types illustrated in Fig. 1, square holes having been generally discarded on account of the excessive friction produced when the gears are shifted. In the illustration referred to, each diagram also shows the section of the shaft that corresponds to the particular hole, the inner lines in each case representing the outline of the shaft, while the outer lines represent the hole in the gear. In the diagram shown at *A* the surfaces of the splines on the shaft, of which *D* is the diameter, are a sliding fit in the grooves of the hole. There is a slight clearance between the splines of the hole and the splines of the shaft and a larger amount of clearance between the splines of the hole and the grooves on the shaft. The diameter of the shaft at the grooves is represented by *d*. This type of shaft can be readily machined, and the sliding surfaces can be ground after the shaft is hardened; but there is no way of finishing the sliding surfaces of the hole.

The type of hole illustrated at *B* is considered a better form. In this design, the surfaces of the shaft, of which *d* is the diameter, are a sliding fit on the splines of the hole. There is a clearance between the splines of the hole and the splines on the shaft and between the splines on the shaft and the corresponding grooves of the hole. The clearance between the splines should amount to several thousandths inch, while the clearance between the splines on the shaft and the grooves of the hole may equal as much as 1/32 inch, as this part of the hole is cut by the portion of the broach that wears most rapidly. By allowing this clearance, the broach can be resharpened many times before the clearance becomes too small. This type of shaft may be form-ground, while the hole can also be ground after the part is hardened. It will be noted that in the type of hole shown at *B* it is not necessary to remove as much metal in the broaching operations as in the type shown at *A*.

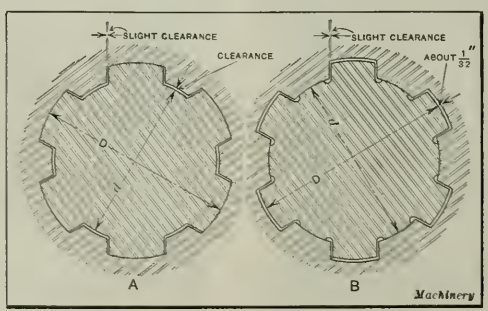


Fig. 1. Types of Holes commonly used in Sliding Transmission Gears

Machining Operations on the Hole and Hub

The first operation on the transmission gear in the method to be described consists of rough-drilling the hole and rough-facing one side of the hub. This operation is performed on a heavy-duty drilling machine. The second operation consists of rough- and finish-boring the hole and finish-facing the side of the hub. A special two-spindle lathe, which is built by the Jones & Lamson Machine Co., Springfield, Vt., is used for the performance of this operation. Fig. 2 shows the gear blanks held by air chucks on a machine of this type and the tools used. There are two steps in the operation, the first consisting of rough-boring the holes with the double-ended rough-boring cutters *B*, which are mounted in the boring-bars *A*; finish-boring the holes by the single-ended cutters *C*, also mounted in the boring-bars *A*; and facing the hubs by tools *D*. Bushings are provided in the chucks for guiding the pilots of the boring-bars. After this step has been completed, the

floating reamers *E* and tools *F* are brought into position for the second step, by a transverse movement of the tool-slide. This step consists of reaming the holes and finish-facing the hubs. This operation is performed very rapidly, as most of the movements are feeding movements; and as two pieces are finished at one time, the production is high. This operation would not be necessary if the gear could be broached with such precision that when mounted on an accurately splined arbor, the hub faced in the first operation would not be more than 0.003 or 0.004 inch out of true. There are few shops, however, that are able to do this commercially.

Broaching the Hole and Milling the Opposite Face of the Hub

The third and fourth operations consist of rough- and finish-broaching the hole in the gear. Care must be taken in these operations to see that the finished hub face has a good bearing on a hardened plate and that this plate is

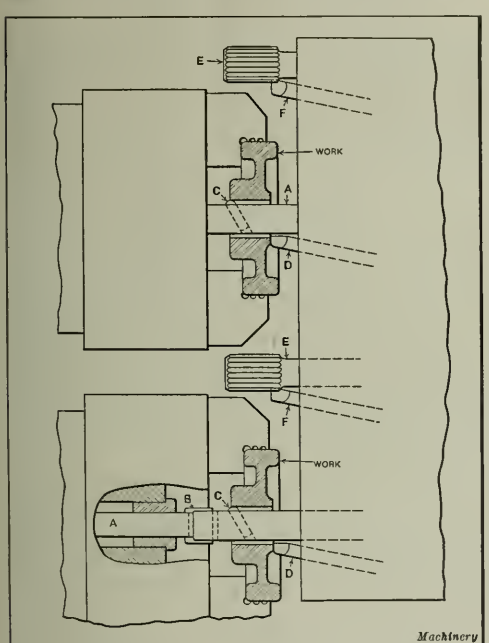


Fig. 2. Tooling Equipment for machining Gear Blanks in a Special Two-spindle Lathe

square with the lines of travel of the broaches. This means that occasional attention must be given to the guides of the machine. In the fifth operation, the unfinished hub face is rough- and finish-faced on a two-spindle heavy-duty drilling machine. The gear is mounted on the fixture shown in Fig. 3, which is first placed beneath the roughing spindle of the machine and then beneath the finishing spindle. The sliding base *A* is so machined as to enable it to be placed beneath both of these spindles. This base supports stud *B* which is milled and ground to be a close but free fit in the splined hole of the work when the work is machined to the minimum tolerance. The hardened grooved washer *C* is provided for seating the work. The upper portion of stud *B* is hardened and ground and serves as a pilot to guide the butt milling cutter *D*, there being a cutter of this type in each spindle of the machine. This cutter is centered on another hardened and ground pilot on the end of the tool shank *E*. The milling cutter and shank are provided with right- and left-hand threads, respectively, to suit the threads in collar *F*, and by this means the depth of cut taken by the cutter can be regulated. The cutter is driven by pin *G*, which is held in a hole in the shank pilot, the threaded end of the milling cutter being slotted to permit the pin to be assembled with the shank, when the cutter and shank are pulled together by collar *F* as the collar is screwed on the two parts. The depth of cut is reached when the rounded end of the pilot on shank *E* comes in contact with the rounded end of the pilot on the stud. This method of regulating the depth of cut is obviously much better than by stopping the descent of the spindle by contact with a collar on the spindle bearing. By having the hub length thus accurately machined, more than one gear blank can be placed on an arbor in succeeding lathe operations, with the assurance that the various surfaces of the gears will always be in the same relative positions.

Rough- and Finish-turning and Facing Operations in Automatic Lathes

The sixth operation consists of rough-turning and rough-facing various surfaces; rough-forming a groove on the hub;

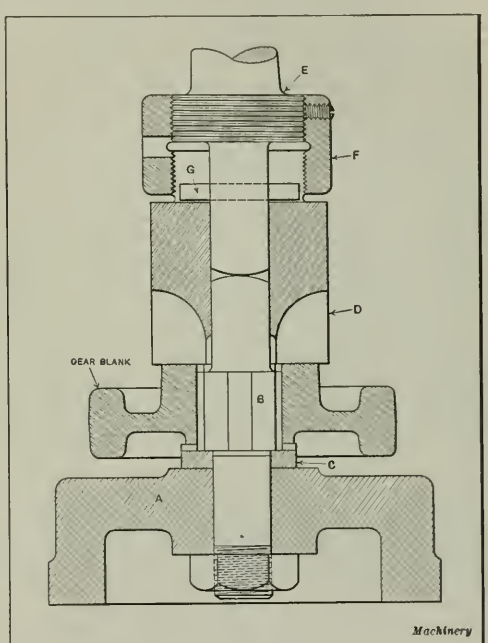


Fig. 3. Fixture and Milling Cutter used in milling Hub Face on a Two-spindle Drilling Machine

and finish-facing one side of the rim. This operation is performed in a Fay automatic lathe which is also manufactured by the Jones & Lamson Machine Co. Three gears are finished on this machine at one time, being held on an arbor as shown in Fig. 4. Two equalizing bushings *A* are placed between the gears so that they may be clamped on the arbor without springing it, if the hub faces are slightly out of true. A detail of one of these bushings is shown in Fig. 6. It will be noted that this bushing has two small flat bearing surfaces diametrically opposite each other on each end, and those on one end are at right angles to those on the other end. The bushing is a loose fit on the arbor, and so can adjust itself to suit the faces of the gear hubs between which it is placed. By this means the extra lathe operation often employed to make the hub face true with the hole is eliminated.

The rear tool-holder, Fig. 4, carries tools *C* which rough-face surfaces *H*, and tools *D* which rough-face surfaces *I* and rough-form grooves *J*. The front carriage travels in two directions, moving first toward the headstock and then radially away from the work. During the first movement, sur-

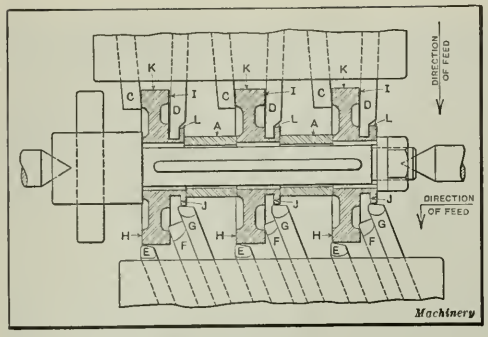


Fig. 4. Lay-out of Tools for machining Gears in a Fay Automatic Lathe, and Method of mounting Gears on Arbor

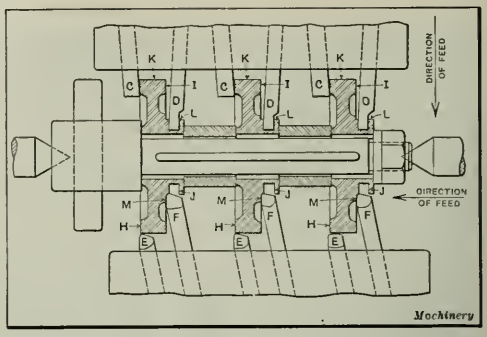


Fig. 5. Tooling Equipment employed to take Finishing Cuts on Gears in Another Fay Automatic Lathe

faces *K* and *L* are rough-turned by tools *E* and *G*, respectively, while during the second movement, surfaces *I* are finish-faced by tools *F*. The tools in the front carriage are engaged in machining the work at the same time as the tools on the rear tool-holder, so that this operation is completed when tools *D* are through machining grooves *J*.

Fig. 5 shows the gear blanks mounted in another Fay automatic lathe for the performance of the seventh operation. This operation consists of finishing all the surfaces roughly machined in the preceding operation. The rear tool-holder is advanced rapidly toward the work until tools *D* reach grooves *J*, which are then finish-formed by these tools, while surfaces *H* are finish-faced by tools *C*. At the same time surfaces *K* are finish-turned by tools *E* and surfaces *L* are finish-turned by tools *F*, which also finish-face surfaces *M*. After surfaces *K*, *L*, and *M* are finished, the carriage is drawn radially slightly away from the work so that the finished surfaces are not scored by the tools as the carriage is returned to its former position. All the cuts in the operation are taken while tools *C* are finish-facing surfaces *H*. The two machines used in the sixth and seventh operations are tended by one operator, and three arbors are provided so that blanks can be clamped on one of these arbors while the operations are being performed on the blanks on the other two, which are mounted on the machines.

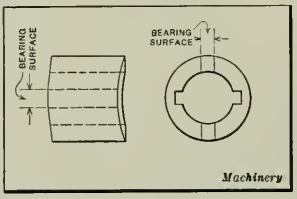


Fig. 6. Detail of Equalizing Bushing

Final Operations on Transmission Gear

The eighth operation consists of cutting the teeth on the gear blank. Fig. 7 shows the method of mounting two blanks at one time on a Fellows gear shaper for this purpose. It will be noted that the blanks are clamped at the rims, this being preferable to the method of clamping at the hubs, because by the former method the work is supported close to the point where the machining occurs, thus permitting heavy cuts to be taken with greater accuracy. Also, when gears are clamped at the hubs and the hubs happen to be slightly out of true, the arbor will be sprung and the teeth will not be cut true with the hole. When the gears are to be clamped together at the rims, they should be so designed that the finished face of the hub is slightly below the finished face of the rim, as shown in the illustration; otherwise, spacers must be placed between the rims so that the hubs do not come in contact with each other and thus prevent clamping at the rims.

The ninth operation consists of rounding the corners of the teeth in a corner-rounding machine. The burrs formed on the gear during the various operations are removed by a tenth operation. The eleventh operation consists of carburizing and heat-treating the gears and removing the scale. In the final operation, the hole is ground on an internal grinding machine, the work being held on a chuck equipped

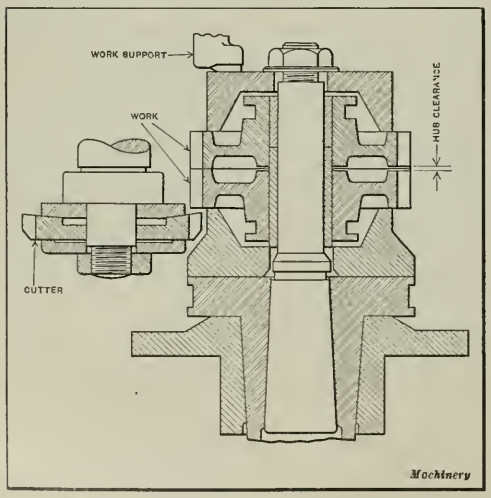


Fig. 7. Method of clamping Gear Blanks on Gear-cutting Machine

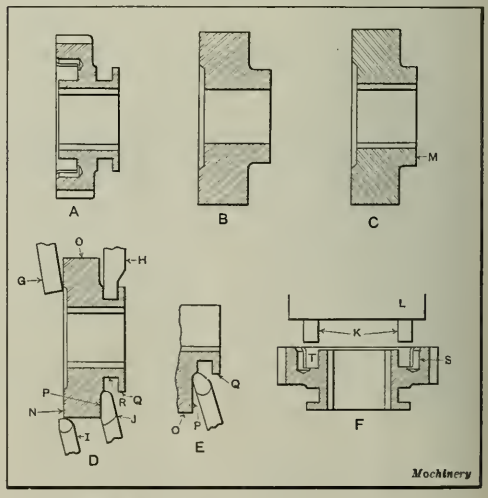


Fig. 8. Methods of machining Other Types of Transmission Gears

with special jaws that grip the work at the roots of the teeth. The gear is also located along the rim instead of at the hub, and the result is a finished hole that is true with the teeth. This is the final important quality necessary for a quiet-running transmission gear.

Machining Another Type of Transmission Gear

Sliding transmission gears may, of course, be of a different design from that just dealt with. For instance, gears used for obtaining the intermediate and high speeds are often of the type shown at *A*, Fig. 8. Holes are drilled in one side of this gear and a recess is cut in the same side, thus forming an internal clutch. The method of manufacturing this gear is very similar to that previously described, so that only a condensed description will be given. Fourteen operations are required, which are performed in the following order: (1) The hole is drilled in the blank, this operation being performed on a drilling machine. (2) The hole is rough- and finish-bored and a recess is machined on one side of the blank as shown at *B*, a special two-spindle lathe of the type shown in Fig. 2 being used for this purpose. (3) The hole is rough-broached. (4) The hole is finish-broached. (5) Surface *M*, on the detail shown at *C*, is rough- and finish-faced on a two-spindle drilling machine, the work being mounted on a fixture of the type illustrated in Fig. 3 and machined by similar tools. (6) This operation is performed in a Fay automatic lathe, the work being mounted on an arbor in the manner illustrated in Fig. 4. The various surfaces machined in this operation and the tools used are shown at *D* in Fig. 8. Surface *N* is rough-faced by tool *G*, and groove *R* is rough-formed by *H*, these tools being mounted on the rear tool-holder. Surface *O* is rough-turned by tool *I;* surface *Q* is rough-turned by tool *J;* and surface *P* is rough-faced by tool *J*, these tools being mounted on the front carriage. When surface *P* is very wide, tool *J* should be of the type shown at *E*, which necessitates that the carriage be moved radially away from the work after surfaces *O* and *Q* are machined, in order to face surface *P*. (7) Finishing cuts are taken on all the surfaces roughly machined in the sixth operation. (8) The teeth are cut on the rim by a gear-cutting machine. (9) The corners of the teeth are rounded in a corner-rounding machine. (10) Holes *S*, in the detail shown at *F*, are drilled and countersunk on a multiple-spindle drilling machine. (11) Recess *T* is machined on a drilling machine, the work being held on a fixture of a similar design to that illustrated in Fig. 3. The recess is cut by cutters *K* which are inserted in the cutter-head *L*. (12) The burrs formed in the various operations are removed from the work. (13) The gear is carburized and heat-treated and the scale is removed. (14) The hole is ground on an internal grinding machine.

* * *

AMERICAN ENGINEERING STANDARDS COMMITTEE

After almost three years of investigation and discussion by engineering societies, the revised constitution of the American Engineering Standards Committee has been adopted, and has been ratified by the American Society of Civil Engineers, the American Institute of Mining and Metallurgical Engineers, the American Society of Mechanical Engineers, the American Institute of Electrical Engineers, and the American Society for Testing Materials, and the three Government Departments, of Commerce, Navy and War. Each of these interests have three representatives, and the committee as it exists today consists of twenty-four members. A. A. Stevenson, the newly elected chairman, is a past-president of the American Society for Testing Materials, and has been officially and actively interested in standardization work for many years. Dr. P. G. Agnew, formerly of the United States Bureau of Standards, is permanent secretary, with headquarters at the Engineering Societies Building, 29 W. 39th St., New York City.

The American Engineering Standards Committee will make it possible to give an international status to approved American engineering standards and to cooperate with kindred organizations in other countries. Similar organizations are now functioning in Great Britain, France, Switzerland, Holland, and Canada. Through the new committee the methods of arriving at engineering standards will be unified and simplified, and, by cooperation, the duplication of standardization work will be prevented. Standards will not be created without giving all interested an opportunity to participate. The approval of a standard by the American Engineering Standards Committee does not mean that the committee has itself worked out and approved each detail, but rather that the work has been carried out by a sectional committee adequately representing the industry concerned, and sponsored by one or more bodies of ability and experience, so that the result may stand for what is best in American engineering practice.

What the Committee is Doing

The American Engineering Standards Committee has already made considerable practical headway. It has approved specifications for standard pipe threads, for which the American Society of Mechanical Engineers and the American Gas Association are sponsors, and is representing America on this subject at an international conference in Paris. Cooperation is in progress with the National Screw Thread Commission, authorized by Congress and composed of representatives of the various technical societies, looking forward to standard screw threads. Through this arrangement, direct cooperation with the British, which is not possible by the official commission, is being carried out. The committee is also in active cooperation with the Canadians on bridge specifications, with the British on specifications for machine tools, and with the Swiss on ball bearings.

A large conference, in which practically all national organizations interested in industrial safety participated, has unanimously voted that all industrial safety codes should be prepared under the auspices of the American Engineering Standards Committee.

How the Committee Operates

Any organization may request the committee to approve standards that it has formulated, or to approve committees that it has appointed, and by so doing becomes a sponsor society. Two or more organizations may act as joint sponsors. Approval of a standard is given when it is the substantially unanimous conclusion of a section committee made up of representatives of producers, consumers, and general interests, and so selected that all interests concerned have adequate representation on the section committee. It is understood that a standard must be referred to as that of the sponsor, using whatever title the sponsor has given it, followed by the words "Approved by the American Engineering Standards Committee." The approval may be given in one of three ways: "Recommended Practice," Tentative Standard," or "American Standard."

Any standard or group of standards adopted by any organization or in process of preparation, prior to January 1, 1920, may be approved by the committee, if in the opinion of the committee, it has either been developed by a properly constituted committee, or has, by actual practice, proved its right to become a standard. In addition to assisting in the selection of committees and certifying that their work has been done under proper conditions, the committee will act as a bureau of information regarding standardization. It will collect information regarding existing standards and the bodies that have formulated or adopted them. This will enable it to properly give the data to those who select a committee to formulate a new standard or revise an old one. Provision is made for direct representation on the American Engineering Standards Committee, of additional organizations interested in engineering standardization.

INSPECTION OF A TRIPLE-TAPERED CHAMBER CHECK

By V. E. AYRE

As explained in an article "Inspection of Tapered Plugs" in the February number of MACHINERY, the different tapers may be determined by taking micrometer readings over wires of equal size, placed at different intervals on the tapered plug. In the diagram of the 30-caliber chamber check, Fig. 1, the angle a may be determined accurately by wire measurements, since the distance H on the check is greater than one inch; but it is rather difficult to determine

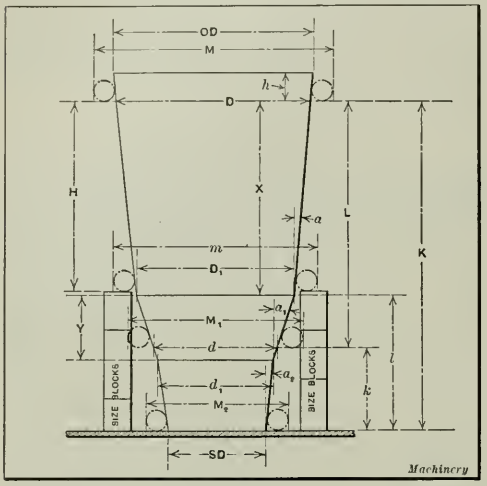


Fig. 1. Diagram illustrating Application of Formulas for measuring Triple-tapered Plugs

accurately the values of angles a_1 and a_2 by taking measurements over wires at different intervals, owing to the fact that the lengths of the short tapers are so short that only differences amounting to a small fraction of an inch can be obtained between any two micrometer readings taken over these tapers. When taking micrometer readings over wires on a plug that has a very slight taper the wires should be lightly weighted in order to keep them from rising so that they will make the proper contact with the plug as the pressure is brought to bear on them by the micrometer spindle.

Referring to Fig. 1,

$$T = \frac{M - m}{H} = \text{long taper per inch}$$

$$\text{Tan } a = \frac{T}{2}$$

If so desired, angles a_1 and a_2 may be similarly determined, or they may be determined by means of a V-block and sine bar, after the angle a has been found. When using the sine bar, clamp the gage in a V-block and align it properly on a mounted sine bar, as shown in Fig. 2. Then adjust the sine bar until the element E is parallel with the surface plate. Measure the resulting angle $2a + b$. Then by subtracting one-half the angle of taper T, the angle that the center line of the gage makes with the sine bar (or the angle that the sine bar makes with the surface plate when the center line of the gage is parallel with the surface plate) is equal to $2a + b - a$, or $a + b$.

Having found this angle $a + b$, which may be called the angle of correction, the angles a_1 and a_2 can be quickly determined as follows: Relocate the sine bar first so that element E_1 and then so that element E_2 will be parallel with the surface plate. Measure the angle between the sine bar and the surface plate while the gage is in each of these positions, and from each measurement thus made subtract the angle of correction $a + b$ and the remainders will be the values of angles a_1 and a_2 respectively. These angles a_1 and a_2 may also be determined by the method described in the February number.

Having determined the size of angles a_1 and a_2 the corresponding tapers may be expressed by the equations

$2 \tan a_1 = T_1 =$ intermediate taper

$2 \tan a_2 = T_2 =$ taper at small end

After the angles of taper are determined, proceed to find the dimensions of the plug. To find the corrections which are to be subtracted from the various micrometer readings over the wires in order that the diameter of the plug at any given height may be determined, apply the following formulas as given in the February number of MACHINERY, in the article previously referred to.

$C = G\,[1 + \cot \tfrac{1}{2}\,(90 \text{ degrees} - a)] =$ correction for taper T

$C_1 = G\,[1 + \cot \tfrac{1}{2}\,(90 \text{ degrees} - a_1)] =$ correction for intermediate taper T_1

$C_2 = G\,[1 + \cot \tfrac{1}{2}\,(90 \text{ degrees} - a_2)] =$ correction for third taper T_2

The diameters at heights K, k, and at the small end of the gage, Fig. 1, may then be expressed by the following equations:

$D = M - C =$ diameter of plug at distance K from small end

$d = M_1 - C_1 =$ diameter of plug at distance k from small end

$SD = M_2 - C_2 =$ diameter of plug at small end

$OD = D + hT =$ diameter at top

To determine the diameters at the intersection of the tapers, use the general formula given in the article "Intersection of Tapers" in the February number of MACHINERY:

$$X = \frac{T_1 L - (D - d)}{T_1 - T}$$

Therefore, the diameter at the intersection of the first and intermediate tapers equals

$$D_1 = d + T_1\,(L - X), \text{ or } D - TX$$

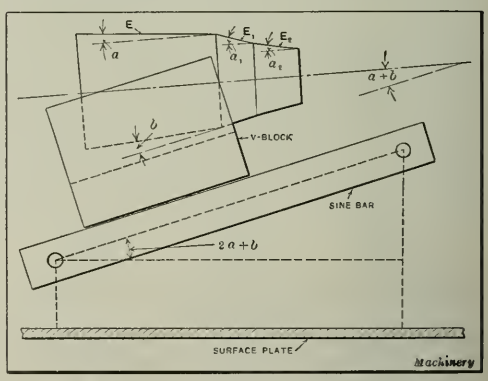


Fig. 2. Method of using Sine Bar when measuring Angles of Taper on Plugs

Again, applying an adaptation of the general formula for intersection of tapers,

$$Y = \frac{(D_1 - SD) - T_2 l}{T_1 - T_2}$$

Using a similar method to that employed for determining diameter D_1, the diameter at the intersection of the intermediate and third tapers equals

$$d_1 = D_1 - T_1 Y, \text{ or } SD + T_1\,(l - Y)$$

It is evident that

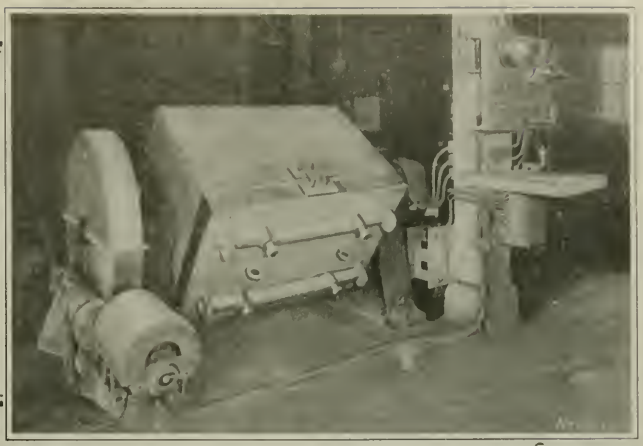
$L = K - k =$ distance between the diameters D and d

$l = K - X =$ distance between the diameters SD and D

$X + h =$ distance from top to intersection of first and intermediate tapers.

Electro Sherardizing

Application of a Rustproof Coating to Miscellaneous Products Including Sheet Metal



PREVIOUS articles on sherardizing, which have been published in MACHINERY, have explained the method of conducting this process in furnaces heated by the combustion of gas, coke, or some other fuel. An improved type of sherardizing equipment has been developed by the General Electric Co., in which the heat is generated by passing electric current through suitable windings. In the following article a discussion will be presented of results obtained from the use of machines of this type, with especial reference to the practice of the Wise Electro Sherardizing Co., of Detroit, Mich.

Sherardizing is one of three commonly used methods of applying metallic zinc to iron and steel products, in order to provide a rustproof coating. Of the various methods which are used to protect iron from corroding or rusting, the application of a zinc surface is one of the most effective. This is due to the fact that zinc is one of the few moderate-priced metals which is electro-positive to iron. To understand the meaning of this statement, it is necessary to know what takes place during the corrosion of a piece of iron or steel that is protected by a coating of some other metal. The corrosive action is started by the setting up of a galvanic electric current which results in carrying metal to the negative pole of the electrolytic cell.

In the case of zinc, which is electro-positive to iron, a galvanic action of this kind causes a slight depletion of the zinc at points where such an action is proceeding, but does not damage the iron. With iron or steel products covered with a coating of some metal which is electro-negative to iron, the result of such a galvanic action would be the reverse; namely, there would be a depletion of the iron beneath the coating of the second metal which covers the work. It is of interest to note that the corrosive action caused by a galvanic current can only take place where there is a flaw in the coating of zinc or other metal with which the iron is covered, that allows moisture to gather. But as it is practically impossible to produce a coating in which there are not at least a few very small openings, the effect of the galvanic action which takes place at such points becomes a matter of importance.

Methods of Applying Zinc Coatings to Iron Products

There are three methods by which a rustproof coating of zinc may be applied to iron and steel products; namely, by hot galvanizing, zinc plating, and sherardizing. Hot galvanizing is the first of these methods and is the one most generally used. It possesses certain noteworthy advantages in rustproofing large work, of which tanks, buckets, sheet metal, etc., are typical examples; but with the exception of sheet metal and wire, that can be wiped after dipping in the molten metal, the coat of zinc applied by this method is rough and uneven in thickness. Owing to this lack of uniformity, it is found impracticable to galvanize threaded parts which must be assembled together, or other machined work where close limits of tolerance are demanded. Furthermore, it is necessary for the work to be thoroughly cleaned before galvanizing, because if this precaution is not taken, there will be a tendency for the coating of zinc to peel off the iron, and thus expose it to corrosive action.

Where a practice is made of zinc-plating the work, a smooth coating of good appearance is obtained. This method can be used on heat-treated parts, owing to the fact that it is applied without requiring the temperature of the work to be raised. Also, the thickness of the coating can be accurately controlled, so that zinc plating may be used in cases where close limits of tolerance must be maintained on machined work. As in the case of pieces to be galvanized, the work must be thoroughly cleaned before plating, because the presence of any foreign matter will cause the coating of zinc to peel off. A further limitation of zinc-plated work is that it will not stand temperatures above 300 degrees F.



Fig. 1. Electro-sherardizing Machine with Cover removed, showing Method of packing Two Kinds of Work in Drum

without peeling; and as in the case of all electrolytic processes, it will be found that there is a tendency for the thickness of the deposit to lack uniformity, being heavy on the high spots of the work and lighter in the depressions and under shoulders. This tendency is particularly noticeable in the case of threaded work, the deposit being heavy at the tops of the threads and light at the roots.

Application of Rustproof Zinc Coating by the Sherardizing Process

Sherardizing is the third method of applying a protective zinc coating to which reference has been made previously. This process possesses many important advantages which should commend it to the attention of manufacturers of metal products. The application of a zinc coating by this method is dependent upon the property of zinc which causes it to vaporize through the application of heat. The sherardizing operation is carried on by packing the work in a sealed drum with a suitable quantity of zinc dust, after which the temperature is raised so that the zinc is transformed into a vaporous condition, in which state it is able to penetrate beneath the surface of the work. It will be evident to all experienced mechanics that there is a distinct analogy between this method of applying zinc and the familiar process of carburizing steel products which are to be case-hardened. Three noteworthy features of the service obtained by sherardizing are that the zinc is firmly bonded to the iron, that the thickness of the rustproof coating can be accurately controlled, and that the zinc deposit is of uniform thickness and is deposited to an equal degree on both flat surfaces and corners of the work.



Fig. 2. Method of winding Sheet Metal into Rolls for sherardizing with Wire Separator interposed in order to provide Space for the Zinc to enter between Adjacent Sheets

The tendency for the zinc to be firmly bonded to the metal is due to the fact that at the time when the process is started, the zinc vapor or particles of zinc dust find their way into the pores of the steel, and create a firm anchorage to which the zinc coating is connected. The photomicrograph of a cross-section of the zinc coating shows that there is a porous area between the iron and the more dense outer coating of zinc, and this condition is believed to be distinctly beneficial. It is a matter of general knowledge that sherardized products can be bent, swaged, and subjected to other treatments with the metal cold, without showing any tendency for the zinc to crack or flake off; and this is explained on the assumption that this porous structure of the lower surfaces of the zinc acts as a cushion between the zinc and the iron, thus enabling such operations to be performed without damaging the coating of zinc.

Thickness of the Zinc Coating

There is a definite relation between the temperature at which the sherardizing operation is performed and the thickness of the zinc coating which is obtained. Knowing this relationship, it is an easy matter to obtain a layer of zinc of the desired thickness. For practical purposes, the zinc is from 0.002 to 0.0025 inch in thickness, and attention is drawn to the fact that the coating should be at least up to the lower of these limits in order to assure rustproofing the work. The possibility of regulating the thickness of the zinc coating, and the assurance that this coating will be of uniform thickness all over the work, enables machined products requiring close limits of tolerance to be sherardized with successful results.

For instance, consider the case of bolts and nuts which are to be assembled together, and where the service to which they are subjected is of such a nature that the steel is likely to be damaged by corrosion. Knowing the thickness of the zinc coating which it is desirable to apply, it is merely necessary for the shop drawing to specify reducing the diameter of the bolt and increasing the diameter of the nut to such an extent that the coating of zinc will bring the dimensions of these two parts back to a point where they will assemble together properly. The same plan can be applied in sherardizing a great variety of other finished parts where accuracy is essential. In addition to its use for applying a rough coating of zinc to protect the work from damage caused by atmospheric conditions, sherardizing may be employed to apply a highly finished surface to the work. Where this result is desired, a practice is made of first polishing the surface of the work with a wheel faced with emery, and then polishing with a rag wheel after the sherardizing operation has been performed, with the result that a finish is produced that is equal in appearance to a good nickel-plated surface.

To obtain successful results in sherardizing, there are three variable factors which must be controlled, namely, the temperature, the time during which the work is exposed to the action of the zinc, and the purity of the zinc dust that is used. In so far as the last two variables are concerned, there is very little difference between the electro-sherardizing process developed by the General Electric Co. and the methods which have been discussed in previous articles in MACHINERY, where the heat for conducting the process is supplied by the combustion of gas, coal, or some other fuel. However, where heat is supplied by electric power, there is a marked advantage in regard to accurate regulation of the temperature, which, in turn, is the means of regulating the thickness of the deposit that is applied to the work, and in certain cases, the uniformity of thickness of the zinc coating applied at different points on the same piece of work. Electric power has the further advantage of being cleaner and affording greater convenience of operation. As regards the zinc dust factor, it may be mentioned that the dust which is used consists of finely subdivided metallic zinc and zinc oxide. This material can be used over and over again, but a practice is made of adding about 10 per cent of fresh zinc to a previously used charge. Experience has shown that this practice is the means of maintaining the purity of the zinc dust at the required level to give satisfactory results.

Cleaning Work Preparatory to Sherardizing

In order for the sherardizing operation to be performed with satisfactory results, it is necessary to have the work clean before it is subjected to the action of the zinc. However, it may be mentioned in this connection, that the same absolute degree of cleanliness is not required as in the case of electroplating and certain other methods of applying metallic finishes to metal products. For sherardizing, the usual practice is to employ a sand blast or shot blast to remove heavy coatings of rust, fire scale, etc., while the work is washed in a solution of caustic or some similar chemical to provide for the removal of thick coatings of grease.

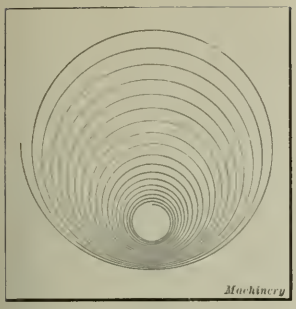


Fig. 3. Diagram showing how Zinc is able to penetrate between Sheets in a Roll

The Wise Electro Sherardizing Co. prefers the use of a 16 per cent solution of sulphuric acid for the removal of fire scale, instead of employing a sand blast. The work is first immersed in a wooden vat of this acid for about ten minutes and then thoroughly rinsed in water to prevent further action of the acid. Before leaving this discussion of cleaning, it is important to note that the presence of a very thin film of grease or a light coating of freshly formed rust, does not present an insurmountable difficulty to the successful performance of the sherardizing operation, as it would to the attainment of satisfactory results in electroplating, etc. When there is grease on the work, it is vaporized by the heat of the sherardizing drum before the zinc begins to attack the work, and so causes no trouble. Likewise, a thin film of fresh rust does not cause any trouble, as the zinc is able to readily penetrate into the pure iron beneath it.

General Electric Sherardizing Equipment

Two sizes of sherardizing equipments are built by the General Electric Co., one of which has a drum 24 by 24 by 40 inches in the compartment in which the work and zinc dust are packed. The other machine has a drum measuring 10 by 10 by .17 inches. In operating either of these equipments it is found that the process of sherardizing proceeds most favorably when the temperature is raised to 340 degrees C. (644 degrees F.) as rapidly as possible. For operating the large sherardizing machine, the current consumption is 53.5 kilowatts to bring the drum and its contents up to the sherardizing temperature, after which the current consumption is 13.5 kilowatts. For the smaller machine, 15 kilowatts are required to bring the drum and work up to the sherardizing temperature, after which 5 kilowatts will maintain the operating temperature. Reference to the heading illustration and Fig. 1, which show one of the large sized sherardizing machines in operation at the plant of the Wise Electro Sherardizing Co., will show that the drum in which the work is packed is supported by trunnion bearings, and that there is an electric motor which provides for revolving the drum by means of a worm and wheel through which the power is transmitted.

Contained in all four sides and both ends of the drum there are electric windings through which the power is transmitted to heat the drum and work; and outside of the windings there is placed a packing of heat-insulating material which retains the temperature at the desired degree. At one end of the machine there are three slip rings and carbon brushes which take electric power from the line and transmit it through the windings in the machine. These windings are so arranged that power may be taken from a direct-current line or from a single-phase alternating-current line of any standard voltage. There is a double switch provided for making connection with the electric windings, and in starting the sherardizing operation, this switch is first thrown into a position which transmits the maximum amount of power through the windings to provide for bringing the temperature up to normal as rapidly as possible.

It usually takes four hours to heat the contents of one of the large sized drums to this temperature. When this result has been obtained, as indicated by a thermometer made by the Taylor Instrument Companies, of Rochester, N. Y., which is attached to the side of the drum and projects inward to come into intimate contact with the contents, the electric switch is thrown into its second position, which delivers a sufficient quantity of power through the windings so that the temperature of the work may be maintained at 340 degrees C. (644 degrees F.) for the period of four hours which is required to give the average depth of zinc that is desired on the work. In order that the process may proceed satisfactorily, it is important that there shall not be a greater temperature fluctuation than ± 5 degrees F. and if the operator of the machine finds that this limit of variation has been exceeded, he immediately makes an adjustment of the regulator to bring the temperature back within its normal range. When the sherardizing has been completed, the work is left in the drum to cool after the current has been shut off, and about three and one-half hours are required to allow the temperature to drop to 230 degrees C. (446 degrees F.)

Method of Sherardizing Steel Plates

There are numerous instances in which it would be found advantageous to apply a rustproof coating of zinc to steel plates by means of the sherardizing process. The bonding which is secured between the zinc and the iron by this method is especially advantageous in the case of plates which are later to be bent or otherwise changed in form, because it prevents the zinc from flaking off. Early attempts which were made to sherardize plates were unsuccessful, difficulty being experienced in securing a uniform deposit of zinc over the entire surface of the work. This trouble was chiefly due to the fact that where large areas had to be covered, it was difficult to so support the work that the entire surface of the steel or iron would be exposed to the zinc. One customer of the Wise Electro Sherardizing Co. engaged in the manufacture of gas ranges was anxious to obtain rustproof plates for oven linings, and the problem of developing a method of sherardizing plates for this purpose was referred to this company. Owing to the restricted size of the drums in which the sherardizing process is conducted, it was necessary to take the plates and roll them up in order to enable a sufficient quantity of work to be put into the drum at a time to avoid making the cost of sherardizing prohibitive.

Acting upon this method of procedure, it was then necessary to devise some means of separating adjacent sheets of metal in the roll, in order to prevent having them lie so closely together that it would be impossible for the zinc dust and zinc vapor to reach all portions of the surface of each sheet. After considering various expedients, it was



Fig. 4. For pickling, Rolls of Sheet Metal are held vertically to prevent Tendency of Sheets to exclude Acid at One Side of Roll

found that the most satisfactory way of obtaining the desired result was to roll up the sheets of steel as shown in Fig. 2, with a single strand of ordinary 15-gage wire between adjacent sheets. This method of rolling is quite simply accomplished by running the sheets of steel over a bench to the winding reel, and having a reel of wire suspended from the ceiling over the reel on which the roll of steel is to be wound. With such an arrangement, it is found that ample space is provided to allow the zinc to penetrate, particularly in view of the fact that the drum in which the sherardizing operation is performed is kept constantly revolving and there is a tendency for the coil of steel to assume a position similar to that shown diagrammatically in Fig. 3. Here it will be seen that at the lower side of the coil, adjacent sheets of steel are as closely in contact with each other as they are able to come with the strand of wire between them, but at the upper side there is considerable space between adjacent sheets. As the drum revolves, the position of that part of the coil is constantly shifting, where the sheets are sufficiently separated to allow the zinc to penetrate, thus allowing all portions of every sheet in the coil to be coated with zinc.

Packing Different Types of Work for Sherardizing

It will frequently happen that it is necessary to run several different classes of work in the same drum. The need of such a practice will at once be apparent when it is remembered that a period of about twelve hours is required to load the drum, bring the work up to the operating temperature, complete the sherardizing process, and cool the drum down again to a point where the work can be removed. Special means must be provided to efficiently handle different classes of work in the same drum during a single run, and this is particularly true in cases where some of the work is threaded or otherwise of a nature that would be readily damaged if allowed to tumble in contact with other work that is being heated at the same time. To protect pieces of this kind while sherardizing, a practice is made of providing separate containers in which different classes of work are placed, and then having these containers supplied with individual charges of zinc dust and placed in the drum of the sherardizing machine. A general idea of the way in which this practice is conducted will be gathered from Fig. 1, which shows a roll of sheet metal in one end of the drum and the remaining space filled with a metal box containing eyebolts. Before leaving the subject of sherardizing plates, attention is directed to Fig. 4, which shows a coil of sheet metal about to be dipped into the sulphuric acid pickling bath. It will be seen that this coil is suspended endwise, which is an important matter, because if it were held with the axis of the cylinder horizontal, there would be a tendency for one side of the plates to press tightly against the other, as indicated in Fig. 3, excluding the acid and thus preventing the accomplishment of a complete cleaning of the work.

In order to test the perfection of a sherardized surface as regards its ability to resist rust and corrosion, the recommended practice is to spray the work with a solution of salt and water, which is made of such a strength that it has a specific gravity of from 1.026 to 1.030 at a temperature of 60 degrees F. The test samples are placed on a rack in a covered box, and a constant spray of brine, atomized by compressed air, is kept playing inside of the box, care being taken not to allow the spray to impinge directly upon the work. Under such conditions, the pieces to be tested are constantly covered with a very thin film of moisture over their entire surface, but there should be very few drops of any appreciable size on the work. This test is a very searching one and reveals any minute holes or uncovered areas on the metal, and thus affords an opportunity of determining the degree of protection against rust which has been provided by the sherardizing operation. When pieces have been properly treated according to the method of sherardizing described in this article, they should be able to stand at least 100 hours of the salt spray and show no evidence of rust or corrosion.



Fig. 5. Sherardized Products may be given a High Finish, Comparable with Results obtained by the Nickel-plating Process

Limitations of the Sherardizing Process

Sherardizing possesses a great many noteworthy advantages over other methods of applying a rustproof coating of zinc to iron or steel products, but despite this fact it has not come into very general use. This fact is especially remarkable when the high cost of copper and other constituents which are required to make brass are taken into consideration. Iron and steel have been freely used as substitutes for these rustproof metals, and they have had to be protected from the atmosphere in order to enable such a substitution to be made with successful results. Sherardizing has been successfully used for the purpose and has given very satisfactory results in practically all cases.

That the process has not come into extremely general use is due to limitations of the equipments which are at present available for performing sherardizing operations, and not to any deficiencies of the results obtained from this method of rustproofing. For one thing, the equipments which are at present built do not make it possible to sherardize large pieces of work; and even in cases where a few pieces would go into the drum, the extended period of time required to complete the operation would not allow such large pieces to be rustproofed by this method at anything but a prohibitive cost. It may also be mentioned that the process is not well adapted for rustproofing parts which have been heat-treated, if they have been subsequently drawn at a temperature below 650 degrees F. If an attempt is made to sherardize such parts, it is found that the temper of the work will be changed. These difficulties are not insurmountable and will doubtless be successfully overcome. Their elimination would mean a considerable increase in the quantity of work sherardized.

* * *

The great Krupp works at Essen, Germany, which previous to the war employed 81,000 men, are now employing 85,000 men on peace-time production. The plants are now manufacturing a variety of machinery and tools including Diesel engines, steam engines, locomotives, railway cars, cream separators, small tools and screw machine products.

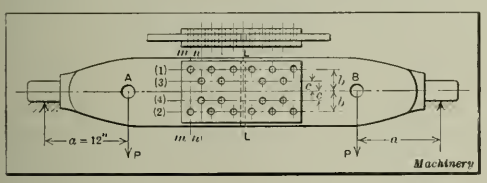
SPLICING LOCOMOTIVE BRAKE BEAMS

By VICTOR M. SUMMA
Engineering Examiner, American Brake Co., St. Louis, Mo.

In order to simplify assembling, the brake beams of locomotives are sometimes made up of two pieces connected at the middle. As the connection admits of no cover plates, an ordinary butt-joint such as shown in the accompanying illustration is used in making the splice. It is, of course, necessary to ascertain the thickness of the splice plates and the diameter of the bolts that will produce a joint as strong as the rest of the brake beam. Let us assume that the flat portion of the brake beam is 9 inches by 1 inch and that the load P at the pins A and B is 18,000 pounds, 12 inches from each journal bearing center. Since the bending moment is constant and a maximum between A and B, the stress at any section of the beam between these pins is

$$\frac{18{,}000 \times 12}{\frac{1 \times 9^3}{6}} = 16{,}000 \text{ pounds per square inch in tension}$$

and compression, and the stress in any of the parts of the splice should therefore not exceed three-fourths of this figure or 12,000 pounds in shear and not more than twice this shear or 24,000 pounds as bearing or crushing pressure. Applying the theory of the beam to the bolts or rivets, it is clear that the strain in each bolt section is directly proportional to its distance from the neutral axis A–B of the beam. So that if Q represents the amount of strain in a bolt which we may imagine to be located at a unit distance from line A–B, the strain on the bolts in the rows (1) and (2) will be $Q \times b$, and that on the bolts in rows (3) and (4) will be $Q \times c$.



Butt Joint employed in splicing Locomotive Brake Beams

Also it is obvious that the external moment Pa on the beam must be equal to the sum of the moments of the strains (or forces) in all the bolts on one side of the center line L–L, about the points of intersection of lines m–m, n–n, etc., and the neutral axis A–B. In other words, we must have

$$Pa = 6Qb \times b + 4Qc \times c$$
$$Pa = Q\,(6b^2 + 4c^2)$$

Therefore

$$Q = \frac{Pa}{6b^2 + 4c^2} = \text{strain in a bolt at a unit distance from line } A\text{–}B. \text{ Or}$$

$$\text{Stress in bolts in rows (1) and (2)} = Qb = \frac{Pa}{6b^2 + 4c^2} \times b$$

$$\text{Stress in bolts in rows (3) and (4)} = Qc = \frac{Pa}{6b^2 + 4c^2} \times c$$

The above expressed as a rule, is as follows: To find the total stress in any bolt of a splice of the type shown in the illustration, divide the bending moment Pa on the brake beam by the sum of the squares of the distances from the neutral axis *of the beam* of all the bolts *on one side* of the center line L–L, and multiply the result by the distance to the axis A–B of the bolt under consideration.

Now assuming that $b = 3$ inches and $c = 1\frac{1}{2}$ inches, we have by substitution in the above formulas:

$$Qb = \frac{18{,}000 \times 12}{6 \times 3^2 + 4 \times 1.5^2} \times 3 = 3428.57 \times 3 = 10{,}286 \text{ pounds}$$

$Qc = 3428.57 \times 1.5 = 5143$ pounds.

Or, since by assumption the unit stress in shear must not exceed 12,000 pounds per square inch, the diameter of the bolts in the outside rows can be found thus (the bolts being in double shear):

$$2 \times 0.7854D^2 \times 12{,}000 = 10{,}286$$

Therefore

$$D = \sqrt{\frac{10{,}286}{2 \times 0.7854 \times 12{,}000}} = 0.738 \text{ or, say, } \tfrac{3}{4} \text{ inch}$$

The diameter of the bolts in the inside rows will be found likewise:

$$D' = \sqrt{\frac{5143}{2 \times 0.7854 \times 12{,}000}} = 0.525 \text{ or say, } 9/16 \text{ inch}$$

But for practical reasons the bolts are all made of the same size, and so the required diameter is $\frac{3}{4}$ inch.

In considering the size of the splice plates, it is clear that the material of the plates in contact with half of the bolt shanks will be crushed if it cannot withstand the 10,286-pound load. For each bolt there are two semi-cylindrical surfaces which will resist the crushing tendency of the 10,286-pound force. It is known that the bearing resistance of each half-cylindrical surface is the same as that of a rectangle having one side equal to the diameter of the bolt and the other side equal to the thickness of the plate. Hence, if t represents the required thickness, and 24,000 pounds the maximum allowable bearing value of the material, the conditions shown in the following equation must exist in order to meet the requirements for safety:

$$2 \times t \times D \times 24{,}000 = 10{,}286$$

or

$$t = \frac{10{,}286}{2 \times 0.75 \times 24{,}000} = 0.285 \text{ inch}$$

Hence, each splice plate must be 5/16 inch thick.

* * *

PRIZE FOR HARDNESS TESTING DEVICE

It has been announced that Sir Robert A. Hadfield has placed in the hands of the Institution of Mechanical Engineers of Great Britain the sum of £200, which, with any income therefrom, may be awarded as a prize for the description of a new and accurate method of determining the hardness of metals, especially of metals of a high degree of hardness. The ordinary tests of hardness fail to some extent when the hardness of the material exceeds about 600 to 800 Brinell. What is desired is the description of a research for or an investigation of some method for accurately determining hardness, suitable for application in metallurgical work in cases in which present methods partially fail. The award will be made by the council of the Institution of Mechanical Engineers, whose decision will be in all cases final. The council will consider annually all communications received, and may then award a prize. But in January, 1922, the offer of prizes will be withdrawn, and any unexpended balance of the prize fund will be diverted to any other purposes to be determined at the discretion of the council. The council may award the whole or any part of the sum available at any time if a communication is received which, in their opinion, is of sufficient orginality and importance and satisfies the object aimed at; or they may from time to time award portions of the fund, not exceeding in all £75 in any one year, for communications which do not completely solve the problem, but which appear to advance the knowledge of methods of testing hardness. The institution will probably be willing and reserve the right to publish in its journal any communications for which a prize is awarded. A communication should be accompanied by scale drawings of any new apparatus described, or by a model or an example of the apparatus itself. If the communication describes a new invention, likely to be of commercial value, it is desirable that provisional protection should have been obtained before it is submitted for consideration. Nothing is said as to whether the competition is confined to British contestants or is international; but information on this point may be had from the Secretary, Institution of Mechanical Engineers, London, England.

Taper, Profile, and Concentricity Gages

By JOHN E. COLLINS



TAPER plug gages are made in various forms designed to meet special conditions. Fig. 1 illustrates three slightly different designs of the ordinary taper plug and ring gage, each being equipped with a standard plug gage handle. Taper plug and ring gages should be made from tool steel, hardened, seasoned, ground and lapped. In setting limits on plug and ring gages, the "Go" line or step, as the case may be, of the plug should coincide exactly with a "Not Go" line on the ring, when the two gages are fitted together. As the plug gage is made first and the ring gage afterward fitted to it, the lines on the ring gage may be transferred directly from those on the plug gage.

The "Not Go" and "Go" diameters on the plug are the same as the maximum and minimum diameters, respectively, that are allowed on the work. The limits on taper limit gages are determined by the longitudinal travel of the gage, which is governed by the maximum and minimum diameters allowed on the part drawings. This method of gaging parts, however, is not the most accurate one, but is the best commercial method devised at the present time.

The type of taper plug and ring gage shown at *B* and *C* is considered very accurate, and differs from the design shown at *A* only in that it has a step ground on the large end of the taper. This step represents the minimum or "Go" diameter on the plugs and the "Not Go" diameter on the rings, as shown in the illustration. The only difficulty experienced in using the step design of taper gages is in attempting to gage work having a very slight taper, in which case the gage is liable to stick in the work and cause difficulty in removing it. This objection may be partly overcome by using a flat plug (shown at *C*), but this gage offers disadvantages in manufacturing, owing to the difficulty experienced in lapping.

Another type of taper gage which is used only on very large work, such as electric generator housings, steam engines, etc., is shown at *D*, Fig. 2. The work end may be provided with a milled step for the minimum depth, the same as a small taper gage, or it may have heavy lines etched on it to indicate the limits allowable on the work. As will be noted from the illustration, bosses are cast on at the ends to furnish a bearing for the lathe centers while the gage is being made. Taper plug and ring gages of this type may be made of cast iron, malleable iron, or steel forgings, as desired.

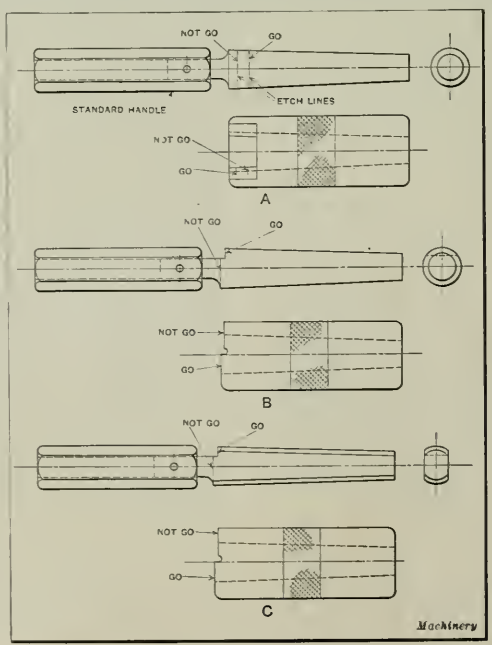


Fig. 1. Taper Plug and Ring Gages

For setting and inspecting tapers, a very good method, and one commonly used, is to employ two straightedges, which are set by means of two accurately ground and lapped disks. This method of laying out and inspecting tapers on plugs is fully illustrated and described in MACHINERY'S HANDBOOK.

All toolmakers' tolerances for taper plug gages should be applied similarly to those for straight plug gages, and also the taper ring gages should have the same tolerance as applied to straight plain rings or female gages. These tolerances are found in Table 4, in the November number of MACHINERY on page 216. Like plain ring and plug gages of the straight type, and in the same manner as previously explained, taper plug and ring gages should be hardened.

Profile Gages

Profile gages which may include gages having contours established either by curved or straight lines, or by both, are used for measuring and inspecting the profile or irregular contours of work. Profiles may be of such form as to require the use of either a male or female gage. It is impossible to standardize this type of gage except in regard to the thickness and grade of steel that should be used.

A few examples are shown in Figs. 4 and 5, reference to which will give an idea of the application of tolerances, and the construction of the solid and built-up designs. No attempt to establish a standard system to be followed in the manufacture of profile gages has been made, but it is suggested that the contour lines of the gage should not deviate more than $\pm$ 0.002 inch at any point from the actual contour of the work, or not more than $\pm$ 0.001 inch from an approved master gage. The use of profile gages should be avoided wherever possible, as this type of gage does not indicate to the inspector the true amount of variation that may exist in the work. The gage must be held in the cor-

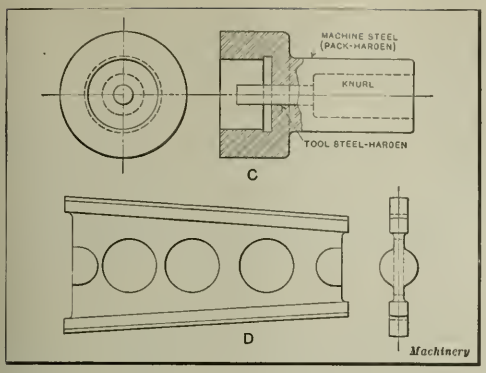


Fig. 2. (C) Combination Male and Female Concentricity Gage. (D) Taper Gage for Large Work

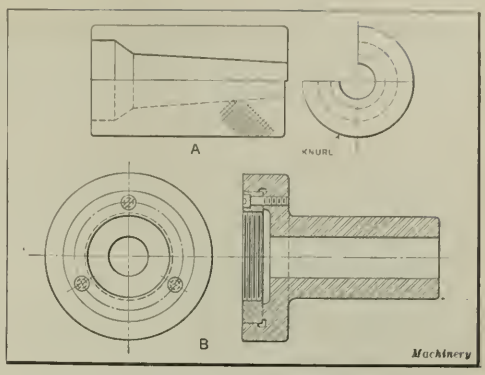


Fig. 3. (A) Profile Gage for Cylindrical Work. (B) Built-up Concentricity Gage for Threaded Diameters

rect position, as shown at *A*, Fig. 5, and the outline inspected by observing if light rays are perceptible between the gage and the outline of the part being gaged. The amount of the deviation from the profile gage outline that is permissible is always more or less arbitrary, and therefore the inspector must rely upon his own judgment when using this type of gage. Profile gages of the flat type should be made from carbon steel containing from 0.30 to 0.50 per cent carbon. The smaller profile gages should be made from ⅛-inch flat stock; those under 6 inches in length should be pack-hardened to a surface content of from 0.90 to 1.00 per cent carbon, then seasoned, ground, and lapped. The larger profiles should be made from 3/16-inch flat stock and hardened on their gaging outline only.

The built-up profile gage is often required to overcome grinding difficulties that are encountered in the solid type of gage. It would be impossible to grind a gage having the dimensions and contour shown at *A*, Fig. 4, if it were made in one solid piece. In the built-up type, the parts are ground to the exact size required and then assembled. The plates are held together by any of the various common methods such as riveting or doweling, or by means of screws, depending upon the size of the gage and general conditions governing its use, but where possible screws and dowels should be used. The method of building up the plates varies in nearly every case, one type being built up flush on one side, and having a back-plate to hold the parts together.

The male profile gage shown at *B*, Fig. 4 is the solid plate type and can be ground and lapped to size without difficulty, in so far as lack of clearance for grinding is concerned. This type is also used as a check for the female gages of both the built-up and solid types. At *B*, Fig. 5, is shown a female profile gage which may be manufactured without being made by the built-up method, since it is possible to relieve the outline of the gage where the different contours or curves join. This relief is indicated by the dotted line which represents the contour of the work. When it is possible to do this, the necessity of making a built-up gage is obviated.

Concentricity Gages

The simplest case in which the use of a concentricity gage is required is where there are two diameters on one shaft which might be correct in size, but not concentric with each other. The concentricity may be determined by making a master gage, which may be considered as being in perfect alignment and as having the correct diameters. For gaging two diameters on one shaft a female gage must be used which should be made to the largest diameters allowed on the work. If the gage passes over both diameters, it is considered correct for all practical purposes. Concentricity gages may take the form of plugs having various diameters, or they may be combinations of male and female gages, as illustrated at *C*, Fig. 2. In gaging the concentricity of tubes, a special type of gage is usually employed, which is known as an indicator gage and which will be described in a later article. The judgment and skill of the designer are of vital importance in producing designs for concentricity gages.

One system for dimensioning concentricity gages is to make all male gages to the minimum diameters allowed on the work and to make the female gages to the maximum work diameters. A gage of this type will always enter the work if it is concentric, provided, of course, that the diameters

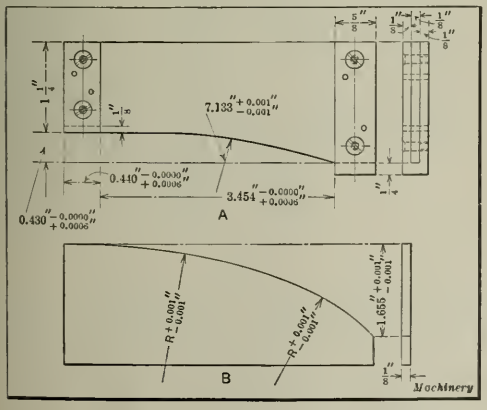


Fig. 4. Built-up and Plate Types of Profile Gages

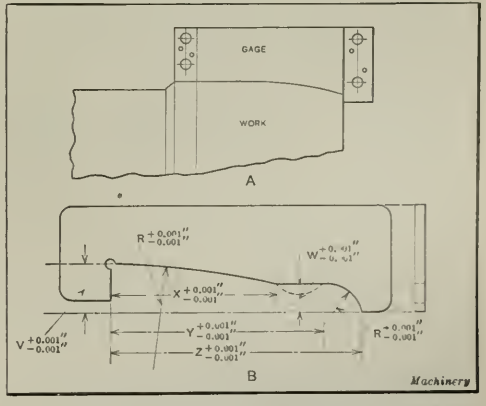


Fig. 5. (A) Application of Profile Gage. (B) Female Profile Gage

themselves have previously been inspected and passed. Another system of dimensioning is based on allowing a percentage for concentricity of the difference between the minimum inside and maximum outside diameters of the work. This system may be best expressed by the following formula:

$$A - X = D$$
$$B + X = d$$

in which

A = minimum inside diameter of work that fits male part of work;

B = maximum outside diameter of work that fits female part of work;

D = diameter of male gage (outside);

d = diameter of female gage (inside);

X = 0.50 per cent of the difference in diameters A and B.

The above formulas are illustrated in the diagram in the lower left-hand corner of Fig. 6. The preferable type of concentricity gage to use depends on the class of work and general shop conditions. Tolerances for concentricity gages are applied in the same manner as those for standard plug and ring gages.

The illustration at E, Fig. 6, outlines a simple type of male concentricity gage for two diameters of different sizes. Standard plug gage handles should be used in every case wherever possible. No detailed explanation of the construction and use of this gage should be necessary. At F is shown a combination male concentricity gage. It would be impossible to make a gage which could be inserted in one end of the work shown at G and which could gage the concentricity of all its diameters at once. By making a gage for each end of the work, and by providing the gage with a sliding plug, the work may be gaged in one operation. In the view at G, the diameters R, S, and T are to be gaged. By referring to the view at F, it will be seen that the gage for diameters S and T contains the sliding plug, which, if the three holes are concentric, will enter a hole in the end of the gage for diameter R, when both gages are in place. The gages are made of hardened tool steel and are provided with standard plug handles.

A type of gage that is used to check or inspect profiles on cylindrical work may be seen at A, Fig. 3. A full lengthwise quarter of the gage is cut away to allow a free inspection of the work. Various shapes may be inspected by the use of gages of this design, and they may also be used to test the concentricity of each part of the work, the profile lines of which do not run at the same angle. One-half of the end

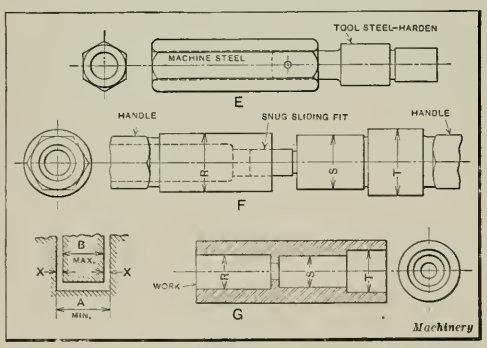


Fig. 6. (E) Plain Male Concentricity Gage. (F) Combination Male Concentricity Gage

area of the gage is milled off shorter than the other half, the amount being determined by the tolerance allowed on the part drawing. This step is shown in the illustration, and gages the maximum and minimum length allowed on the work.

A concentricity gage having internal threads is shown at B, Fig. 3. This type is used to check the concentricity of a part that screws into another part, the part having a close tolerance and being required to be in alignment with the outside diameter or with the shank of the work. As will be seen, the gage is of the built-up type, so as to facilitate machining and to provide for reversing the thread ring when it becomes worn at the end. This design may be made in either the male or the female form. The illustration at C, Fig. 2, is a combination of male and female concentricity gages, and its use is to gage the diameter of a hole and its relation to an outside diameter. This gage may be made in various shapes for both plain and threaded diameters.

* * *

COMPUTATION OF DIAMETERS AND CIRCUMFERENCES OF CIRCLES

By E. T. MEEHAN

The values shown in the accompanying table may be employed to simplify calculations ordinarily required in computing the diameter of a circle from a given circumference or vice versa. It will be seen by inspecting the table that these values consist simply of the value π, multiplied by each unit from 1 to 9 inclusive, and also the reciprocal of π, similarly multiplied by these units.

VALUES FOR COMPUTING DIAMETERS AND CIRCUMFERENCES OF CIRCLES

(VALUES OF π)

Integer	Multiple	Reciprocal	Integer	Multiple	Reciprocal
1	3.1415926536	0.31831	6	18.8495559216	1.90986
2	6.2831853072	0.63662	7	21.9911485752	2.22817
3	9.4247779608	0.95493	8	25.1327412288	2.54648
4	12.5663706144	1.27324	9	28.2743338824	2.86479
5	15.7079632680	1.59155	..	.....	Machinery

It is the belief that the use of these tables will result in a great saving of time for draftsmen and others engaged in work requiring the use of such mathematical computation. As is well known, the circumference is generally found by multiplying the diameter by the value 3.1416, or π, and reversing this operation when the circumference is known and the diameter is required. By using the values in the table and following the method to be explained, slightly more accurate results can be obtained, a considerable amount of time can be saved, and the possibilities for errors will be greatly reduced. It will be noticed that the multiples of π are carried out ten places, but of course in common use there is no need of using more than four or five of these. The reciprocals are carried out only to five places and, as shown by the following examples, will give ample accuracy.

Examples—The diameter of a circle is 37.541 inches; find its circumference. From the multiple values in the table:

$30 \times \pi = 94.24778$
$7 \times \pi = 21.99115$
$0.5 \times \pi = 1.57080$
$0.04 \times \pi = 0.12566$
$0.001 \times \pi = 0.00314$

117.93853 inches

Find the diameter of a circle whose circumference is 37.541 inches. According to the reciprocal values:

$30 \div \pi = 9.5493$
$7 \div \pi = 2.2282$
$0.5 \div \pi = 0.1591$
$0.04 \div \pi = 0.0127$
$0.001 \div \pi = 0.0003$

11.9496 inches

* * *

The United States Senate has passed the Kenyon Americanization Bill which requires all residents of the United States between the ages of sixteen and twenty-one, not mentally disqualified, and all alien residents of the United States between the ages of sixteen and forty-five, who cannot speak, read or write English, to attend school not less than 200 hours a year.

Rescission of Sales Contracts

By CHESLA C. SHERLOCK

IT is just as necessary for men engaged in business to know what constitutes a valid termination of a contract as it is to be familiar with the requirements for the writing of a contract that will be legal. There are times when a sales contract must be rescinded, and the question is, what legal requirements must be preserved in order to permit the sales contract to be rescinded by one of the parties, or by an agreement between both? When can the seller rescind, when can the buyer rescind, and what is necessary to terminate an agreement between two parties by voluntary action on the part of both?

It is generally stated as a broad rule of law that the same elements that are necessary to constitute a valid contract in the first instance are necessary to rescind the same contract—that is, there must be some kind of agreement between the parties, either expressed or implied; there must be a consideration; and the object must be lawful and the agreement must be adequately expressed. When the parties to the contract mutually agree to dissolve the agreement, there is not much that can be said; but the parties do not agree on a matter of this kind in about nine out of ten of the cases. One party is generally going to profit by the contract and he wants to hold the other party to it.

The United States Supreme Court decided a case which throws some light upon the subject. In that case the buyer purchased a stated number of tons of old iron rails. Later the board of directors of the railroad company ratified the contract and notice was sent to the buyer stating that the "tons" were short tons. The agreement had been for long tons, but that was not expressly mentioned in the contract. The buyer immediately notified the company that the agreement had been for long tons and that he would expect delivery and requested a reply. He did not, however, receive a reply, and therefore acted upon the assumption that the company had rescinded the agreement. Upon the matter coming before the court, it was held that this conduct on the part of the company did not amount to a rescission of the contract and that the company could hold the buyer to the agreement.

General Principles Governing Rescission of Contracts

It is a general rule that contracts may be rescinded by mutual assent between the parties. This rescission may be made orally, even though the former agreement was in writing. There is nothing in the law that requires a rescission, in order to be valid, to be in the same form as the original agreement. Formerly, at common law, it was held that all contracts under seal could not be rescinded except by a specific agreement also under seal. The tendency has been, however, to remove this restriction even as to contracts under seal, so that it may now be stated as a general rule that oral agreements to rescind are valid and enforceable.

Rescission need not necessarily be express; it may be inferred from the conduct of the parties, provided that it is such as to evidence clearly their intention to treat the contract as at an end. If the seller under a sales contract refuses to make delivery according to its terms, such refusal may be treated as ground for rescission by the buyer. The buyer is under no obligation to take delivery under a sales contract unless it is made in conformance with the terms of the contract.

Where the contract calls for the delivery of the goods at a specified time, the buyer is under no obligation to accept delivery at some other time, and may treat the failure to make delivery as a basis for rescission. The same rule holds true where the contract calls for delivery of a certain amount at a specified time, and the seller tenders only a part of this amount. On the other hand, the refusal of the buyer to take delivery may be treated as ground for rescission by the seller; default in payment of price on proper tender of delivery will also ordinarily justify the seller in rescinding the contract.

Sales and Contracts Involving Credit

A great deal of the importance of this subject of the law arises in the case of sales on credit or on the installment plan. The vast majority of the cases are lodged under these two classes, as the difficulties occurring do not seem to be so numerous where the sale is for cash upon delivery. It is held by the courts, where a contract has been entered into between the buyer and the seller, on credit, that it is an implied condition that the buyer will keep his credit good; and in case he becomes insolvent, the seller has a right of rescission, or may decline delivery, except upon payment of cash, regardless of the terms of the contract.

It is also a general rule that even though the sale is executed so as to pass title, mutual rescission and the return of the property to the seller releases the buyer from any liability for the payment of the purchase price. In Connecticut and Virginia, particularly, it has been held that where there is a mutual rescission of a contract of sale, under which part payments have been made, the buyer is entitled to the return of the payments made in the absence of express or implied agreements to the contrary.

Sales on Credit and Partial Payment Basis

The great majority of sales contracts executed at the present time are on a credit basis; and many sales are on an installment basis. Since this basis enters so largely into everyday business relations, it is surprising that the legal aspects of the relation are so little understood. Sellers contract to sell machinery upon installment payments; later, when they agree to rescind the contract and take back the machinery, they expect to keep all the payments which the buyer has made. Goods are sold every day on the installment basis, the seller thinking that in case of default or rescission of the contract that he will have the right to both the payments made and the property.

It is a broad rule that failure to make delivery upon one installment or payment, as the case may be, is not sufficient to permit the other party to rescind the contract, unless such default was accompanied with conduct sufficient to evidence an intention to abandon the contract.

There seems also to be, however, a common interpretation to the effect that default of either party with respect to one installment, provided such default has not been waived, justifies the other party in putting an end to the contract. The courts of Indiana, Maryland, New York, and Tennessee have so held, in cases now considered as leading cases on this point. The general effect is that rescission will be justified on the part of the seller where the buyer fails to pay for an installment, or he may refuse further performance of the contract, but it does not, if the buyer has not otherwise repudiated the contract, authorize the seller to treat such non-payment as a breach of the contract that will entitle him to recover anticipated profits on the unperformed part of the contract without a tender of further installments in accordance with the terms of the contract.

Contracts Invalidated by Non-Compliance

So far we have been dealing largely with instances where the ground for rescission is found in the implied acts of the other party. Where the conduct of the other party is express and there is no need to resort to inferences, some little difference naturally arises as to the rights and obligations of the parties under the law. There is a great difference between default of a contract or non-performance, and rescission. Rescission implies something of a mutual consent or assent. Many of the rights permitted to the parties on failure to meet installments in sales contracts are permitted as penalties because of non-performance, and not because there has been ground for rescission. As one authority pointed out, if there has been a rescission of the agreement, then the liabilities contained in the contract cease with the contract. If there has been no rescission, but the seller or the buyer, as the case might be, has performed his share of the agreement, he can enforce the contract against the other party and hold him to the terms of the agreement or receive damages for non-performance. But rescission does not permit any of this on the part of the seller. If the seller, for instance, upon default of the buyer, rescinds the contract, then the seller loses all right to proceed under its terms against the buyer. If the seller rescinds the contract upon the default of a payment by the buyer and the buyer returns the machinery or the goods to the seller, then the seller must return the installments already paid to the buyer.

The same is true where the seller has failed to make his deliveries in the time and manner specified in the contract. If the seller fails to deliver his installment in the manner and in the amount specified in the contract, the buyer can rescind the contract. If he returns the goods already delivered, he has a right to receive back such installments as he has paid. If he retains the goods already received, the seller has a right to retain the installments that have already been paid.

There is a mutuality to the rescission of sales contracts which is everywhere present. It is a subject, which like that of the formation of contracts in general, must rest upon the meeting of the minds, express or implied, of the parties. The form of such assent is not so material as that it should be clearly evidenced.

* * *

THE EUROPEAN INDUSTRIAL SITUATION

An Abstract of a Resume of the General Findings of the Trade and Finance Committee of the Council on Foreign Relations

England, France and Italy are making encouraging progress in reconstruction. As a rule the manufacturers are working to capacity and find a ready sale at high prices for their products. The principal difficulties are: First, reduced production due to the general attitude of labor; second, the inability to enlarge plants or to run to capacity already existing plants, due to shortage of labor; and third, the excess of imports over exports, producing an unfavorable exchange situation in dealing with the United States. It is generally agreed that there are two remedies for the exchange problem: First, a temporary remedy, which can be brought about by loans, investments, and credits by citizens of the United States to those of other countries; and second, a permanent remedy which can only be accomplished by those other countries exporting more goods than they import. This balance of exports is necessary to pay the interest and principal of the war debts to America.

British and other European manufacturers are of two minds regarding the exchange situation at present; as citizens they regret to see the currency of their country depreciated as compared with that of any other country, but as manufacturers they recognize that this gives them a considerable premium on the sale of merchandise to the United States. British, French and German goods of various kinds are now beginning to come into the United States, and there would already be a great flood of foreign merchandise here but for the fact that the purchases in their own home markets are larger than ever before. The people in England and France are living extravagantly, just as they are here, and it seems impossible to turn out merchandise that will be too expensive to find a market.

In some countries there is a well organized effort being made to create increased output on the part of the manufacturer and the individual worker, and reduce home consumption by showing that the exchange question and hence the cost of living can only be remedied by consuming less, and selling more abroad; and among manufacturers and business men abroad there are many who feel that stimulation of production and rigid economy to bring down costs are the *only* things that will correct exchange. There is a great development along the lines of association work in the different trades to bring about this result.

The greatest difficulty which foreign manufacturers are now facing outside of their high cost of production is the fact that their bankers, who before the war cooperated with them in financing foreign trade, now find the foreign countries going to the United States for money. This emphasizes one great opportunity which the United States now has; wherever we can make loans or give sufficient credits to enable the foreign purchasers to trade with us we have an opportunity to trade. This is only possible, however, if the American manufacturers and bankers can learn to work together as closely as did those in Great Britain and those in Germany before the war.

We have been accustomed to feel that our home market was the sole consideration of our manufacturers; hence the manufacturer in this country has always favored a high protective tariff. During the war many of our industries have increased their capacities to where they can more than supply the normal home trade and they are looking abroad for markets. The high premium on our dollar more than offsets the tariff; hence the foreign manufacturers can send goods here more advantageously than they can sell them at home, while the same premium on the dollar practically prohibits our manufacturers from selling abroad when there is any sort of competition from countries whose exchange is lower. The fluctuations in exchange also introduce a speculative factor which compels us to put on a larger percentage of profit to offset any change in exchange which may occur between the booking of an order and its delivery.

In discussing these subjects both abroad and at home one is struck with the fact that able men are individually or in small groups working on these problems, but they seem to have found no way to coordinate their efforts. Even among our New York bankers there are decidedly different opinions as to the best course to pursue. It is useless for us to look for a panacea for all our ills, but all authorities agree that no country can be independent commercially or financially from the rest of the world, that the present problems must be approached broadly as world problems, and that the United States has now its great opportunity for leadership if it has the vision and will take the responsibility.

* * *

NORTON CO. TO BUILD HOMES FOR EMPLOYES

The Norton Co., Worcester, Mass., is planning to erect homes for 100 families in the Norton Village, the second community to be established at Indian Hill, Worcester, for men working at the Norton plants. A tract of over fifteen acres has been laid out on the northern slope of Indian Hill and the Frank T. Ley Co. of Springfield, Mass., has undertaken the contract to erect 100 houses to be completed in the early part of June. It is planned to create a village to have its own park, community buildings, boarding houses, stores, and five-room homes. The intention is to rent these homes to employes of the Norton Co., but an opportunity will be provided for the occupants to purchase them, should they so desire.

LETTERS ON PRACTICAL SUBJECTS

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FLAT SPRING BENDER

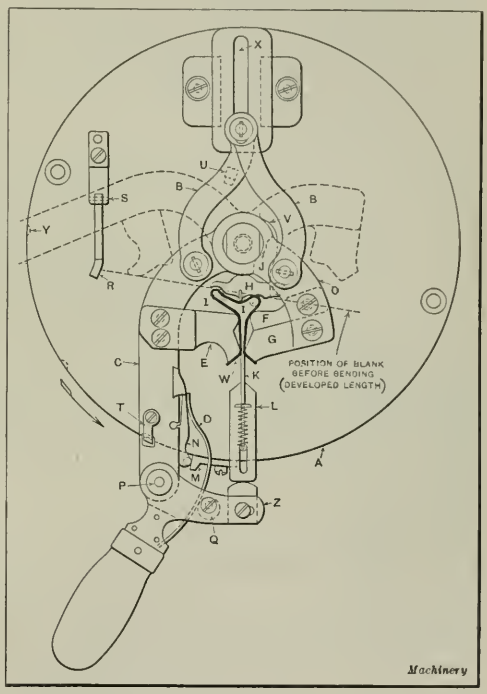
The flat spring bender illustrated embodies some interesting mechanical movements. In the design of the fixture, the movements were worked out by means of a cardboard templet—a method which will save considerable time in laying out the functional parts of mechanisms of this general type. The work for which this fixture was designed is made of flat spring brass, 0.025 inch thick and 3/16 inch wide, and contains eight bends, as shown in the illustration, *W* representing the shape of the spring after being formed.

The fixture consists of a cast-iron base *A* which is machined all over and on which the various parts are mounted. To load the fixture, the operating lever *C* is swung clockwise to the position shown by the dotted lines. In this position, the operating lever arm *D* is raised so as to permit the insertion of the blank in the position shown in the illustration. It will be apparent that lever *C* and arm *D* operate in unison and that they are connected by means of two toggle levers *B* which are hinged together so as to travel radially in the slot *X*. With the operating lever in the back position under joint *S*, the stop *R* is held in place while the fixture is being loaded, and the cam section *J* of the operating lever is swung around permitting cam-lever *H* to be sufficiently raised by the action of the flat spring *V*, to permit the work to be readily placed in position. The radial position of the operating lever is determined by the index spring *T* engaging the spot *Y* on the periphery of the base. The operating lever is next swung in the direction of the arrow, raising the stop and causing the toe of the cam *J* to force the cam-lever *H* against the work, thus securing it against the two pins *I*. In the meantime, the two forming members—*E* on the left-hand side and the two-piece former consisting of parts *F* and *G* on the right-hand side—will bend the ends of the stock until they are closed as shown. It will be noted that the cam-lever *H* has a blade which prevents the stock from "creeping" after it starts to bend.

Attention is directed to the fact that the forming members are not similarly constructed. The explanation for this is that the bend formed by the heel on the left-hand side, is considerably further removed from the left-hand pin *I* than is the corresponding bend on the right-hand side. Provision for adjusting the location of this bend is made by constructing the right-hand former in two parts, so that *F* may be set to suit. The ductility of the stock from which the springs are made may influence the relative location of the bends sufficiently to require adjustment of this former. The lower ends of the spring are prevented from closing by a flat separator bar *K* against which the stock is forced by the formers, causing the ends to spread slightly. Directly following this operation, the lever *N* comes into contact with the lever stop *M*, causing the end of the lever to swivel outward and force the joint spring *O* out of contact with its stop, thus permitting the joint *P* to be broken. Adjustment of tension for spring *O* is accomplished by means of the eccentric cam *Q*.

It will be seen that continued pressure on the handle of lever *C* will operate the extension arm and advance the end former *L*, against the force of a coil spring, upward against the partially spread ends of the work, and thus complete the forming of the spring. A certain amount of lateral deflection is provided for bar *K*, which is necessary in order to allow it to align itself with the work, thereby compensating for the slight amount of lost motion produced by the toggle jointed levers. The spring is removed from its position on the fixture by swinging the lever *C* clockwise until it comes in contact with the trigger *U*, which is located in the base and which operates a device on the under side of the base, by means of which the two pins *I* are depressed. At the same time, the action of the flat spring *V* lifts the cam-lever *H* upward so that with both pins *I* depressed and the cam *H* raised, the finished spring simply lies on the top of the base.

When in use, the fixture should be placed on an inclined plane, so that when the spring is released, as just explained, it will slide off the fixture, enabling the operator to swing the lever again into the position shown in the illustration,



Bending Device for forming Flat Springs with Eight Bends

load another piece of work, and continue the cycle of operations as before. All the functional parts of the device are made of tool steel and are hardened, while the inoperative parts, except the base, are made of cold-rolled steel, case-hardened.

Worcester, Mass. L. W. RICHARDSON

KEEPING RECORDS OF AUTOMATIC SCREW MACHINES

It is often desirable to keep a permanent record of each cam designed for producing various types of work on automatic screw machines. These records should consist of the calculations required in proportioning the cam, the method of laying out, and the method of setting up the milling machine when cutting. A set of data sheets such as was used to keep records of the cams required to produce the pivot screw shown in Fig. 1, on a Brown & Sharpe automatic screw machine, will facilitate the keep-

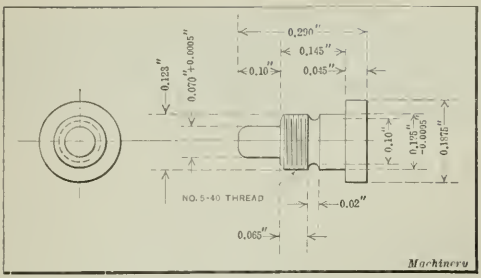


Fig. 1. Sample of Work produced on an Automatic Screw Machine

ing of such records. These data sheets are illustrated in Figs. 2, 3, 4, 5, and 6, and quantities of blank forms should be kept on hand to be filled out.

Before designing a cam, it is necessary to determine the spindle speed most suitable for the kind of material and size of stock that the work is to be made from; the number of revolutions of the spindle required to perform each

Gears			Time For One Piece 12 Seconds
	Driving	40	
	1st		
	2nd		
	Driven	48	

OPERATIONS	Spindle Rev. for Oper. Based on 927 R.P.M.	Spindle Rev. for Each Oper. Based on 1748 R.P.M.	Hundredths of Cam Circumference
Form—Front tool			
0.079" + 0.005"			
Feed P. R. 0.0005" & 0.0003"		178	51
Tool clearance			4¼
Thread on No. 5-40 Std. die	7	13	3¾
Thread off		7	2
Tool clearance			2
Index turret			
Cut off—Back tool			
0.094" + 0.025"			
Feed P. R. 0.0016", 0.0005 & 0.002"		107	30
Tool clearance			1
Feed stock to stop		16	5
Tool clearance			1
Index turret			
Total number of hundredths			100
Total number of revolutions		321	
Number of revolutions figured on		350	

CALCULATION DATA SHEET
Part No. 231 Name:—PIVOT SCREW
No. 00 B. & S. Auto. Screw Machine
Machinery

Fig. 2. Record of Calculations Necessary for designing the Cams

operation; and the number of revolutions of the spindle during the feeding of the stock and the indexing of the turret. Sufficient time must also be allowed to enable the tools to clear each other. From these data the lay-out of the cam can be made. The circumference of the cam blank is first divided into 100 equal parts. Each of these divisions represents a certain number of revolutions of the spindle, which is determined by dividing the total number of revolutions of the spindle required to produce one piece of work, by 100. The contour of the cam is then laid out on the blank, these divisions being used to obtain a curvature which will impart the required motion to the tools.

The data sheet used to record the calculations involved in designing the cams for the pivot screw is shown in Fig. 2. This sheet provides space for a list of the operations performed on the screw; the number of spindle revolutions required for certain operations based on the slow speed of the spindle; the number of spindle revolutions required for each operation based on the fast speed of the spindle; and the number of hundredth divisions of cam circumference required for each operation. It will be noted that the screw was threaded while the spindle was revolv-

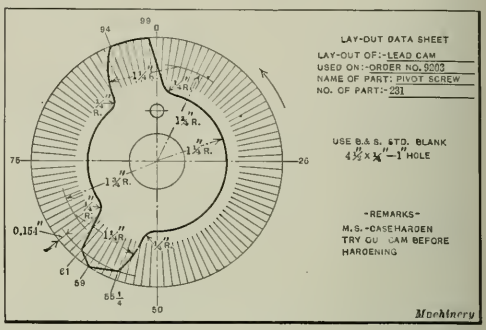


Fig. 3. Lay-out Data Sheet of Lead Cam for producing Screw shown in Fig. 1

ing seven revolutions at a rate of 927 revolutions per minute, and that all of the other operations were performed with the spindle revolving 1748 revolutions per minute. As the cam design was based upon a rate of 1748 spindle revolutions per minute, the time consumed in threading the screw would be equivalent to about 13 revolutions at that rate of speed. Information relating to the cutting operations, such as the depth of cut and the rate of feed, was placed on the data sheet with the various operations. Thus, "0.079 inch + 0.005 inch" means that the forming tool was fed 0.079 inch into the stock and that 0.005 inch was allowed for clearance; and "Feed P R 0.0005 inch and 0.0003 inch" means that at the beginning of this operation the feed was 0.0005 inch per revolution and reduced to 0.0003 inch per revolution in order to produce a smooth finish. Memoranda of the change-gears used and the time required to produce one piece of work are also included in this record sheet.

The time consumed in indexing the turret would frequently enter into the design of the cam, and proper portions of the cam circle should be allowed for this purpose. In this particular case, however, the turret was indexed during the forming and cutting-off operations so that this factor did not enter into the design of the cam. It will be noted that 350 revolutions of the spindle were allowed for the production of one piece so that one division on the cam circumference represented 3.5 spindle revolutions.

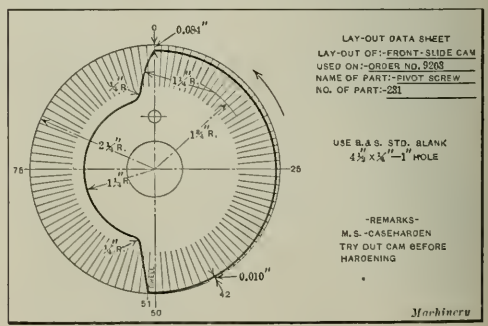


Fig. 4. Data Sheet Record of the Front-slide Cam

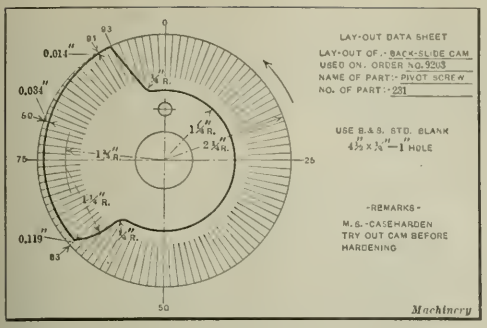


Fig. 5. Data Sheet Record of the Back-slide Cam

The lead cam lay-out illustrated in Fig. 3, as well as the front- and back-slide cam lay-outs, Figs. 4 and 5, were developed according to the calculations tabulated in Fig. 2. The divisions of the circumference of the cam circles corresponding to the various operations performed in making one screw are as follows: From 0 to 51, forming; 51 to 55¼, tool clearance; 55¼ to 61, running the threading die on and off; 61 to 63, tool clearance; 63 to 93 cutting off; 93 to 94, tool clearance; 94 to 99, feeding stock to stop; and 99 to 100, tool clearance. A record of the method of setting up the milling machine dividing head to provide for milling the lead, front-, and back-slide cams was kept on a data sheet of the type shown in the illustration Fig. 6. Tables for computing the gears to be used and the angular setting of the dividing head for this purpose, can be found in various handbooks.

Hartford, Conn. SVEND HELWEG

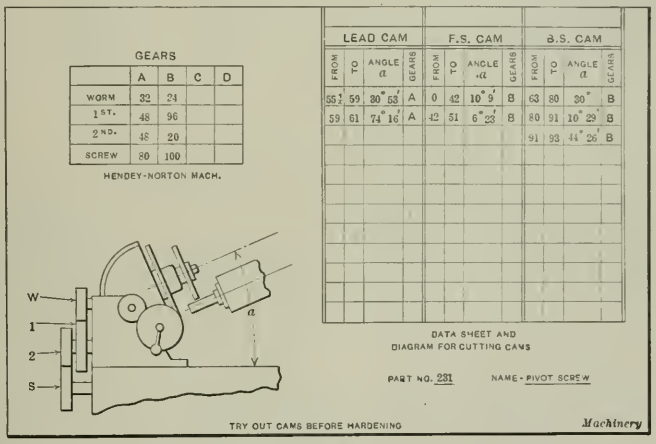


Fig. 6. Set-up of the Milling Machine for milling the Cams

PRESSURE FACTORS FOR FORCE FITS

It is often required in the routine of machine shop work to know how much pressure is required to force a steel shaft into a machined hole of a specified length and sufficiently under size to produce a good forced fit. The pressure in tons that will be required to force the shaft into the hole, may be easily determined by multiplying together the circumference of the shaft, the length to which the shaft is to be forced in, the amount in thousandths of an inch that the shaft is larger than the hole, and a constant selected from the accompanying table.

Diameter (Inches)	Pressure Factor	Diameter (Inches)	Pressure Factor	Diameter (Inches)	Pressure Factor
1	250	2¾	85	5	45
1¼	200	3	80	5½	40
1½	160	3¼	70	6	37
1¾	140	3½	65	6½	34
2	120	3¾	60	7	32
2¼	105	4	55	7½	30
2½	95	4½	50	...	..

Machinery

The rule given may be conveniently written as a formula:

$$3.1416\ DLBF$$

in which D = diameter of shaft;
L = length of fit;
B = forced fit allowance in inches;
F = pressure factor.

Example—What pressure will be required to force a steel shaft 2¼ inches in diameter into a hole which is 0.006 inch smaller than the diameter of the shaft, if the length of fit is 3 inches?

Substituting the values given in the above formula we have:

$2¼ \times 3.1416 \times 3 \times 0.006 \times 105 = 13$ tons, approximately

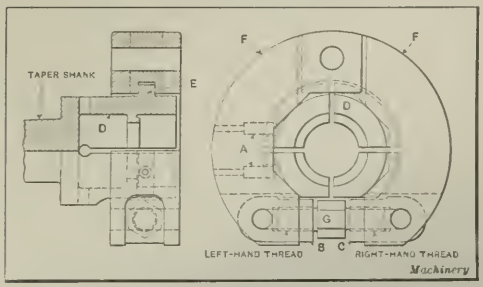
In performing forced fit operations on an arbor press, it is recommended that a lubricant consisting of white lead and lard oil mixed to the consistency of thick paint be used.

Bridgeport, Conn. R. S. MYERS

CHUCK-TYPE DRIVER FOR CAMSHAFT

The accompanying illustration shows a chuck type of driver of unusual construction, which was designed for use in facing the cams and flanges on a one-piece automobile camshaft—a machining operation for which an ordinary lathe dog provided insufficient driving power. The device consists of an arbor D and means for clamping the work in the arbor proper, which is constructed on the same principle as the common spring collet, but the means of clamping is more powerful and less complicated than that ordinarily used in connection with spring collets. The clamping arrangement consists of two C-shaped clamps F hinged at one side of the arbor and connected at the other by two links B and C, and screw G by means of which the clamps are tightened. The opening formed by the C-clamps is octagonal in shape, four sides of this opening being in contact with the arbor, while the other four sides have 1/16 inch clearance. Lateral movements of these parts is prevented by a flange E turned on the arbor, which fits into a groove in the C-clamps, while pins A prevent the clamps from rotating on the arbor.

A desirable feature of this arbor is that it has no projecting screws or pins, thereby lessening the chance of injury to the operator. In machining the camshaft on which this chuck



Chuck Type of Driver employed to hold and drive One-piece Camshaft while performing Multiple Facing Operations

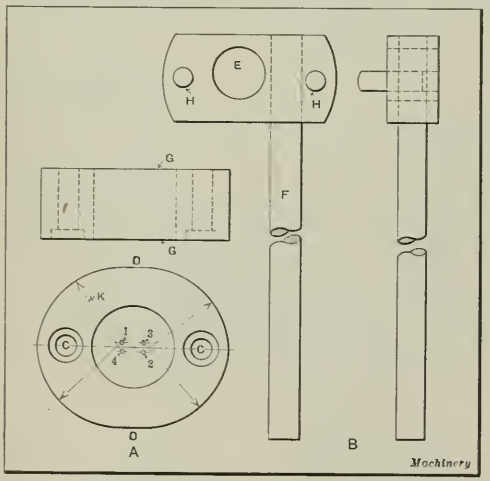
was employed, it was first necessary to center the rough shaft at both ends. The end having the larger diameter was next turned to size, being held within close limits so that the special driver described could be employed on all the succeeding lathe operations. As the driver was employed when facing both sides of four cams and the faces of two flanges at one time, it is evident that the device is a very powerful and efficient driving medium and can be employed for taking heavy cuts with little possibility of the work slipping away from its driver.

Buffalo, N. Y. LEROY JAGOW

HOLDING DEVICE FOR GRINDING CAM PERIPHERY

The accompanying illustration shows a cam *A*, and the holding fixture *B* which was designed and successfully used for grinding the periphery of the cam. The work was made of machine steel and was ground after hardening. After being laid out, the piece was roughed down to grinding size; the holes *C* accurately spaced and carefully drilled and reamed; and the large hole in the center rough-machined, leaving sufficient grinding allowance. The cam was then hardened and the large hole, the two sides *G*, and the two flat parallel spots *D*, ground to size.

The cam was then ready to be ground on its periphery, for which operation the fixture *B* was especially designed. When grinding, the cam is held on two dowel-pins *H* located in the fixture so as to correspond with the location of the holes *C* in the work. The hole *E* is located in the fixture so that its center bears the same relation to the center of the dowel-pins that the holes *C* bear to one of the four centers from which the cam radii are located. The cam is secured to the fixture by means of a special stud, the diameter of which fits in hole *E* and permits the fixture to be swung about the stud center. The central hole in the cam is large enough to allow the stud to pass through it so that the work may be readily clamped in position by the use of a nut and washer. Then, by locating the piece in the fixture so that center 4



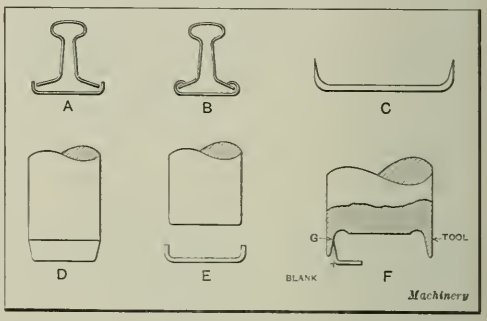
Cam and Special Holding Fixture employed in grinding Periphery

coincides with hole *E*, the periphery of the cam determined by radius *K* may be ground. By relocating the cams in the fixture so that centers 1, 2, and 3 will, in turn, coincide with hole *E*, the remainder of the periphery may be accurately ground. The stud, or mandrel, contains centers by means of which it is supported between the centers of the grinding machine, the rod *F* being used as a handle for oscillating the cam through an arc of approximately 45 degrees while being ground. This handle is also employed as a stop to locate the end of the stroke, it being allowed to drop down so as to rest against a parallel clamped to an angle-plate which is secured to the table of the machine. By properly adjusting the parallel, the four arcs may be ground to the desired radius so they will be tangent with flat sides *D*.

Beverly, Mass. JOHN T. CLARK

PUNCH AND ROLLING TOOL FOR SMALL METAL PARTS

Rolling operations are often performed on small sheet-metal articles such as collar buttons for the purpose of locking the parts together. Such operations usually consist of rolling the edge of the stock as shown in the illustration at *B*. Preparatory to performing this operation, the stock should be beveled off at the edge as shown at *C*. This bevel or taper is produced during the pressing operation by a punch



Work requiring Rolling Operation, Shape of Plate to be rolled and Tools employed

of the type shown at *D;* thus instead of using a straight punch and folding the metal to the shape shown at *E*, it is squeezed against the side of the die. When the metal is simply folded over as at *E*, the edges, when rolled, are likely to be uneven, while if tapered as at *C*, the top edge is nearly smooth and uniform, and the operation can be performed in a very satisfactory manner with little difficulty. The tool employed is shown at *F* and is designed so that its rolling surface will contact with the tapered part of the blank at *G*, causing the metal to curl in the circular recess within the rolling tool and produce a smooth even roll as the tool descends. The curved part of the tool must be absolutely smooth, and should be first polished with a wooden stick, using an abrasive material such as very fine diamond dust, after which it should be polished in a speed lathe with crocus.

Philadelphia, Pa. S. B. ROYAL

AUTOMATIC FEED FOR DIE AND PIVOTED STOP FOR STOCK

The feed mechanism illustrated in Fig. 2, is an inexpensive arrangement and may be satisfactorily employed in connection with blanking dies. As shown, a reel is placed on each side of the power press and in line with the stock slot in the die. The reel at the right side of the machine holds the stock and turns on a dead axle, while the one at the left is for scrap and is turned by a flanged pulley driven by a very loose belt. While the punch is in the stock, the slippage of the loose belt will allow the feed to stop, but as soon as the punch is cleared, the left-hand reel will again revolve and pull the scrap stock forward against an automatic stop. The cores of the reels are split at an angle, so that by loosening the wing-nut *W*, the front flange with half the core attached may be removed. This leaves the scrap coil on the back half of the reel core, so that it can be easily bundled and removed.

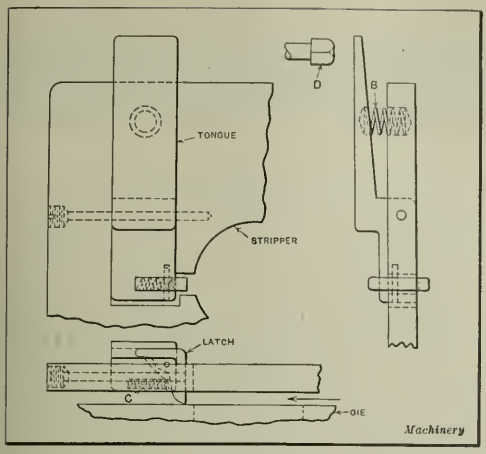


Fig. 1. Latch Stop used in Connection with Automatic Feeding Arrangement

The position of the automatic stop previously referred to is shown at *A*, Fig. 2, and the details of its construction are shown in Fig. 1. The stop consists of a pivoted tongue carrying at one end a latch which is hinged in a slot as shown. The point of the latch has a movement of about 1/16 inch and when free is kept forward by spring *C*. The function of spring *B* is to keep the latch against the top of the die, where it acts as a stop after the punch has been withdrawn from the work. As the stock is fed into the die, it is stopped by the point of the latch, which it forces back about 1/16 inch or as far as the depth of the slot will permit. This locates the work in the proper position, and as the punch descends and enters the stock, the latch is raised by means of the set-screw *D* which depresses the tail of the tongue. The latch is snapped forward by spring *C* as soon as it has been raised sufficiently to permit this action.

After the punch has completed its work and has begun its ascent, the point of the latch is in the advanced position so that when spring *B* forces the latch down it will come in contact with the top of the scrap between the blanked holes. The stock then feeds forward and as soon as the bridge between the two holes has passed the point of the latch, the action of spring *B* forces the latch into contact with the die. The latch is now in its original position, from which it is again forced back into the slot to the correct location by the advancing stock. This stop is an excellent one for use on hand-fed dies, as the operator is only required to start the stock and then with the press-treadle held down, pull the scrap through until the entire strip is blanked.

Montclair, N. J. ROY V. TERRY

A COMBINATION LOCATING BUTTON AND PRICK-PUNCH

A combination locating button and prick-punch shown in the upper right-hand corner of the accompanying illustration has proved a satisfactory tool for locating holes in dies and similar flat work in which the holes must be in an exact relation to each other. As shown, the tool consists of the button *A* having a concentric hole in which a prick-punch *B* is carefully fitted. The point of the prick-punch is, of course, located in the center of the button, so that it is concentric with the outside circumference.

In the lower view is shown the method of employing the tool when locating three holes in a plate. The flat square *C* is first clamped to the work. Then by putting size blocks of the correct thicknesses between the edge of the square and the circumference of the button as shown at *D* and *E*, and lightly tapping the prick-punch, marks are produced which if trued up accurately and bored will prove to be very accurately located in their required relation to each other. When locating the hole at *E*, a stack of size blocks must, of course, be used in the same manner as shown at *D*, to obtain the setting indicated by dimension *H*. To obtain accurate results, it is obvious that all holes must be laid out at one setting of the square. The saving in time over the button method usually employed is considerable, as no time is wasted in drilling and tapping for the button screws, and the tedious job of locating is also eliminated. An accurate flat square and a set of size blocks are required, however, but for quickly and accurately locating holes in work such as described, this method is as satisfactory as any that the writer has employed or heard of.

Newark, N. J. JOHN A. SHAND

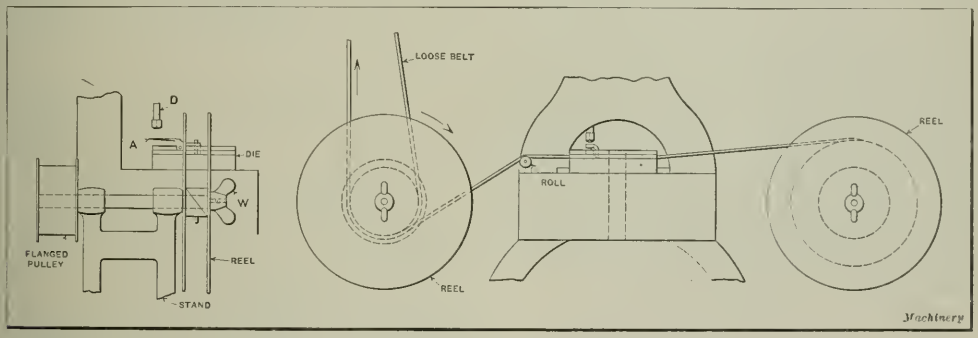
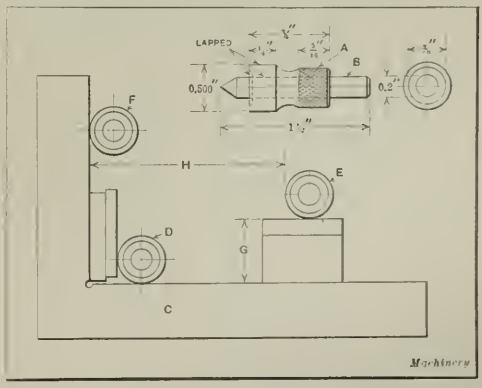


Fig. 2. Arrangement of Reels for Power Press Automatic Feed

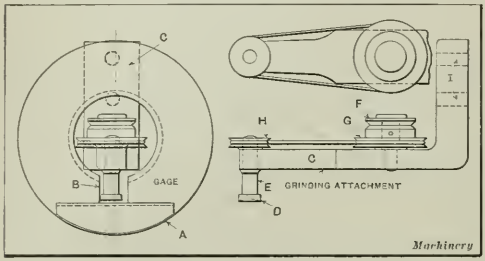


Combination Locating Button and Prick-punch, and Diagram showing Method of Application

SHOP AND DRAFTING-ROOM KINKS

GRINDING ATTACHMENT FOR BENCH LATHE

In making the special thread gage shown at *A* in the accompanying illustration, it was found necessary to grind the side *B* of the slot. To do this a special grinding fixture



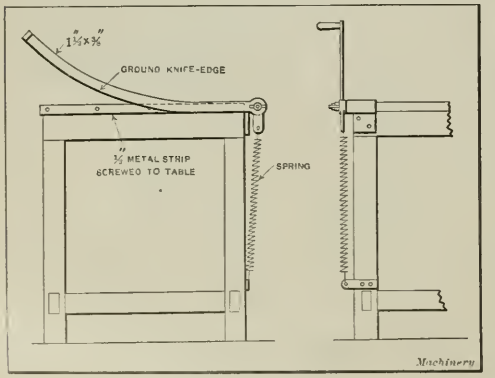
Bench Lathe Attachment for grinding Slot in Special Thread Gage

was devised and used as an attachment on a Pratt & Whitney bench lathe. The fixture consists of an arm *C*, an emery wheel *D* which is fastened to the spindle *E* with sealing wax, and three V-grooved pulleys *F*, *G*, and *H*. The pulley *F* is driven by a round belt from an overhead pulley, and transmits power to the grinding wheel by means of a similar round belt connecting pulleys *G* and *H*. For performing this job, the fixture was fastened to the milling attachment furnished with the lathe, by means of bolts passing through holes *I*. The gage was fastened to the faceplate, so as to permit the grinding wheel to gain access to the slot. The lathe spindle was then securely fastened to prevent it from turning, and the grinding wheel traversed over surface *B* until the necessary amount of metal was removed. This arrangement produced very satisfactory results.

Newark, N. J. JOHN A. SHAND

BLUEPRINT TRIMMER

The simple blueprint trimming device here illustrated has proved to be the means of saving considerable time when trimming large quantities of prints. A metal strip was screwed to the end of a table and a bracket was secured to the back of the table. A pin was then inserted in this bracket to support the knife, the cutting edge of which was properly



Simple Device for trimming Blueprints

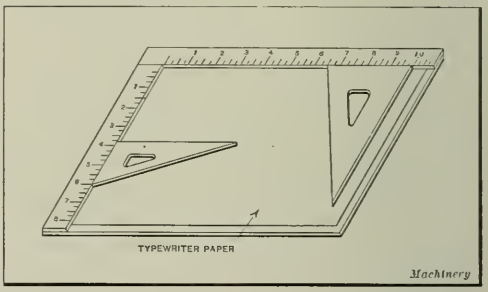
aligned with the metal strip. A compression spring, one end of which was secured to a lug on the bearing end of the knife, and the other end to a bracket on the table leg, pulls the knife upward after each cutting operation.

Toronto, Canada JAMES NELSON

DRAWING-BOARD FOR BRIEF CASE

The illustration shows a drawing-board of such size and weight that it can be conveniently carried in a brief case and used when a regular drawing-board is not available. It consists of a piece of seven-ply illustrating fiber board, 11¾ inches long by 9¼ inches wide, and two ¾-inch strips of the same material which are pasted along the upper and left-hand edges of the board. These strips are graduated in inches from the corner where they are joined, the horizontal strip being graduated from 1 to 11 inches and the vertical strip from 1 to 8 inches. The inch divisions are sub-divided into quarters of an inch. The weight of the board is approximately 3 ounces.

Any kind of paper may be used with the board, but its size is particularly adapted for sheets of typewriter paper. If two of the edges of the paper are placed along the strips,



Small Drawing-board which can be conveniently carried in a Brief Case

the paper will not have a tendency to move when the triangle is being shifted. This board is especially suitable to the work of field engineers, being of great assistance in making small sketches or preparing charts and data sheets.

New York City R. J. HOFFMAN

RESIZING WORN BRONZE BUSHINGS

Worn bronze bushings may often be satisfactorily resized by the following method, thus eliminating the necessity of replacing them with new ones. Remove the worn bronze bushing, sweat its outside surface with solder, and then press the bushing back into place. This will cause the bore of the bushing to contract and it can then be reamed to its original size.

New York City C. NYE

* * *

The British Engineering Standards Association has undertaken the standardization of spindle noses for milling machines. It is anticipated that when the new standards are finally decided upon, they will be widely adopted in Great Britain. Before such a standard is settled upon in Great Britain, however, it would be of great value if American milling machine manufacturers were consulted through the medium of the American Engineering Standards Committee, and if both countries could ultimately adopt a single standard.

HOW AND WHY

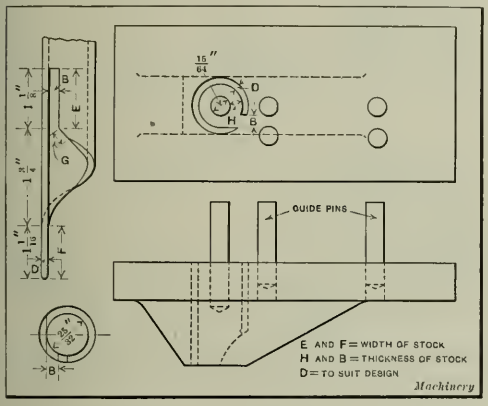
QUESTIONS ON PRACTICAL SUBJECTS OF GENERAL INTEREST

PRODUCTION PROBLEM FOR THE FORGE SHOP

H. C. T.—The end of a flat steel bar must be rolled to the shape and dimensions shown in the illustration which accompanies the original presentation of this problem, page 273 in the November number of MACHINERY. The end of the bar in which the eye is to be rolled has previously been hand-forged, but it is desired to increase production and decrease manufacturing expense by equipping a power press with suitable dies. This problem is submitted to the readers of MACHINERY with the hope that suggestions may be offered as to the construction of suitable dies to use and advice as to whether or not this job could be performed cold.

ANSWERED BY HARVEY MEAD

The forging equipment here shown is of a type that has been used successfully in bending large wire forms and



Forging Equipment for bending Eye in Flat Steel Bar

could probably be used in producing the piece in question from hot stock. The forging press plunger shown at the left in the illustration has a guiding extension, the length *F* of which is equal to the width of the stock. Immediately above this extension the stock of the cylindrical plunger is cut away spirally, as shown, so that its developed length is equal to that of the circumference of the eye to be formed. From the top of the spiral, a distance *G* slightly greater than the width of the stock serves to complete the closing-in of the eye, as will be explained later. From this point on, a slot is cut, the length *E* of which is equal to the width of the stock, and the width *B* equal to the thickness of the stock. The edges of the plunger should be rounded to prevent shearing, and the face of the spiral cut should be so backed off that the action of the plunger will permit the stock to be readily rolled.

The die used in connection with this forging equipment is of very simple construction and is shown at the right in the illustration. A circular slot is milled in the die, the width of which is sufficient to allow the plunger to operate freely within it. The metal which is left to connect the core made by this circular slot with the rest of the die is shown at *B*, its width being equal to that of the slot in the plunger and governed, of course, by the thickness of the stock. A pin of proper diameter around which the eye is rolled, is located in the center of this core as shown, the distance *H* being sufficient to permit the rolling of the stock. Pins for guiding and locating the stock are provided, and a reinforcing web is added to the bottom of the die, as shown, to provide strength for the area around the slot and center pin.

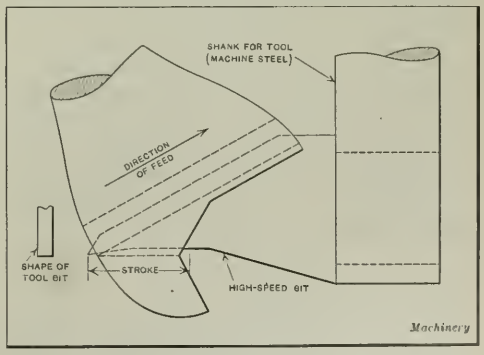
The operation of the plunger and die is as follows: As the plunger descends, the extension *F* enters the die first, preventing any tendency of the plunger to spring out of alignment. In continuing its descent, the spiral edge of the plunger contacts with the stock and rolls it around the pin. The section *G* serves the purpose of tightly closing the eye, preventing its gapping at the completion of the operation. Since there is a tendency for the stock to bend a little closer at the top than at the bottom, the plunger should travel over the stock farther than the mere length of the spiral, and hence the straight slot is provided in the plunger.

PRODUCTION PROBLEM FOR THE MACHINE SHOP

M. M. S.—What is the best method to employ, on a production basis, in removing stock from a wrench head in which the movable jaw of the wrench operates, as shown on page 1086 in the July number of MACHINERY? The stock removed forms a slot which cuts into the previously drilled hole for the jaw rack.

ANSWERED BY J. C. TONKIN, WALTHAM, MASS.

The following method may be employed with success to machine the wrench head. The work is to be performed on a shaper equipped with a fixture for holding the jaw in the position shown in the illustration and feeding it at an angle to the travel of the shaper ram. As a suggestion for the type of fixture to use, a plain milling machine vise might be employed, bolted to the side of the table, having screws to secure the work to the movable jaw of the vise, and fed by hand with the crank-handle of the vise. If so desired, a special fixture might be used having a slide and a



Arrangement for machining Wrench Head on Shaper

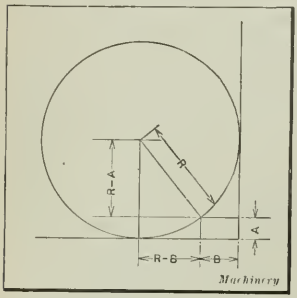
block for carrying the work, automatically fed by means of a cam designed so as to return the fixture to the loading position at the completion of the cut. This would permit loading without stopping the shaper. A special tool made to fit the toolpost of the shaper could be designed after the manner shown in the illustration.

The shank of this tool should be made of machine steel and carry a high-speed bit of the approximate shape shown, pinned or brazed to the tool shank. This arrangement should secure the desired result, and if the stroke of the shaper is sufficiently shortened, the work may be performed in production time.

TRIGONOMETRIC PROBLEM

F. E. M.—The diagram shows a disk which is laid against two surfaces located at right angles to each other. If a size block of known dimensions is placed as shown, how can the diameter of the disk be calculated which will be tangent to both sides, and to the corner of the block?

ANSWERED BY FREDERICK J. NAAB, PHILADELPHIA, PA.



The following solution of the above problem is simple, and does not involve complicated calculations. Referring to the diagram:

$$R^2 = (R - A)^2 + (R - B)^2$$

Expanding the above equation and solving for R,

$$R = A + B \pm \sqrt{2AB}$$

If, as in the previous solution of this problem in the January number of MACHINERY, we assume the dimensions of the size block to be $A = \frac{1}{4}$ inch and $B = \frac{1}{2}$ inch, and then apply the above formula,

$$R = 0.25 + 0.5 + \sqrt{2 \times 0.25 \times 0.5}$$
$$= 0.75 + \sqrt{0.25} = 1.25 \text{ inches}$$

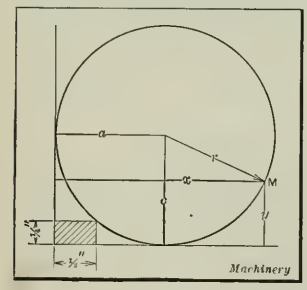
The diameter, therefore, equals 2×1.25 or 2.5 inches.

It is obvious that the conditions of the problem do not warrant using the minus value in the above algebraic equation as this condition does not apply. This solution is identical in principle with the one appearing on page 497 in the February number of MACHINERY.

ANSWERED BY V. CHARUSHIN, FITCHBURG, MASS.

The problem which appeared on page 459 of the January number of MACHINERY can be readily and simply solved by means of analytical geometry as follows: Draw the coordinates x and y from any point on the circumference of the circle, as M. Take the general equation of the circle

$$(x - a)^2 + (c - y)^2 = r^2$$



in which a and c are the coordinates of the center of a circle of radius r. According to the conditions of the problem $a = c = r$, and by substitution in the equation of the circle

$$(x - r)^2 + (r - y)^2 = r^2$$

or

$$r^2 - 2(x + y)r + x^2 + y^2 = 0$$

Assume that the dimensions of the block are the same as before, that is, ¼ inch thick and ½ inch wide; then, substituting these values in place of the coördinates x and y, and solving this quadratic equation, the value of r can be readily found. Thus,

$$r^2 - 1\tfrac{1}{2}r + 5/16 = 0; \text{ and } r = \tfrac{3}{4} \pm \sqrt{9/16 - 5/16}$$

Hence, $r = \frac{1}{4}$ inch or $1\frac{1}{4}$ inches.

It is quite obvious that of the two roots of the quadratic equation, the larger one applies to the conditions given.

DIFFERENCE BETWEEN STATIC AND RUNNING BALANCE

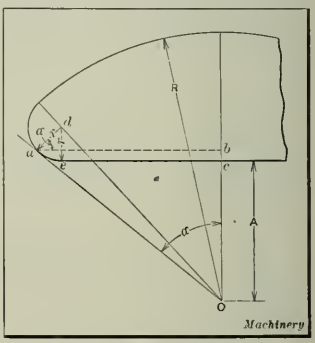
J. R. L.—What is the difference between a static balance and a running balance? If a part that is to revolve rapidly is in standing or static balance, will it also be in running balance?

A.—If a wheel, disk, or other body is mounted so that it is free to turn and will stand in any position, the part is said to be in standing or static balance. It does not follow, however, that the balance will be perfect when the part is revolving at high speed. If a thin disk is in static balance it will also be in a balanced state when revolving, but pulleys, drums, etc., especially if long in proportion to the diameter, may be decidedly out of balance at high speeds, even though the static balance is perfect. This is due to the fact that the unbalanced portions are at opposite ends or in different planes. To obtain a good running or dynamic balance, as it is also called, there should be a static balance in every plane at right angles to the axis of rotation.

MATHEMATICAL PROBLEM

ANSWERED BY JACOB YOUNG, WINTHROP, MASS.

A problem encountered in the design of a field pole tip was submitted to the readers of MACHINERY for solution in the January number of MACHINERY, page 459. The only known dimensions are the radius R, distance A, and the size of the angle α. It is required to find radius r of the arc.



Draw ab through point a parallel to the line ce. Then

$$Ob = A + bc = A + (r - r\sin\alpha)$$

$$\cos\alpha = \frac{Ob}{Oa} = \frac{A + r(1 - \sin\alpha)}{\sqrt{(Od)^2 - r^2}}$$

But

$$Od = R - r$$

Therefore

$$\text{Cos } \alpha = \frac{A + r(1 - \sin\alpha)}{\sqrt{(R - r)^2 - r^2}} = \frac{A + r(1 - \sin\alpha)}{\sqrt{R^2 - 2Rr}}$$

Then, squaring the above equation and solving for r in terms of the known quantities A, R, and α, the resulting equation is

$$r = \frac{A(\sin\alpha - 1) - R\cos^2\alpha}{(1 - \sin\alpha)^2} \pm \frac{\sqrt{[A(1 - \sin\alpha) + R\cos^2\alpha]^2 - (1 - \sin\alpha)^2(A^2 - R^2\cos^2\alpha)}}{(1 - \sin\alpha)^2}$$

Example—$A = 2$ inches; $R = 4$ inches; and $\alpha = 45$ degrees; then, by substituting in the above equation, we find

$$r = 0.765 \text{ inch}$$

[A reply leading to a similar result has also been received from V. Charushin, Fitchburg, Mass., H. A. Randall, South Portland, Me., Charles Boehnlein, Minneapolis, Minn., Harry Levene, Philadelphia, Pa., Thomas A. Reilly, Hartford, Conn., A. J. Pruszyuski, Chicago, Ill., Otto H. Schafer, Detroit, Mich., and Elmer Latshaw, West Philadelphia, Pa.—EDITOR]

ANSWERED BY WILLIAM W. JOHNSON, CLEVELAND, OHIO

Referring to the diagram, angle $AOB = \beta$, and $BOC = \alpha - \beta$; then from the right triangle OCB

$$r = \frac{R\sin(\alpha - \beta)}{1 + \sin(\alpha - \beta)} \quad (1)$$

In like manner from the right triangle OAB

$$r = \frac{R\cos\beta - a}{1 + \cos\beta} \quad (2)$$

From Equations (1) and (2), by comparison, it follows that

$$\frac{R\sin(\alpha - \beta)}{1 + \sin(\alpha - \beta)} = \frac{R\cos\beta - a}{1 + \cos\beta}$$

Clearing the above equation of fractions and simplifying,

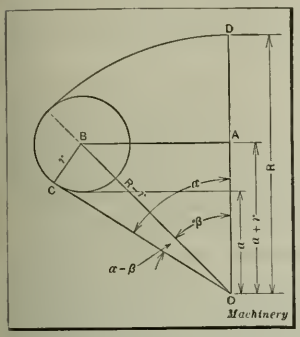
$$(R + a) \cos \alpha \sin \beta + [R - (R + a) \sin \alpha] \cos \beta = a$$

Dividing by $(R + a) \cos \alpha$ and cancelling,

$$\text{Sin } \beta + \frac{R - (R + a) \sin \alpha}{(R + a) \cos \alpha} \cos \beta = \frac{a}{(R + a) \cos \alpha}$$

In the above equation let

$$\frac{R - (R + a) \sin \alpha}{(R + a) \cos \alpha} = \tan \gamma$$



from which γ may be determined. Then, by substitution,

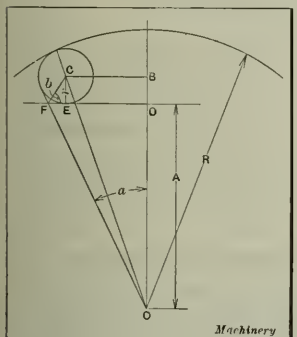
$$\text{Sin } \beta + \tan \gamma \cos \beta = \frac{a}{(R + a) \cos \alpha}$$

Multiplying this equation by cos γ, the equation may be written in the following form:

$$\text{Sin } (\beta + \gamma) = \frac{a \cos \gamma}{(R + a) \cos \alpha}$$

From the above, angle β may be found, and by substituting in Equation (2) the value of r may be readily determined.

ANSWERED BY FREDERICK J. NAAB, PHILADELPHIA, PA.



The problem encountered in designing a field pole tip, which was submitted in the January number of MACHINERY may be solved in the following manner:

Referring to the diagram, let $A = 7$ inches; $R = 10$ inches; and angle $a = 33$ degrees 38 minutes 40 seconds.

$$CB^2 = OC^2 - OB^2 = (R - r)^2 - (A + r)^2$$

$$= (10 - r)^2 - (7 + r)^2$$

Therefore

$$CB = \sqrt{51 - 34r}$$

In the triangle CFE, $FE = r \cot b$ but

$$b = \frac{90 \text{ deg.} + a}{2} = 61 \text{ degrees } 49 \text{ minutes } 20 \text{ seconds}$$

Therefore

$$FE = 0.5357r$$

In triangle FDO

$$FD = A \times \tan a = 7 \times 0.66552 = 4.6586 \text{ inches}$$

But $FD = FE + CB$; therefore by substituting the values previously found in this equation and solving for r,

$$4.6586 = 0.5357r + \sqrt{51 - 34r}$$

Transposing and squaring both sides of the equation

$$21.70255 - 4.99122r + 0.28697r^2 = 51 - 34r$$

from which $r = 1$, almost exactly.

INCLINATION OF TEETH ON SPIRAL END-MILLS

F. L.—Should the flutes of spiral end-milling cutters be right-hand or left-hand in the case of a right-hand cutter or one which revolves to the right as seen from the shank end?

A.—Theoretically, a right-hand cutter should have right-hand spiral flutes, as the teeth then have positive rake. Although, the right-hand flutes tend to pull the cutter out of the socket when used for side-milling, this disadvantage should not be allowed to outweigh the advantage of having the cutter teeth made with positive rake. It is good practice to hold the cutter firmly in the socket by means of a threaded rod which passes through the spindle and engages the end of the cutter shank, thus drawing the cutter firmly into the spindle socket. Many of the end-mills made by small tool manufacturers have a left-hand spiral for right-hand milling cutters and a right-hand spiral for left-hand cutters. The fact that the left-hand spiral on a right-hand mill tends to push the cutter firmly into the socket is often considered a greater advantage than the positive rake of the right-hand spiral on a right-hand cutter. This applies only when the cutter is used for milling slots and a considerable number of the axial teeth are engaged. If the mill is used as an end cutter only, then the spiral on the right-hand cutter should be right-handed, because the teeth then have a positive front rake. Some manufacturers of milling cutters prefer end-mills with teeth cut straight for ordinary use, in order to avoid the difficulties due to either the right-hand or left-hand spirals.

TO CARBURIZE COLD-ROLLED BALL RACES

F. M. C.—Can any reader of MACHINERY furnish information for carburizing cold-rolled ball races, so that they will be hard and tough but not brittle?

ANSWERED BY S. P. ROCKWELL, METALLURGIST WEEKES-HOFFMAN CO., SYRACUSE, N. Y.

In carburizing races for ball bearings, great care should be exercised because, unlike most work, the load is concentrated on a very small area and the case must support this load and at the same time resist the abrasive action caused by the rolling balls. The thickness of the case must be such that the load will not puncture it and impair the toughness furnished by the core. It is the usual practice among the manufacturers of ball bearings to provide a depth of case according to the rated load and thickness of stock. The depth of case being established, the most important consideration then is the determination of the carbon percentage of the case. By using a well proportioned carburizing material, of which there are many on the market, steel will carburize uniformly for various known temperatures. To raise the rate of penetration, the temperature is raised, which causes richer gases to be liberated from the carburizing material. The result is that instead of causing deeper penetration the gases will carburize the steel with a greater intensity, that is, with a higher percentage of carbon. Under ordinary conditions, the case may be considered as composed of three layers or laminations: (1) Hyper-eutectic steel, containing over 0.90 per cent carbon, composed of pearlite and free cementite; (2) eutectic steel, containing 0.80 to 0.90 per cent carbon, composed of pearlite; and (3) hypo-eutectic steel containing from 0.8 per cent carbon diminishing to the carbon content of the core. Cementite is 100 per cent brittle and is unannealable; therefore, for ball bearings and where rolling or sliding contact under heavy load occurs on small area, it should be avoided. Cementite forms no bond with the rest of the steel and when subjected to the strain of rolling contact, chips and cracks and causes pin marks. Pearlite is the most homogeneous constituent of the case and has the ability of holding this homogeneity when hardened; it gives the maximum hardness with the minimum amount of brittleness. It is this constituent, therefore, that is most desirable to produce in the case when hardening ball bearings. Nevertheless, since most ball bearings are ground after carburizing, a lamination containing excess free cementite is permissible, if the depth does not exceed the amount of grinding allowance.

Carburizing Materials and Methods

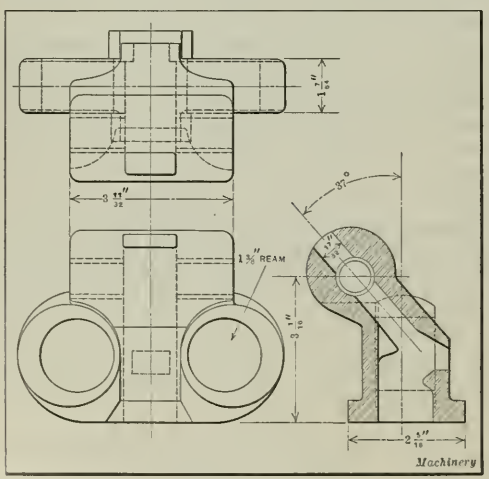
One manufacturer of carburized ball races buys carburizing material under the guarantee that 0.005 inch turned from a 1 inch diameter bar of low-carbon chromium steel, when carburized in the new mixture at 1650 degrees F. for a period of twenty-four hours, shall not contain over 1.10 per cent carbon, and not less than 0.95 per cent when the carburizing mixture contains one part new and four parts old. For ball bearings where the thickness of the case is from 1/32 to 3/64 inch, chemical carburizers such as barium salts, may be satisfactorily used at temperatures not exceeding 1625 degrees F., but for long heats, charcoal, and animal charcoal, sugar-bone, etc., (used with oil hydrocarbons) will undoubtedly produce the best results.

These carburizers have the properties of long endurance and minimum shrinkage, and at 1650 to 1700 degrees F. do not give off gases causing undue cementite formation. For long heats, fine carburizers are superior to the coarse material, on account of the shrinkage in the pack being less. The examination of the cross-section of pot-cooled work magnified to 100 diameters when polished and etched with a fluid of 10 per cent nitric acid and 90 per cent alcohol for a period of from ten to twenty seconds, will enable the different carbon zones to be determined so that the breadth of each may be measured.

Comparisons of several pieces of work carburized with different materials at different strengths, using different heats and different lengths of time, will soon disclose the best temperature and carburizer for producing the broadest eutectic zone and a hyper-eutectic zone not deeper than the specified grinding allowance. It is sometimes claimed that pitting, which really comes from poor heat-treatment, is caused by the carburizing material. When the work is pot-cooled and a single hardening resorted to, the different zones in the case will laminate. This may be avoided by pot-quenching and then refining the case by hardening; or by either pot-quenching or pot-cooling followed by first refining the core by hardening and then the case.

HEAT-TREATMENT PROBLEM

A. M. C.—We have experienced considerable difficulty in carburizing and casehardening chain blocks of the general dimensions and design indicated by the accompanying illustration. These blocks are steel castings having from 0.20 to 0.30 per cent carbon. It is required to obtain the greatest tensile strength together with a depth of casehardening of approximately 1/32 inch.



A GEOMETRICAL PROBLEM

ANSWERED BY J. OLSON, ROCHESTER, N. Y.

Referring to the solution of the geometrical problem, published in the November number of MACHINERY, page 273, the following suggestion is offered. The conditions of the problem require that the lengths x and y (see accompanying illustration) be determined, the only known elements of the

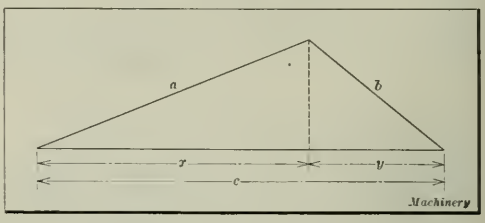


Diagram used in Connection with Problem in Geometry

triangle being the lengths of the three sides. A convenient method to use in the solution of this problem involves the following geometrical proposition: In any oblique triangle where the three sides are known, the ratio of the length of the base to the sum of the other two sides equals the ratio of the difference between the length of the two sides to the difference between the lengths x and y.

Therefore, if in the accompanying diagram, $a = 14$, $b = 12$ and $c = 16$ inches, then

$$c : (a + b) = (a - b) : (x - y)$$

$$16 : 26 = 2 : (x - y)$$

$$(x - y) = \frac{26 \times 2}{16} = 3\tfrac{1}{4} \text{ inches}$$

But

$$x = \frac{(x + y) + (x - y)}{2} = \frac{16 + 3\tfrac{1}{4}}{2} = 9.625 \text{ inches}$$

and

$$y = \frac{(x + y) - (x - y)}{2} = \frac{16 - 3\tfrac{1}{4}}{2} = 6.375 \text{ inches}$$

HEAT-TREATMENT FOR GEARS

ANSWERED BY EDWARD J. RANTSCH, BROOKLYN, N. Y.

The following information relative to the heat-treatment of clashing tractor transmission gears is given in reply to the questions submitted by P. H. B. in the January number of MACHINERY, on page 459. The writer would say from his experience in the heat-treatment of chrome-nickel steel gears, intended to withstand sudden shock and stand up under severe conditions, that the following method would give P. H. B. satisfactory results.

In order to treat gears of 8 diametral pitch so that they will have a soft core suitable to withstand shock, first heat the gears in carburizing pots to 1600 degrees F. for seven hours. Then remove the pots from the furnace and allow the box and work to cool over night. The next morning empty the pots and reheat the gears to 1400 degrees F. Then take out and quench in oil. This is known as the refining heat. Reheat the gears to 1450 degrees F. and quench in water, and the gears will be found to be properly hardened. Several gears should be treated in this way, and the teeth should be broken from one in order to ascertain the depth of case on the teeth, which should be 1/32 inch. The analysis of the steel used by P. H. B. shows that the steel is suited to the requirements specified. In reference to the gears that have already been heat-treated, it is the writer's opinion that they should be scrapped, as the carburizing has penetrated entirely through the steel, thus making it practically a tool steel which cannot be used with success for the purpose for which it is intended in this case.

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW AMERICAN METAL-WORKING MACHINERY

The New Tool Descriptions in MACHINERY are restricted to the special field the journal covers—machine tools and accessories and other machine shop equipment. The editorial policy is to describe the machine or accessory so as to give the technical reader a definite idea of the design, construction, and function of the machine, of the mechanical principles involved, and of its application.

Hanson-Whitney Tool and Die Shaper. Hanson-Whitney Machine Co., Hartford, Conn. 669
Rockford No. 3 Milling Machine. Rockford Milling Machine Co., Rockford, Ill. 670
Automatic Thread Milling Machine. Automatic Machine Co., Bridgeport, Conn. 672
Leeds & Northrup Hump Method for Heat-treating Steel. Leeds & Northrup Co., Philadelphia, Pa. 673
Garrison Duplex Gear Chuck. Garrison Machine Works, Dayton, Ohio. 674
Kempsmith Vertical "Maximiller." Kempsmith Mfg. Co., Milwaukee, Wis. 675
Casler Drill Chuck Boring Head. Marvin & Casler Co., Canastota, N. Y. 676
General Electric Automatic Arc Welder. General Electric Co., Schenectady, N. Y. 676
Brown Portable Potentiometer. Brown Instrument Co., Philadelphia, Pa. 676
Direct-current Motor Starters. Cutler-Hammer Mfg. Co., Milwaukee, Wis. 677
Crankshaft-cheek Milling Machine. Newton Machine Tool Works, Inc., 23rd and Vine Sts., Philadelphia, Pa. 678
Davenport-Slocomb Direct-reading Micrometer. J. T. Slocomb Co., Providence, R. I. 678
K. R. Wilson Tools for Ford Repair Shops. K. R. Wilson, 10-16 Lock St., Buffalo, N. Y. 679
Cincinnati Geared-head Lathes. Cincinnati Lathe & Tool Co., Oakley, Cincinnati, Ohio. 679
General Electric Muffle Furnace. General Electric Co., Schenectady, N. Y. 679
"Thor" Universal Repair Vise for Pneumatic Drills. Independent Pneumatic Tool Co., Chicago, Ill. 680
Columbia Heavy-duty Shapers. Columbia Machine Tool Co., Hamilton, Ohio. 680
Ryerson-Conradson Milling Machine. Joseph T. Ryerson & Son, 16th and Rockwell Sts., Chicago, Ill. 681
Pangborn Rod Cleaning Sand-blasting Cabinet. Pangborn Corporation, Hagerstown, Md. 681
Cold Saw Cutting-off Machine. Newton Machine Tool Works, Inc., 23rd and Vine Sts., Philadelphia, Pa. 682
Gabrielson Milling Machine. Gabrielson Mfg. Corporation, 318 First Trust and Deposit Co. Bldg., Syracuse, N. Y. 682
Morris Engine Lathes. Morris Machine Tool Co., Court and Harriet Sts., Cincinnati, Ohio. 683
Garrison Grease Cup. Garrison Co., 348 George St., Bridgeport, Conn. 684
Bench Centers. American Gage Co., Dayton, Ohio. 684

Hanson-Whitney Tool and Die Shaper

This machine is adapted for the performance of shaping operations on various types of tools and dies. Although it is of comparatively small size, sufficient range is provided for handling a variety of classes of work. In designing this machine special attention was given to the development of means for accurately controlling its functions so that precision work can be performed on it within close limits. Rapid ram travel permits a high rate of output.

TO meet modern requirements in the manufacture of fine tools the Hanson-Whitney Machine Co., Hartford, Conn., has recently started to build a vertical tool and die shaper. This machine is especially suited for use in making punches and dies of various types which are widely used in the production of parts for electrical appliances, typewriters, adding machines, clocks, watches, etc. Although it is of comparatively small size, sufficient range is provided to enable large sized dies to be swung in all directions without interference; on the other hand, it is claimed that small tools for precision operations can be used with the utmost sensitiveness. In working out the design of this machine, especial attention was given to the development of means for accurately controlling all of the functions, so that the most refined work can be done under conditions that enable the operator to depend upon the machine holding his work within close limits. The ram travels very rapidly, thus increasing the rate of output.

Liberally proportioned bearings support the vertical slide or ram and the knee is rigidly secured to the column, being guided at the center by a dovetail and locked at the edges with square locks. The working slides are furnished with narrow guides, and for the size of the machine, they have a large range of action.



Fig. 1. Vertical Tool and Dis Shaper built by the Hanson-Whitney Machine Co.

A combination of flat and tapered bearings supports the rotary table which has an indexing mechanism of the same type that is employed on a universal milling machine. An automatic feed is provided for both slides, and the feed in all cases occurs on the return stroke of the ram. There are several features of the design of this machine which are believed to be entirely new. Among these mention may be made of the following: Provision is made for adjusting the length of stroke, regardless of whether the machine is running or at rest, and such adjustments can be made with equal facility under either condition. Variations in the length of stroke are accomplished by a handwheel shown at the side of the column just back of the ram, the mechanism used for this purpose being of simple and durable construction. When the machine is stopped, the ram will automatically come to rest at the top of its stroke. The handle shown on the right-hand side of the column is pulled toward the operator to start the machine, and this handle is pushed back into the position shown in Fig. 1 to bring the machine to rest. No matter when this is done the ram will stop at the end of its up stroke. On the back stroke, the tool positively recedes from the work, and on the down stroke it is returned to the operating position. In this way no

trouble is experienced through dragging the edge of the tool over the piece that is being machined.

By examining the construction of the tool-holder, it will be seen that there is no set-screw or any other projecting member to prevent the ram from clearing the work. In other words, a long overhang of the tool is not necessary when planing the outside of a piece, and when planing on the inside of a die or similar part, it is only necessary to have the overhang of the tool as long as the cut which is to be taken. The standard tool is made with a clearance as illustrated in Fig. 2, and when sharpened it only needs to be ground at the end. Various shaped tools can be made to meet the requirements of different jobs such as square-nose, round-nose, diamond-point, etc. All working surfaces, in connection with the clapper mechanism, are made of hardened and ground steel. In addition to the rotary motion of the table, it can also be tilted so that when making dies, where a clearance is desired, this result can be easily obtained, a segment graduated in degrees indicating the amount of taper that is necessary. Feed-screws on the slides have the usual micrometer dials graduated to 0.001 inch.

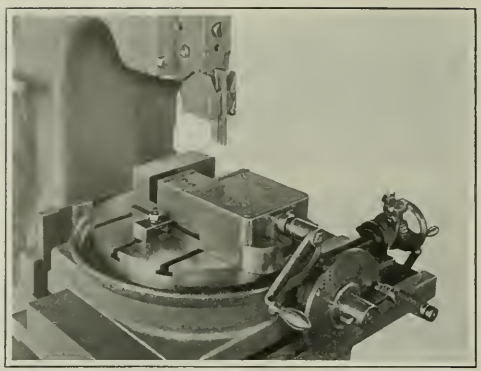


Fig. 2. Close-up View of the Table, Cutter, etc., on the Hanson-Whitney Vertical Tool and Die Shaper

Three changes of speed are provided in the driving mechanism which receives power from a tight and loose pulley on the left-hand side of the column. No countershaft is necessary, as the machine can be driven directly from the main lineshaft. An interlocking device in the speed change mechanism enables shifting to be done without danger of injuring the gears. The fast driving pulley may be running constantly and a speed will be engaged by the handle at the right-hand side of the machine, of which mention has already been made, which engages the ram motion through an expanding friction clutch without shock or noise. About one-half way down on the right-hand side of the column there is a handwheel that can be engaged with the mechanism when the machine is at rest, to provide for turning the machine by hand while setting up a piece of work to make sure that there is no interference. The knee may be adjusted relative to the positioning of the stroke. Fig. 2 shows a work vise of substantial construction which is made for holding small pieces of work, the design of this tool being distinguished by the fact that it has two gaps, one of which is capable of opening up to 2 inches, and the other up to 4 inches. This vise is finished all over, and has hardened and ground jaws. A tool-holder for securing small tools and other work on the machine is also made to special order.

Dies of the types which are machined on this vertical tool and die shaper are finding a steadily increased application in industrial plants that are engaged in the manufacture of a diversity of products.

ROCKFORD NO. 3 MILLING MACHINE

In working out the design of a No. 3 all-geared milling machine which has recently been developed by the Rockford Milling Machine Co., Rockford, Ill., an effort has been made to combine in its mechanism features which will assure a maximum productive capacity for a machine of this size with the greatest possible convenience of operation. In order to adapt this miller for handling either tool-room or production work, it was necessary to not only provide for the attainment of a high degree of accuracy but also to furnish ample power and rigidity for taking heavy cuts at high speed and coarse feed. An all-geared drive assures the positive transmission of power, and especial care has been taken in arranging cross-ribs at the base of the column in order to stiffen the construction and afford sufficient rigidity to withstand stresses set up by the most severe classes of service.

Another highly important feature in adapting this miller for the efficient performance of manufacturing operations is the arrangement that has been made for clamping the knee to the column through tightening the nuts shown at *A* and *B* in Fig. 2, and for securing the saddle in a fixed position on the knee by screwing down nut *C*. Where a machine is engaged on repetition work, movement of these members is not required, and by clamping them in the manner just men-

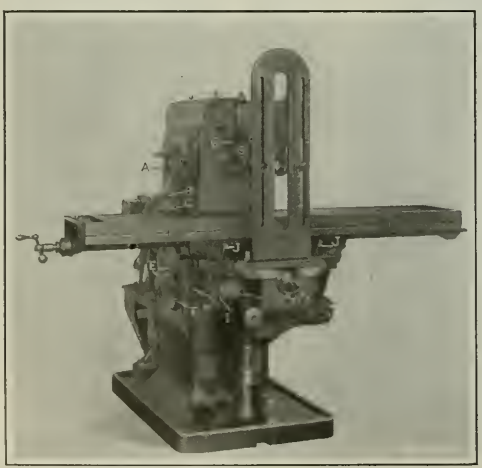


Fig. 1. No. 3 Milling Machine built by the Rockford Milling Machine Co., showing Control Levers for the Speed and Feed Changes, etc.

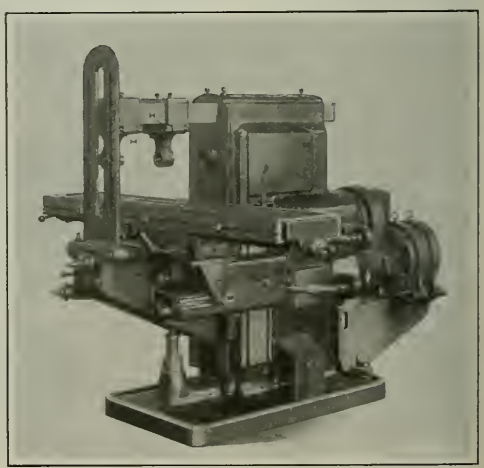


Fig. 2. Opposite Side of Rockford No. 3 Miller showing Motor Drive and Method of clamping the Knee to the Column and the Saddle to the Knee

tioned a degree of rigidity comparable to the Lincoln type of machine is attainable for handling production milling under severe operating conditions. As regards convenience of manipulation, attention is called to the fact that all of the control members for obtaining changes of speed and feed are centralized at the side of the column, as shown in Fig. 1, where they are within easy reach of the operator; and there is a clutch lever at each side of the machine, so that provision is made for instantly starting or stopping after the operator has his job set up. Mention was made of the care that has been taken in bracing the column at its base in order to afford the degree of rigidity that is required for heavy manufacturing work; but this is also an important factor in enabling the machine to handle accurate tool-room milling operations, because it assures a perfect uniformity of movement in elevating the knee. Failure of similar numbers of revolutions of the screw to cause exactly equal degrees of movement of the knee would necessarily be reflected in corresponding errors in the accuracy of the work.

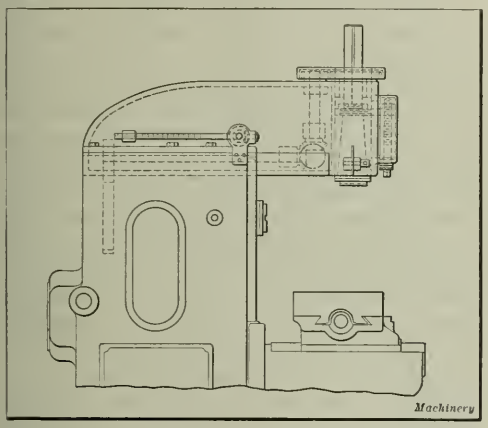


Fig. 3. Gear-driven Vertical Attachment for the No. 3 Rockford Miller

Arrangement of Geared Drive to Spindle

According to the requirements of the consignee, a machine of this type may be arranged with single pulley drive or with an individual electric motor direct-connected to the machine, the latter type of drive being shown in the accompanying illustrations. An unusual method is employed for obtaining changes of spindle speeds in the gearing provided on the machine for that purpose. This will be best understood by referring to Figs. 1 and 5 which show the side of the milling machine on which the control mechanism is located and a cross-sectional view through the speed gearing. Mounted inside the column of the machine there is a cone of three gears, *A*, *B*, and *C*, carried by an arm which is arranged to rock about one of the intermediate driving shafts, a pinion on this shaft transmitting power to the cone of three gears. Provision is made for rocking these gears over to engage either of the two gears *D* and *E* which are splined to slide on shaft *F*. Particular attention is called to the fact that the cone of gears *DE* slides on its shaft which is free to rotate but occupies a fixed position otherwise; and that the cone of gears *ABC* rotates on its shaft which is free to swing, but there is no endwise movement.

To the right of gears *DE* on shaft *F* it will be seen that there are two gears *GH* which are mounted in a fixed position on the shaft; and still further to the right there is a pinion *I*, the teeth of which are cut in an integral part of the shaft upset for that purpose. This pinion meshes with teeth in gear *K*, which is loosely mounted on the milling machine spindle. Carried on the spindle behind the gear *K* there are two sliding gears *L* and *M* which are arranged to mesh with gears *G* and *H*, respectively, and by sliding these gears still further to the right than the position which they occupy in the illustration, pins *N* enter holes cut in the side of gear *L* for that purpose. It will be noticed that there are compression springs behind pins *N*, and when the gears are pushed to the right the pins move into the gear *K* against the compression of these springs. Then, as gear *L* rotates so that the holes come opposite the pins, they snap into place and provide a direct clutch connection between the gears *K* and *L*.

Having made a general statement of the way in which the speed mechanism functions, a brief review will make it apparent that three changes of speed are provided by gears *A*, *B*, and *C*. Gears *D* and *E* multiply this number by two, making a total of six changes, and the pairs of gears *LG*, *MH*, and the clutch pins *N*, introduce a multiplying factor of three, thus making a total number of eighteen speed changes available on the machine. These changes of speed are in geometrical progression and cover a range from 15 to 360 revolutions per minute. Referring to Fig. 1, attention

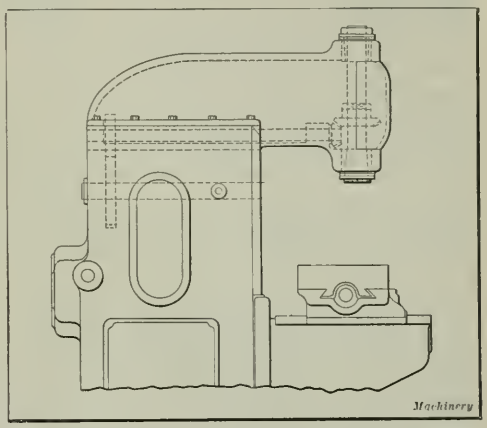


Fig. 4. Vertical Attachment with a More Simple Arrangement of Gearing

is called to the fact that an index-lever moving over three-station dial *A* provides for sliding the cone of gears *LM* (Fig. 5) to mesh with gears *GH* or to make direct connection through pins *N*. The horizontal speed-change mechanism *B*, with six stations, provides for setting the control lever that manipulates gears *DE* to engage either of these gears in any desired position on the cone *ABC*; and a six-station dial *C* provides for rocking the cone of gears *ABC* (Fig. 5) into either of the desired positions to mesh with gears *DE*.

Arrangement of the Feed Mechanism

A somewhat similar arrangement to the one shown in Fig. 5 for controlling the speed changes is employed for obtaining the required variations of feed on the Rockford miller. The mechanism employed for this purpose consists of a cone of four gears carried by a rocker arm, with provision for driving this unit of four gears at either of two speeds. This cone of gears rocks but occupies a fixed longitudinal position. On the driven shaft there is also a cone of four gears which are splined to slide on their shaft, so that the largest gear on each cone may be brought into mesh with either of the gears on the other cone.

From this general outline of the method of operation, it will be evident that two changes of feed are made available through the two preliminary speeds at which the first cone of gears may be driven, and seven changes of feed are secured by the possible combinations in which the largest gear on each cone may be meshed with the remaining gears of the other cone. As a result, there is a total of fourteen changes of feed covering a range from 9/16 inch to 18 inches per minute. At the bottom of the milling machine column, there will be seen a dial *D* in Fig. 1, that has two stations and

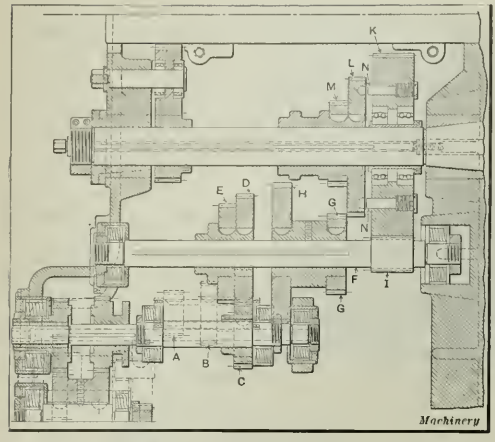


Fig. 5. Arrangement of Gears for obtaining Changes of Speed

a lever for sliding two gears which drive the swinging cone of gears at different rates of rotation. The lever running over dial *E* provides for rocking this cone into the proper positions for meshing with either of these two gears; and the lever running over seven-station dial *F* provides for sliding the other cone of gears into the proper positions for meshing with the different gears on the swinging cone.

All mechanics who read this article will at once be impressed by the form of over-arm construction which is shown in the illustrations. Mention has already been made of features of the design which adapt this miller for the efficient performance of production work, but the discussion of this subject would be incomplete without calling attention to the fact that the liberally proportioned over-arm of rectangular form not only affords ample metal for resisting strains resulting from the pressure of the cutter on the work, but that the rectangular form of the arm also affords a datum surface that is useful in setting up gages and other tools used in making measurements and for locating holes while performing precision tool-room milling operations.

Another convenient feature is that by simply removing a screw, shown at *G* in Fig. 1, the arbor support may be swung on pivot *H*, Fig. 2, to get it out of the operator's way. A three-step dial *I*, Fig. 1, provides for forward or reverse movements of the feed, and levers *J* govern the forward and reverse movement of the rapid traverse. Figs. 3 and 4 show two different types of vertical milling attachments which are available for use on this milling machine. While the term "attachment" is used, it is really somewhat of a misnomer because the bearing for the rectangular shaped over-arm used on the horizontal machine may be removed and the vertical attachment substituted in its place in a manner which produces a vertical milling machine that is just as much of a standard machine tool of its type as the horizontal machine is representative of millers of this class.

AUTOMATIC THREAD MILLING MACHINE

To provide for the rapid performance of thread milling operations on various metal products, the Automatic Machine Co., Bridgeport, Conn., has recently developed a machine which is here illustrated and described. This thread miller is adapted for internal or external work, and taper or straight threading, and it should be noted that all movements are automatic, with the exception of backing the cutter-spindle away from the work after the operation has been completed. From Figs. 1 and 2, it will be apparent that a liberal sized opening is provided through the work-holding spindle, making it possible for long pieces of considerable size to project back through the spindle, so that a thread may be milled at the forward end of the work. Various forms of chucks, collets, expanding arbors etc., may be provided on this machine to adapt it for handling thread milling operations on a wide range of work. This work-spindle swivels to provide for cutting tapered threads or to allow for making adjustments, so that a perfectly true straight thread can be cut, even though the high-speed steel cutting hob has not been welded squarely on the soft steel shank.

Before starting upon a discussion of the way in which the different movements are automatically obtained on this thread miller, attention is called to the fact that it is a production machine, and is ordinarily used continuously for the same work. On that account it was not considered that the expense of a speed-changing mechanism would be justified. Power for driving the work-spindle and related parts is furnished by a belt running over a two-step pulley at the head end of the machine. From this pulley power is transmitted through spur gears *A*, and a worm and wheel *B* to a vertical shaft, from which the drive is transmitted to the work-spindle through a second worm and worm-wheel.

Carried by this vertical shaft there is also another worm that meshes with worm-wheel *C* to provide for transmitting power to camshaft *D* that runs along the back of the machine. Two cams *E* and *F* are mounted on this shaft. Face cam *E* provides for imparting a longitudinal feed movement to the cutter-slide, corresponding to one pitch of the thread to be milled, during the period that the work is making one and one-tenth revolutions; and cam *F* has a concentric surface running practically all the way around its circumference which holds the cutter in to the required depth for milling the thread. As shown in the plan view of the machine, Fig. 3, it will be seen that there is a sudden drop in this cam which allows the cutter to recede from the work immediately after the milling operation is completed, and the operator then withdraws the cutter-spindle carriage from the work by means of hand-lever *G*, so as to allow ready access to the work-spindle if the chucking happens to be from the front instead of from the rear of the work-spindle.

On the top of lever *G* it will be seen that there is a small rod *H*, actuated by a thumb-lever, which lifts a latch that drops into a hole in the machine frame to hold the cutter-spindle back from the work while the operator is engaged in removing the milled piece from the chuck and setting up a fresh blank in its place. A counterweight and cable draw the cutter-slide forward when the operator re-

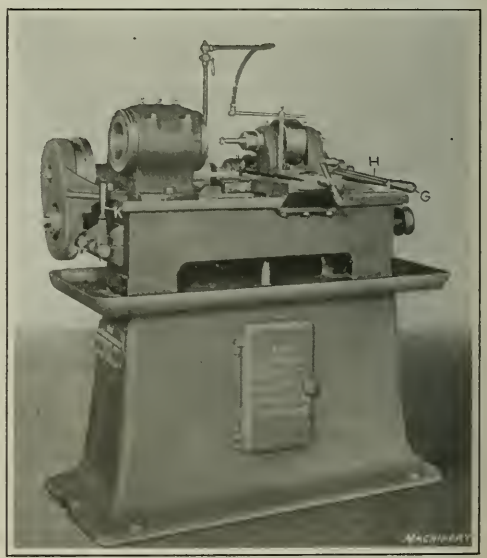


Fig. 1. Thread Milling Machine built by the Automatic Machine Co.

leases the latch, this movement bringing the cutter into the desired position for starting the thread milling operation, since the face cam acts also as a positive stop. In Fig. 3, attention is called to the fact that bronze block *I* is secured to the cutter-carriage, and it is this block that projects beyond the guard over cam *E* and comes into engagement with the throw of the cam, which is indicated by a dotted line. This imparts the necessary longitudinal feed movement to the cutter, and the broad surface of this shoe, instead of the line contact of a roller, eliminates possibilities of trouble from surface irregularities on the face cam.

Similarly, bronze block *J* on the cross-slide of the cutter-carriage engages cam *F* to provide for feeding the cutter into the work. Cams *E* and *F* are so synchronized that when the cutter has been fed across the work a distance corresponding to one pitch of the thread, cam *F* will have fed the cutter in to depth and come around to bring the notch or drop on the cam into contact with block *J*. When this point is reached, the cutter recedes from the work automatically and the operator withdraws the cutter-slide by manipulating handle *G* for chucking the next piece.

In order to obtain the desired results in the operation of a thread milling machine of this kind, it is important for the work to make just in excess of one complete revolution and then for rotation of the work to be stopped. This result is accomplished by incorporating an ordinary power press latch mechanism on the main driving pulley. The latch utilized for this purpose is shown at *L* and it enters a notch in the pulley, which is also clearly illustrated. In starting the machine the operator throws over lever *K* and the work will then rotate through the required distance, when latch *L* will come into engagement and stop further movement.

Contained in the bed of the machine there is a reservoir for the oil or emulsion that is used to cool and lubricate the cutter and work. The pump for circulating this coolant is belt-driven from the countershaft, and Figs. 2 and 3 clearly show the arrangement of the pump and piping. The relief pipe discharges directly into the reservoir again instead of into the pan. The milling-cutter spindle, which is running continuously, is driven by an independent belt from the countershaft, as a fairly high speed of rotation is required for the milling cutter, which is usually of quite a small diameter.

As previously mentioned, this is a production machine,

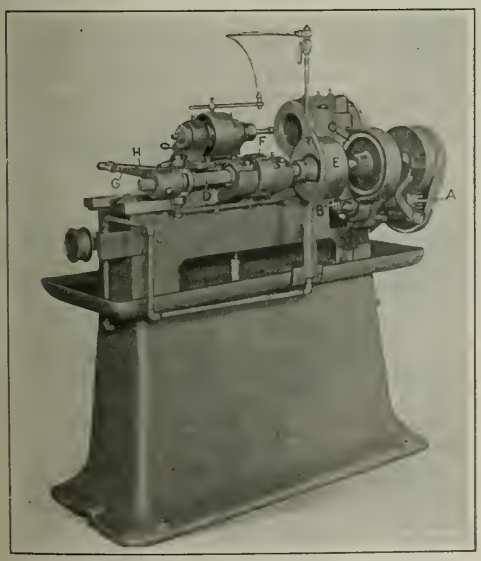


Fig. 2. Rear View of the Automatic Thread Milling Machine shown in Fig. 1

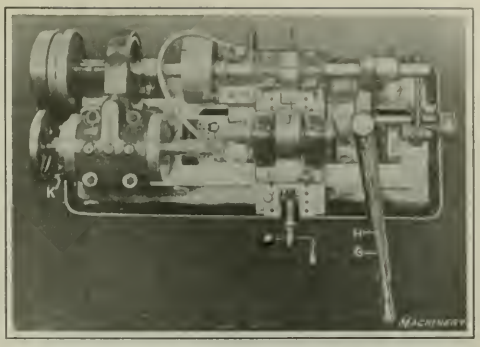


Fig. 3. Top View of the Automatic Thread Milling Machine

generally used continuously on a single class of work, and hence it was not considered desirable to put the customer to the expense of a speed-changing mechanism. It is usual for information to be sent to the Automatic Machine Co. concerning the class of work that is to be done on the machine, and with such information available, suitable gears are placed in train *A* to give the required speed of rotation to the work. Gears for this purpose are made in a standardized range of sizes, so that it is merely a question of selecting those gears which will cause the work to revolve at a suitable rate.

It will be evident that the automatic features of this machine eliminate hand operations and enable one operator to tend to several machines at the same time.

LEEDS & NORTHRUP HUMP METHOD FOR HEAT-TREATING STEEL

A new method for the heat-treatment of steel has recently been introduced by the Leeds & Northrup Co., Philadelphia, Pa., which represents an important development in hardening-room practice. It is known as the hump method, and utilizes the outward manifestation of changes in internal structure which take place when steel is heated past the so-called critical or transformation point to indicate when the work should be withdrawn from the furnace. In using this method, the temperature of the furnace, and therefore of the work, is raised at a uniform rate until the transformation point of the steel is reached. At this time there will be a marked decrease in the rate of temperature rise. This change in the rate of rise is made plainly visible to the operator by an autographic recorder connected to a thermocouple placed close to or in contact with the work. The effect is clearly shown by a bend or hump in the curve as shown in Fig. 1. This hump corresponds to a pause in temperature rise or decrease in the rate of heating of the steel, which occurs in spite of the fact that heat is being transferred to the work during this interval as rapidly as before or after. It is explained by metallurgists as being due to the dissolving of cementite or carbide of iron in the pure iron or ferrite, and to other chemical and physical changes depending upon the composition of the steel. By microscopical and chemical means, it is known that the physical and chemical structure of steel after quenching is profoundly influenced by the relative time of quenching with respect to the time at which the arrest occurs. The hardness, strength, ductility and toughness are all definitely influenced.

As a guide in hardening, the temperature pause or decalescence point, as it is called, is claimed by the Leeds & Northrup Co. to be much more reliable than is the furnace temperature as indicated by a pyrometer. The arrest in temperature, as signaled by the hump or bend in the line drawn by the pyrometer pen, shows that the internal changes affecting the qualities of the finished steel, are actually

taking place, and once the proper subsequent interval to allow before quenching has been determined, there is no uncertainty about the results of hardening. The user of the hump method need not concern himself about the absolute accuracy of his pyrometer, nor bother with independent transformation point determinations. It is not at all necessary that the temperature indicated by the thermo-couple should be the correct temperature of the work, for so long as the recorder connected to the thermo-couple shows clearly the pause in temperature rise, the moment at which transformation occurs is definitely known. Having learned by trial just how many minutes should elapse after the beginning or end of the transformation before the work is removed from the furnace, he is upon sure ground and can repeat results. Uniform standardized conditions and a control of the rate of heating the work are essential to the hump method of heat-treatment. The heating element consists of a vertical, cylindrical resistor, surrounded by insulating material in a sheet-iron jacket. The resistor rests upon a refractory block, which is supported by a cast-iron bottom plate. The heating chamber is closed at the top by a refractory cover, while a cast-iron top plate confines the loose insulating material, filling the space between resistor and jacket. An iron-constantin thermo-couple of bare No. 8 gage wire projects upward from the center of the bottom refractory block.

By means of a small wire attached to a tool support on the top plate of the furnace, the work to be treated can be suspended in close proximity to, or touching, the end of the thermo-couple. In production furnaces other methods of supporting the work are used. For example, in a furnace that is especially designed for heat-treatment of automobile transmission gears, the work is placed upon holders before insertion in the furnace. Covers placed on the furnace completely close in the heating chamber, preventing renewal of the atmosphere, and the work is thus protected against oxidation and scaling. At the moment when the work is introduced into the furnace, the temperature of the latter is, say, 1400 degrees F., but the heat storage capacity of the furnace walls being small compared with that of the charge, the temperatures of both thermo-couple and furnace walls drop rapidly a few hundred degrees, the current through the heating element or resistor being shut off during this time. The result can be seen in the chart made by a curve-drawing pyrometer connected to a thermo-couple located in a furnace operated in the manner just described, as reproduced in Fig.

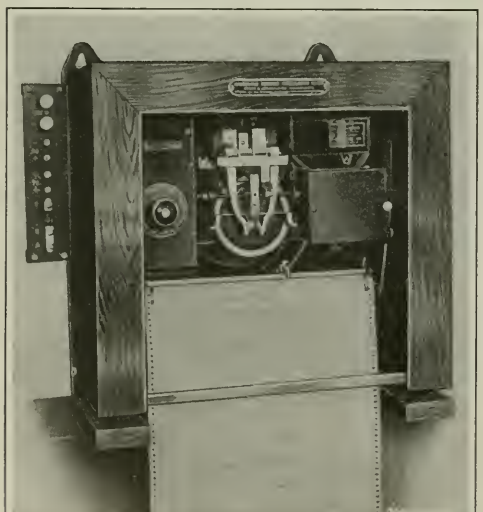


Fig. 1. Recording Pyrometer made by the Leeds & Northrup Co., which is used in applying the Hump Method of heat-treating Steel

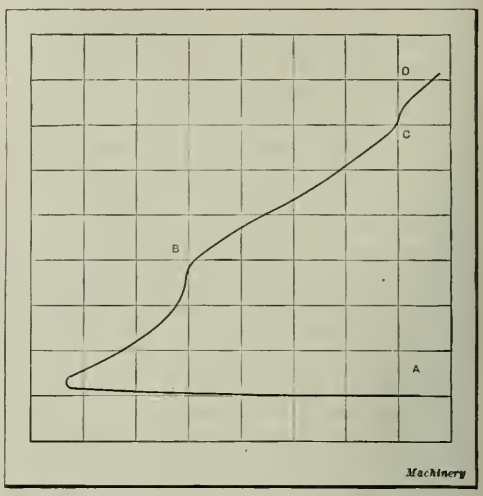


Fig. 2. Diagram showing how the "Hump" is produced on the Recording Pyrometer Chart

2. The temperature drops rapidly from 1400 degrees F. at *A* to about 870 degrees F., and then rises slowly to *B*, where it is stationary, the thermo-couple, furnace walls, and all parts, small and large, of the charge having reached approximately the same temperature. The switch is then closed, the input being so regulated that the temperature rises at the desired rate. The fact that the work and furnace start from the same temperature at *B*, far below the critical point, coupled with a proper arrangement of the heating element, with respect to the charge, insures that all parts of the work will go through the critical point at the same time. This is desirable in order to avoid stresses and distortion that would follow from unequal expansion or contraction if different parts of the work passed through the transformation point at different times.

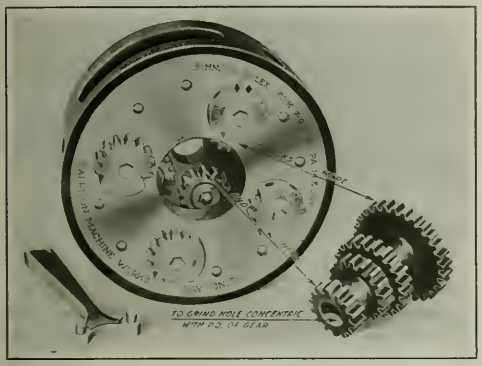
The arrival of the work at the transformation point *C* causes an abrupt change in the rate of heating, due to the suddenly increased capacity of the steel to store heat. The temperature stops rising or proceeds much more slowly than before, although the rate of supply of heat energy has not been changed; however, once the transformation is completed, as at *D*, the temperature again rises rapidly. The pause is plainly shown by the hump in the curve. Before quenching, it is necessary to heat the work for a certain time after this point, the time depending on the mass and shape of the steel, the quenching medium employed, and the qualities desired. The exact further heating to be allowed after the completion of the transformation point is learned by experience or trial, but once known, all uncertainty as to the result is practically eliminated. In using the hump method, the metal is quenched without hesitation, as soon as the pen has gone the prescribed distance past the "hump," which indicates the transformation point.

GARRISON DUPLEX GEAR CHUCK

A duplex gear chuck for holding cluster gears to provide for grinding the bore concentrically with the pitch circle is a recent product of the Garrison Machine Works, Dayton, Ohio. This chuck makes it unnecessary to trust the judgment or skill of the grinder hand. In setting up a cluster gear in one of these chucks provision is made for holding the two end or outer gears of any cluster, and the number of gears in the cluster, the design, or the pitch is not a limiting factor. This duplex gear chuck can be applied to a grinding machine the same as any ordinary chuck through the use of an adapter or by attaching it to the faceplate. The chuck con-

sists of front and rear units secured together by a container which is rigidly attached to the rear unit and bored to receive the front unit. The front chucking unit is free to rotate in its container.

Rotating the front chucking unit in a forward direction simultaneously locates and chucks the front and rear gears of the cluster with an automatically balanced pressure; and a reverse movement of the front chucking unit simultaneously opens both the front and rear units, so that the gear may be removed from the chuck. The average chucking time is said to be from 5 to 8 seconds. These chucks will hold gears from + 0.010 to — 0.020 inch on the pitch diameter and they are guaranteed to chuck the gear so that eccentricity of the pitch line will not exceed the standard specification of 0.003 inch after the hole in the gear has been ground. The container is open on all four sides between the front and rear chucking units, enabling the chuck to automatically clean itself at all times and preventing the accumulation of grinding solution or emery at any point within the chuck. Ample provision has been made for lubrication of all bearings and for the exclusion of grit.



Duplex Chuck made by the Garrison Machine Works for holding Cluster Gears

KEMPSMITH VERTICAL "MAXIMILLER"

In October, 1918, the Kempsmith Mfg. Co., Milwaukee, Wis., announced to the trade a new milling machine which was designated as a No. 4 horizontal "maximiller." This machine has already become well-known to manufacturers and mechanics, and its favorable reception has led to the development of a No. 4 vertical "maximiller" which is here illustrated and described. In developing this new milling machine, it was not found necessary to make other than minor changes in the table, knee, feed, and traverse mechanisms etc., and as a result the following description will be chiefly confined to those modifications which were involved in the design of the original horizontal machine to produce a vertical miller.

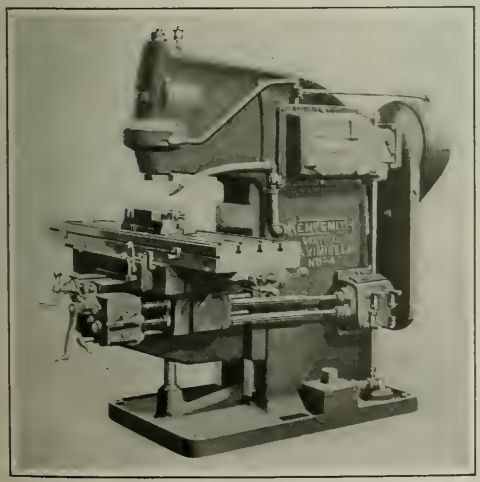


Fig. 1. No. 4 Vertical "Maximiller" built by the Kempsmith Mfg. Co.

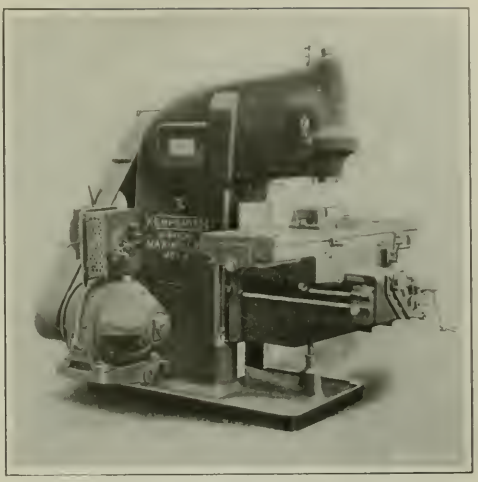


Fig. 2. Opposite Side of the Kempsmith "Maximiller" Showing the Driving Motor

The No. 4 vertical "maximiller" is intended for handling work that requires a heavy, powerful machine constructed along lines that will adapt it for rapid operation and the attainment of accuracy in the finished product. Great care has been taken in working out details of the design to provide for the saving of both time and labor in the performance of milling operations. The main frame members, including the column, knee, saddle, and table are made of semi-steel, and the metal has been carefully distributed to provide ample strength and rigidity at all points, without unnecessary weight. Attention is called to the design of the column, which has very few openings, and these of small size. This fact, in conjunction with ribbing of the column, affords ample strength to avoid springing under the heaviest cuts.

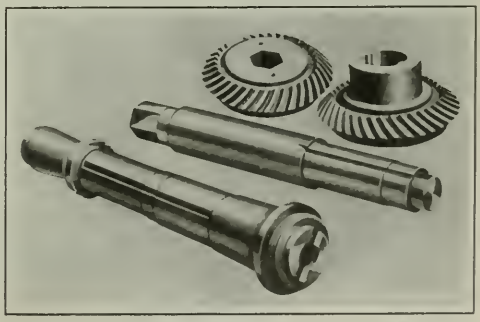


Fig. 3. Spindle, Gears and Driving Shaft of the Kempsmith "Maximiller"

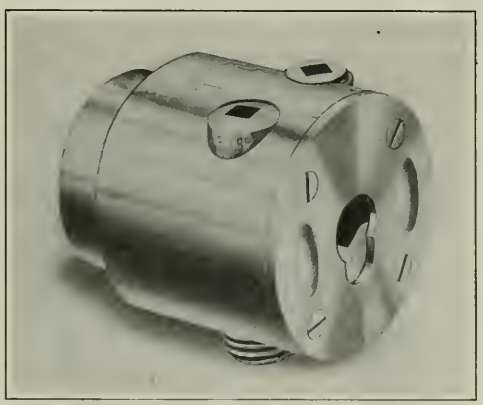
The table has a working surface 70 by 18 inches, in size, with a maximum longitudinal movement of 42 inches. By counterweighting the knee, table, and saddle, with weights placed inside the column, provision is made for securing an easy vertical adjustment of the work in relation to the

cutter, making it unnecessary to have an auxiliary vertical slide for the spindle. The spindle nose is of the Kempsmith patented type, and it is hardened to give ample durability. Provision is made for driving face milling cutters in either direction, and the design of the spindle is such that it also permits the cutter to be quickly and easily removed. The spindle is made of alloy steel, and runs in phosphor-bronze bearings which are easily adjusted to compensate for wear. All other shafts in the speed transmission run on ball bearings. Eighteen spindle speeds are provided covering a range from 14 to 355 revolutions per minute.

Slow speed shafts in the spindle drive are liberally proportioned and made of heat-treated alloy steel. The bevel gears are of large size with coarse-pitch teeth, and they are of the spiral-bevel type giving a smooth silent drive. The driving pulley on the machine is 16¾ inches in diameter and it carries a 6-inch double belt. This pulley is usually arranged to run at 400 revolutions per minute. It is mounted on ball bearings and with the clutch is enclosed in a protective housing. When individual motor drive is employed, the motor is mounted on a bracket at the base of the machine as shown in Fig. 2, and belted to the driving pulley. A 15-horsepower motor is recommended running at 1200 revolutions per minute.

CASLER DRILL CHUCK BORING HEAD

The Marvin & Casler Co., Canastota, N. Y., is now making a tool known as the No. 112 Casler drill chuck boring head, which has been designed to meet the requirements of plants that have use for a Style A boring head of this company's manufacture, but which does not need all of the features that are furnished on it. The drill chuck boring head is equipped with two screws, one for gripping the drill or boring tool, and the other graduated to 0.001 inch, which controls the offset. Drills, reamers, or counterbores with shanks up to ¾ inch in diameter may be chucked. An offset of ⅜ inch can be obtained with either round or hexagonal boring tools up to 9/16 inch in diameter, while an offset of ½ inch is obtainable with round or hexagonal boring tools up to ¼ inch in diameter. This boring head can be equipped with

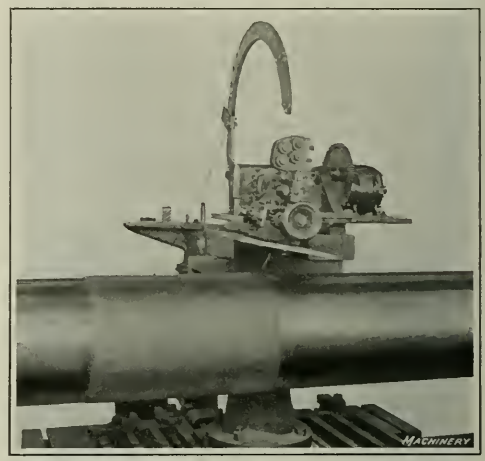


Casler Drill Chuck Boring Head made by the Marvin & Casler Co.

a taper shank and mounted on a milling machine to provide for drilling, reaming, and boring holes in jig, fixture and gage work. It is said to be exceptionally convenient for under-cutting and recessing when used in a turret lathe.

GENERAL ELECTRIC AUTOMATIC ARC WELDER

Automatic arc welding is now accomplished by a new device perfected by the General Electric Co., Schenectady, N. Y., and soon to be put on the market, which is known as the automatic arc welder. It is for use with the regular welding set and is designed to take the place of the hand-controlled electrode. This welder consists of a pair of feed-rollers, driven by a small steady supply of wire, which automatically maintain the best working distance. The whole apparatus is controlled from a small panel. The welding head is held by a suitable support with a certain amount of



A 14-inch Shaft with the Fit increased ⅜ inch in Diameter by the Automatic Arc Welder built by the General Electric Co.

hand-regulated adjustment, and consists of a steel body carrying feed-rolls and straightening rolls which are both adjustable for various sizes of wire. The arm is supported on a gear-box, together with the motor. This box contains gears which give three gear ratios, thus extending the range of the device while allowing the motor to operate at its most favorable speed.

The control panel carries an ammeter and voltmeter for the welding circuit, as well as rheostats, a control relay, and the contactors and switches for the feed motor. It is possible to start and stop the equipment from the work by a pendant push-button, but adjustment of the feed conditions must be made from the panel. The adjustment for arc conditions by regulation of the speed of the feed motor, as the arc voltage varies, is taken care of by the panel equipment. The result is a practically steady arc which increases the speed of the welding.

The whole apparatus is mounted on a base which can be bolted to any form of support. Thus a great variety of working conditions can be met, but provision must be made for carrying the arc at uniform speed along the weld. For instance, for straight seams, a lathe or planer bed may be used, and for circular ones, a lathe or boring mill. However, the local conditions will dictate the method to be followed. The device is especially valuable where a large amount of routine welding is to be done, since it is capable of from two to six times the speed possible to skilled operators and gives a uniform weld of improved quality. It is adaptable for welding seams of tanks and plates, rebuilding worn or inaccurately turned shafts (as shown in the illustration), rebuilding worn treads and flanges of wheels, and for many other kinds of work.

BROWN PORTABLE POTENTIOMETER

The Brown Instrument Co., Philadelphia, Pa., has recently developed a precision portable potentiometer to provide for accurately measuring all electromotive forces in pyrometry. While the use of this instrument is not restricted to such measurements, the ease with which it can be operated makes it especially serviceable for checking millivoltmeters and po-

tentiometers and directly determining the E.M.F.'s of thermo-couples. The limit of accuracy in an instrument of this type is determined by the scale length which is often made about 10 inches. If a 10-inch scale is calibrated to 50 millivolts, one millivolt space will have a length of about 1/5 inch. The scale of the Brown potentiometer is 8 feet or 96 inches in length, and with a range up to 50 millivolts each space indicating a millivolt is nearly 2 inches in length and is graduated to 1/50 of a millivolt. A cadmium sulphate cell having an unsaturated solution, a negligible temperature coefficient, and conforming with the recommendations and specifications of the Bureau of Standards is supplied. These cells are aged for many months before being used. A No. 705 "Ever Ready" dry cell furnishes current for the main circuit and can be bought at any electrical supply store.



Portable Potentiometer made by the Brown Instrument Co., for Use in accurately measuring Electromotive Forces in Pyrometry

Nearly all portable potentiometers have a drum wire of low resistance, measuring about 20 ohms, requiring a comparatively large current and producing a rapid falling off of the dry cell current due to polarization, and also resulting in the dry cell current being unsteady if used for any length of time. The Brown potentiometer has a drum wire of 150 ohms resistance, and the total instrument resistance for 50 millivolts is approximately 4000 ohms, which includes the rheostats. This is gradually reduced to a minimum of 3400 ohms, when the dry cell is exhausted and must be renewed. More than 0.00036 ampere is never required to operate this instrument. An extremely sensitive double-pivoted galvanometer is used, responding to the most minute current. Standard instruments are calibrated from 0 to 25, 0 to 50, 0 to 75 and 0 to 100 millivolts. Special ranges can be supplied up to one volt, if required. Instruments can be calibrated with two scales, equivalent temperature and millivolt scales or equivalent fahrenheit and centigrade scales, if so desired. The Brown precision portable potentiometer can be automatically compensated for the cold junction temperature of one particular type of thermo-couple, provided compensating leads are brought to the instrument.

CUTLER-HAMMER DIRECT-CURRENT MOTOR STARTERS

Although safety is the primary cause of the demand for enclosed starters, some installations require the enclosed type as a means of keeping the contact-making parts clean and the starter in good operating condition. Of the latest additions to the line of enclosed starters manufactured by the Cutler-Hammer Mfg. Co., Milwaukee, Wis., one shown in Fig. 1, consists of the familiar type of direct-current faceplate starter enclosed in a sheet metal case having an external lever which engages the movable arm of the starter. The external, or operating lever is insulated from the revolving contact arm by a block of molded insulation. A pointer on the lever and legends stamped on the cover indicate to the workman whether the starter is "off" or "on." In the smallest size of starter, a knob of black insulating composition is provided in place of the operating lever. A low-voltage release coil in series with the shunt field protects the motor in case of voltage failure or if the field should be opened while the motor is running. The armature resistor is completely enclosed in the starter case, which is kept well ventilated by a flue in the top. Both the enclosed and open type of starters are used with direct-current motors up to 50 horsepower, operating at 115, 230, and 500 volts.

Fig. 2 shows an automatic motor starter panel of the counter E.M.F. type completely enclosed in a cast-iron case with a hinged cover. The automatic feature is obtained by an accelerating contactor which closes when the motor attains about three-fourths full speed, and automatically shunts out the starting resistor. A magnetic main line contactor mounted on the panel allows remote control from two push-button switches of the momentary contact type. The operation of the contactors in conjunction with the push-button switches is as follows: Pressing the "run" button closes the magnetic main line switch, thereby starting the motor with the armature resistor in circuit. The motor accelerates until it reaches about three-fourths normal speed, when the resistor is automatically cut out of circuit by the closing of the accelerating contactor, the operating coil of which is connected across the motor leads and is energized by the counter E.M.F. of the armature. The motor is stopped by pressing the "stop" button, or by voltage failure, both of which cause the main line contactor to drop out. A common snap switch, a float switch or a pressure regulator can also be used for the remote control of the motor. When remote control is not desired the magnetic main line contactor is omitted, and the motor is started by a fused knife switch mounted on the panel with an operating handle outside of the case. The handle can be locked in the open position to prevent unauthorized operation. Interlocks prevent lifting the cover while the switch is closed or throwing the switch with the cover opened. When the knife switch is used, low-voltage release is inherent in the accelerating contactor,

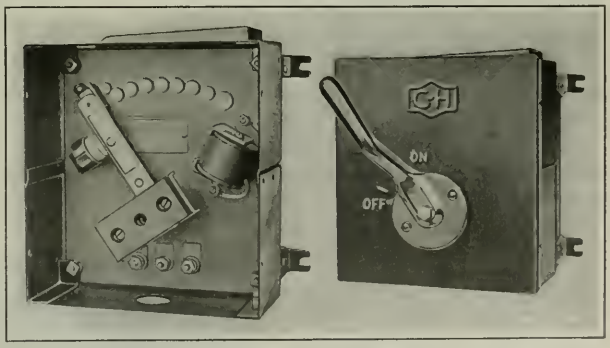


Fig. 1. Faceplate Enclosed Starter made by the Cutler-Hammer Mfg. Co. for Small Direct-current Motors

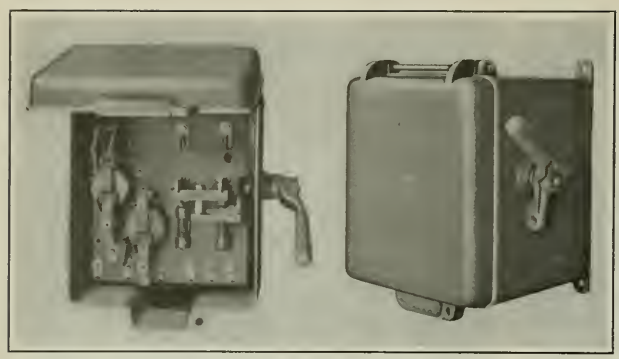


Fig. 2. Automatic Starter made by the Cutler-Hammer Mfg. Co., which can be operated by the External Lever or Push-buttons

which will again close after the voltage returns and the motor has accelerated to three-fourths normal speed, provided the knife switch is still in the closed position. The cast-iron enclosing case is arranged for conduit wiring and can be mounted on a wall or any flat surface. This starter is for use with small direct-current motors not rated over 2 horsepower at 115 volts, or 3 horsepower at 230 volts.

CRANKSHAFT-CHEEK MILLING MACHINE

Machining the outside surfaces of the cheeks of crankshafts on an ordinary lathe is usually an expensive operation, due to the fact that no cutting is done during a considerable portion of the time in which the crankshaft revolves in the lathe. In order to eliminate this non-productive operating time and expense, the Newton Machine Tool Works, Inc., 23rd and Vine Sts., Philadelphia, Pa., have recently developed a crankshaft-cheek milling machine, which is here illustrated and described.

This machine has a work-table *A*, 72 inches long and 32 inches wide, on which is fitted the crankshaft holding fixture *B*, the top slide of which is adjustable crosswise through a rack and hand-operated pinion. This table has forward as well as reverse fast power traverse in addition to hand adjustment. The movement of the table is controlled by a revolving screw and a stationary nut. The table is provided with six changes of geared feed obtained through sliding sleeves on which the gears are mounted, and which are enclosed in an oil-tight box. These sleeves are controlled by latch levers conveniently located outside the cover.

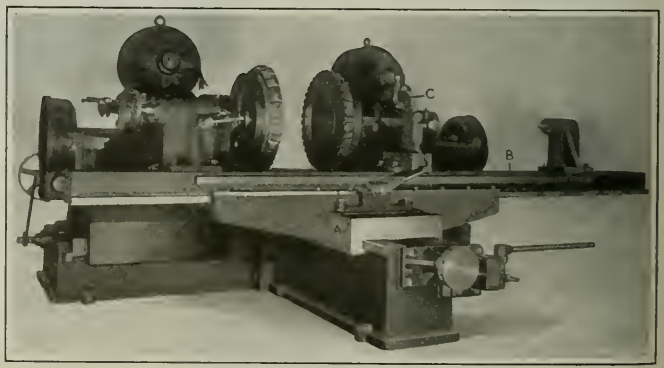
The main table has a traverse of 30 inches and hand adjustment along the base. Each cutter-head is 40 inches in diameter over the cutting tools, and each cutter-head saddle has independent hand adjustment on its wing to permit the heads to be adjusted and operated within 4 inches of each other or up to a maximum distance between centers of 30 inches. On the top slide of the crankshaft-holding fixture there is mounted a pair of centers for holding the crankshaft; the center on the right-hand side of the machine occupies a fixed position, and that on the left-hand side is provided with hand adjustment to permit its insertion into the center of the crankshaft. Both center stands are adjustable upon the top slide, the maximum distance between centers being 15 feet. The distance from the centers on which the crankshaft is mounted to the top of the slide is 11 inches. Suitable hand-operated arch clamps *C* are provided for clamping the cranks in place while they are being machined.

Each cutter-head is made from a steel casting, containing slots for the tools which are machined from the solid. The teeth which mesh with the driving gear at the rear of the head are also cut from the solid. The width of each wing on which the spindle saddles are mounted is 56 inches, and the actual length of each spindle saddle bearing on the wing is 50 inches. The height of each wing above the floor is 18 inches, and the height of the main base on which the main table is supported is 28 inches. The cutter-heads are driven by individual motors through internal gears, the latter being fully enclosed. The table is driven by a motor mounted at the back of the machine, which is of the interlocking type, and is so arranged that in stopping the machine this motor will come to a stop before the motors driving the cutter-heads cease to rotate. When starting up the machine, the motors which drive the cutter-heads will start first, thus preventing the breakage of tools or roughing the finished surfaces of the work.

DAVENPORT-SLOCOMB DIRECT-READING MICROMETER

The J. T. Slocomb Co., Providence, R. I., has recently placed on the market a micrometer equipped with a counting device which permits direct reading on every thousandth, from 0 to 0.999 inch. It is claimed that this is the first micrometer caliper to be equipped with such a device, and that in the addition of this new feature none of the well-known Slocomb wear-resisting qualities have been sacrificed. The accompanying illustration of the micrometer, with a portion of the mechanism housing cut away, shows the method of mounting the counting wheels and pinions. It will be seen that the pinions are mounted on an eccentric barrel, which is provided with a clamp screw. This allows the pinions to be thrown into mesh in the same way as the back-gears of a lathe, and, of course, permits of a fine adjustment for mesh. The counting wheels are 0.425 inch in diameter and are mounted on a sleeve that runs concentric with the spindle. A keyway and key in the spindle provide means of driving this sleeve, allowing the spindle a traverse of 1 inch.

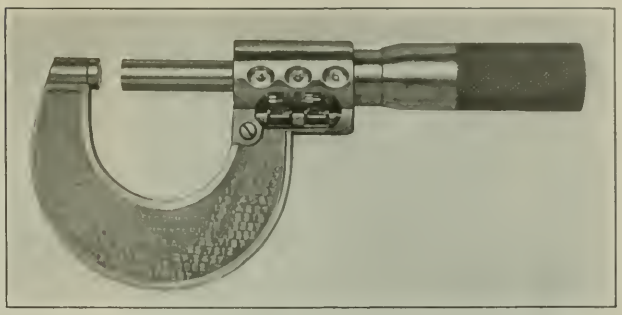
It will be noted that this device adds but little to the size and weight of the instrument, and as it is located centrally the micrometer balances well, so that it may be readily held and operated by one hand in the usual way. The frame is a steel drop-forging produced by cold hydraulic pressing in finished steel dies, the same as that of the frame of the regular No. 26 micrometer of this company's manufacture. A pressure of 300 tons is used, which compresses the steel



Crankshaft-cheek Milling Machine built by the Newton Machine Tool Works, Inc.

and adds greatly to its stiffness. This feature assists the workmen to maintain a more uniform "feel" in measuring, as the thimble will come to a dead stop more abruptly. The comparative lightness of this type of frame also makes it more convenient to use.

As previously stated, the reading is direct on every thousandth, and for measurements to an accuracy of 0.0005 inch it is only necessary to see that the right-hand figure is about central in its aperture. Where greater refinement is required, it is necessary to refer to the nearest graduation on the thimble and note how it corresponds with the revolution line on the sleeve, but in any case no calculation whatever is required, and as the pitch of the screw is finer than that employed on the regular type its magnifying power is considerably greater.



Davenport-Slocomb Direct-reading Micrometer made by the J. T. Slocomb Co.

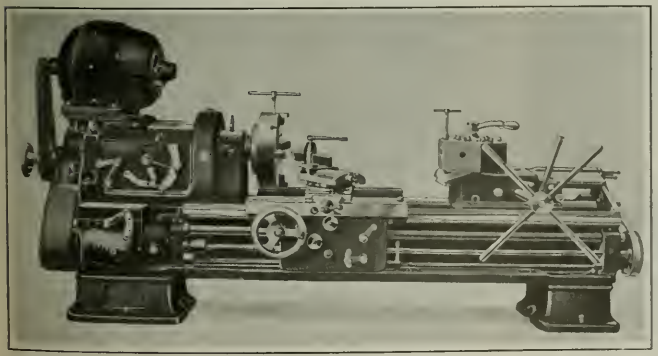
K. R. WILSON TOOLS FOR FORD REPAIR SHOPS

K. R. Wilson, 10-16 Lock St., Buffalo, N. Y., has recently placed on the market a line of tools especially designed to meet the requirements of garages specializing in the work of repairing Ford automobiles. Recent additions to this line of garage equipments include a valve seater and facer, a propeller shaft reamer with a guide, a propeller shaft bearing end-mill, a combination end-mill and arbor for facing spindle body bushings and worn axle forgings, and a spiral reamer and jig for cast-iron camshaft bearings. This line of tools includes a total of fourteen different equipments and others are in course of development.

CINCINNATI GEARED-HEAD LATHES

The lathe shown in the accompanying illustration represents one of the latest types of patented geared-head lathes built by the Cincinnati Lathe & Tool Co., Oakley, Cincinnati, Ohio. This lathe is now made in 16-, 18-, 20-, 22-, 24-, 26-, and 28-inch sizes and may be either single-pulley belt-driven, or motor-driven. It may also be obtained with the regular type of tailstock in place of the turret. Equipped with the hexagon turret as shown, and with power feed and silent chain drive, this lathe is said to be particularly well adapted for general manufacturing purposes.

Twelve mechanical speed changes in geometric progression are secured through sliding gears by simply manipulating the three levers marked *CD*, *AB*, and 1 2 3. A neutral position is also obtainable, which permits the spindle to be easily revolved by hand. By referring to a simple easily read index-plate, the operator can quickly determine the proper position of change-gear levers for any desired speed within the wide range of spindle speeds obtainable on this lathe.



One of the Recent Types of Geared-head Lathes built by the Cincinnati Lathe & Tool Co.

No safety device is necessary, as the levers and gearing are so arranged that the gears cannot be made to lock while operating, and any lever may be shifted without interfering with the others. At the apron there is a control lever by which the spindle may be stopped, started or reversed without stopping the motor, or the driving pulley.

The range of feeds and threads obtainable is almost unlimited, and a convenient index-plate is furnished to show how any desired feed may be obtained. All bearings and gears are oiled automatically by the splash system, oil being properly distributed by the gears to grooves provided in the top cover. An indicator shows at all times the amount of oil in the base of the head. The design of these lathes is similar in many respects to the cone type of lathes manufactured by this company for the past fifteen years.

GENERAL ELECTRIC MUFFLE FURNACE

The General Electric Co., Schenectady, N. Y., has developed an electric furnace of the muffle type, which is designed to meet the demand for a durable, economical and convenient furnace for temperatures up to 850 degrees C., (1530 degrees F.), for baking vitreous enamel, hardening and tempering tools, dies, etc. This device consists of the furnace proper with a control panel mounted above it. The furnace is very strongly built, but small enough to be placed anywhere that will prove convenient. A heating element, which is mounted on the outside of the muffle and covered with compound, is so placed as to give a very even distribution of heat throughout the inside. This element is divided so that it is possible to get two degrees of heat, for convenience called "low" and "high" heat. The former is used to give a high initial heat so that the maximum temperature can be reached quickly—in an hour and three quarters to be exact—and the latter is sufficient to maintain this temperature. The muffle is mounted in a strong steel casing, and the walls, door, etc., are thoroughly insulated, thus preventing loss of heat from radiation.

The control panel, which carries the necessary apparatus for controlling the furnace, is equipped with a main line switch, a double-throw switch for high or low heat, and a red pilot lamp which acts as a warning to the operator when the furnace is on high heat. There are connections at the side of the panel for connecting rheostats when temperatures as low as 300 degrees C. are desired. By this arrangement, a very good control of the temperature is assured, and, due to the pilot lamp, there is very little excuse for the destruction of material due to carelessness, or inability on the part of the operator to tell what heat is on. The furnace is further provided with a shelf in front for the convenience of the



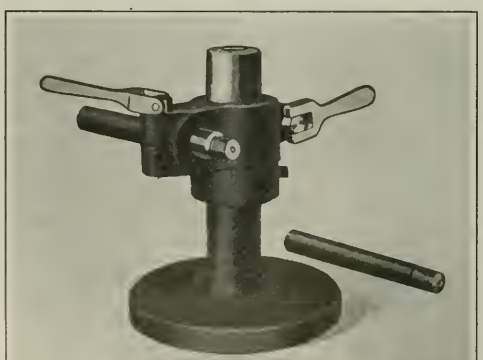
Electrically Heated Muffle Furnace made by the General Electric Co. Temperatures up to 1530 Degrees F. are Available

operator, and the door is equipped with counterweights to keep it open. The high heat necessitates 4 kilowatts to bring it up to 850 degrees C.

The advantages claimed for the use of this furnace for laboratory or shop service are manifold. Fumes, noise, and smoke that accompany the use of some furnaces are absent. The fire risk of the furnace is said to be practically non-existent. It is perfectly safe to go away and leave it alone for any length of time, on low heat, and the pilot lamp serves as a warning so that the high heat will not be left on. This furnace does not occupy a great deal of space, and can be set in the most convenient place for operation, without disturbing any of the rest of the installation. It is adaptable to numerous applications, such as heating carbon steel in tool making, baking patterns on china, and laboratory work of all sorts.

"THOR" UNIVERSAL REPAIR VISE FOR PNEUMATIC DRILLS

For use in tool-rooms and machine shops which are called upon to handle repair work on pneumatic drills, the Independent Pneumatic Tool Co., 600 W. Jackson Blvd., Chicago, Ill., has recently developed the "Thor" assembling and repair vise which is suitable for holding all makes of pneumatic drills. It provides for firmly clamping and holding the drill in various accessible positions while the necessary repairs, assembling, and testing are done. It will be seen that the vise consists of a flanged upright stand, a sliding collar to quickly adjust the vise to the proper height for convenient working, a set-screw for holding the collar in place, and a clamp that swivels on the collar and is securely held in any position by tightening a screw. At the other end of the clamp there is a hole which receives a threaded stem on which the drill is screwed. For small sized drills a stem support or adapter is used to enable a stem of proper size to be utilized.



"Thor" Universal Repair Vise for Pneumatic Drills made by the Independent Pneumatic Tool Co.

COLUMBIA HEAVY-DUTY SHAPERS

In the accompanying illustrations there are shown two views of a heavy-duty crank shaper which is built in 16-, 20-, 24-, and 28-inch sizes by the Columbia Machine Tool Co., Hamilton, Ohio. These machines have a friction clutch and brake, adapting them for either single-pulley or constant-speed motor drive. Four changes of speed are provided by the speed-box and this number is doubled by the back-gears, giving a total of eight rates of speed. The friction clutch and brake enable the shaper to be quickly started or stopped at any point of the stroke. Changes of feed are furnished by the gear-box that provides eight variations on the 16- and 20-inch shapers and twelve changes on the 24- and 28-inch machines. A small handle, which is conveniently located

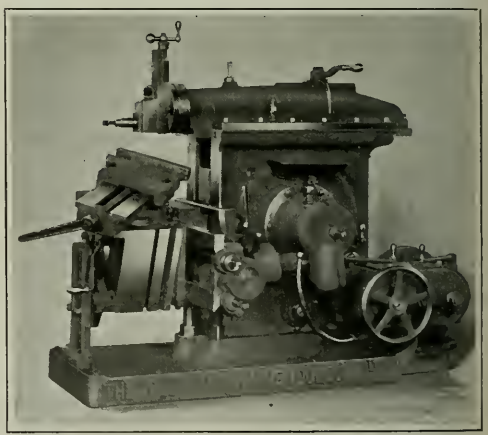


Fig. 1. Heavy-duty Crank Shaper built by the Columbia Machine Tool Co.

for the operator, provides for obtaining either of the available rates of feed, and changes can be made while the machine is running. The arrangement is such that feeding only takes place on the return stroke and the mechanism automatically adjusts itself to the position of the cross-rail. A small lever is provided just behind the cross-rail, which controls and indicates the direction of feed; and this lever can also be operated without stopping the machine. A safety friction guards against damaging the mechanism, and the feed-gears are made of steel and hardened, these gears operating in a bath of oil.

An important feature of these shapers is the revolving table, which is of exceptionally rigid construction. The table is carried on a hub or trunnion bolted to the saddle of the machine, and in addition an outer support is provided, this arrangement being an adaptation of the standard table support used on other machines of this company's manufacture. The arrangement will be readily understood from Fig. 1. The base extends beyond the outer end of the table and is of the so-called "pan" construction, with the top fully en-

closed, thus preventing oil from dropping on the floor. This enclosed top, supplemented by a heavy flange and ribs, assures a rigid foundation for the machine. The column is of box section and is made flush at the front without overhang and allowing ample traverse of the ram with the head set at an angle.

Extending the ram guides at the rear affords a long bearing surface, and the ways for the cross-rail are V-shaped, the rail being gibbed and locked on the operating side by one lever. A ram of girder construction is employed, and the head has vertical feed with micrometer adjustment and can also be set at any desired angle. The use of a collar

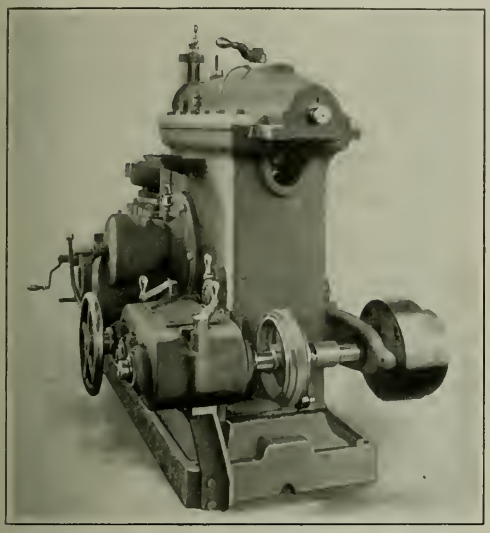


Fig. 2. Rear View of the Columbia Heavy-duty Crank Shaper

graduated in degrees facilitates the making of such settings. A powerful friction clutch and brake placed between the driving pulley or motor and the speed-box is operated by the curved handle at the side of the column, which is easily reached by the operator and provides for quickly stopping or starting the machine at any point of its stroke, a feature that is especially valuable in tool-room work.

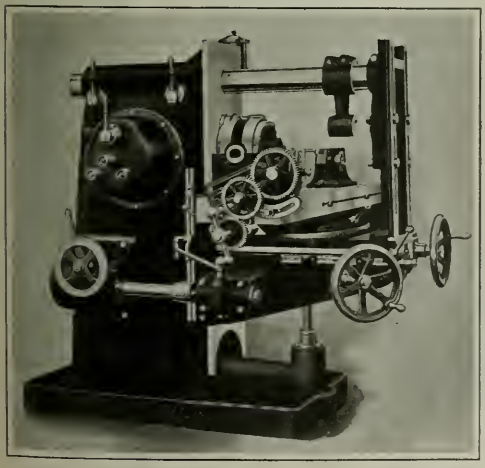


Fig. 1. No. 3 Milling Machine built in Plain and Universal Types by the Conradson Machine Tool Co. and sold by Joseph T. Ryerson & Son

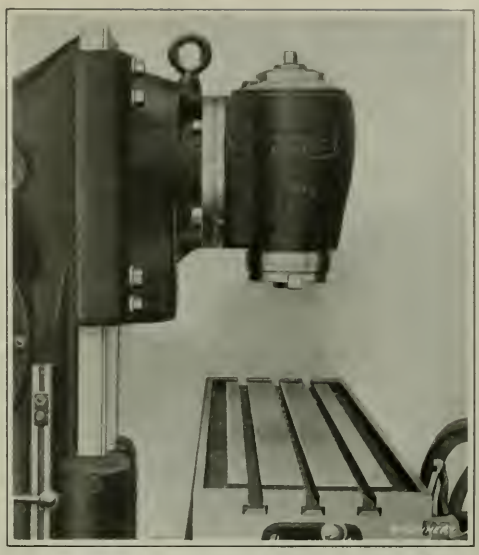


Fig. 2. Vertical Attachment for the Ryerson-Conradson Milling Machine

RYERSON-CONRADSON MILLING MACHINE

In the March, 1917, number of MACHINERY a description was published of a No. 3 plain milling machine with single-pulley drive, which had just been developed at that time by C. M. Conradson, Eau Claire, Wis. The most noteworthy feature of the design of this machine was the arrangement

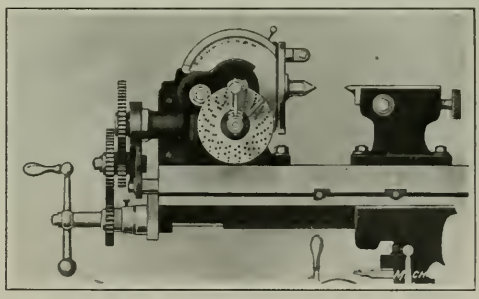
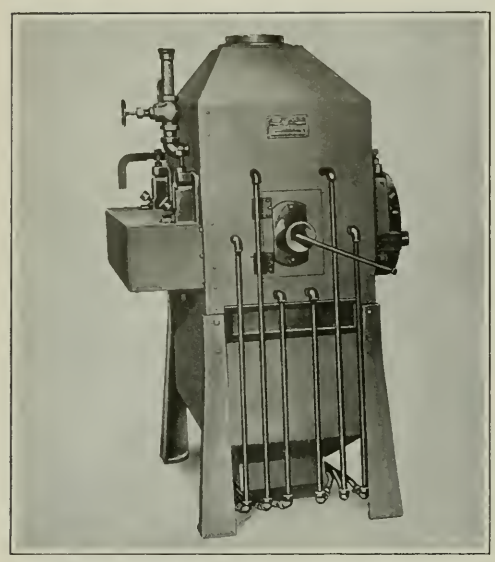


Fig. 3. Universal Dividing Head for the Ryerson-Conradson Milling Machine

of an oscillating speed-box, having sliding change-gears to transmit power through either a spiral pinion to a spiral gear keyed to the milling machine spindle, or through a worm to a worm-wheel mounted on the spindle. This machine is now being built in plain and universal types by the Conradson Machine Tool Co., Green Bay, Wis., and Joseph T. Ryerson & Son, 16th and Rockwell Sts., Chicago, Ill., are sales agents, the machine being one of a line of machine tools to be known as Ryerson-Conradson machines.

PANGBORN ROD-CLEANING SAND-BLASTING CABINET

A new cabinet for sand-blasting various shaped rods, from $\frac{3}{8}$ to $\frac{7}{8}$ inch in diameter, just produced by the Pangborn Corporation, Hagerstown, Md., embodies the features of continuous operation and a hygienic construction for the protection of the operator. The blasting operation being entirely confined, the cabinet can be readily installed with other machine tools without detriment; and this feature



Rod-cleaning Sand-blasting Cabinet built by the Pangborn Corporation

also removes the operator from all contact with the dust laden air. A set of rolls and guides at either end of the cabinet provides constant, uniform travel of the rods through the blasting zone. The feed-rolls are shaped to handle all diameters from ⅜ to ⅞ inch and of varying shapes.

By six blast projectors, centering to the rod at a 45-degree angle, the blast stream covers the entire surface of the rod, the discharge being directed toward or into a small chamber that utilizes the rebound effectiveness of the abrasive. Scale has been removed from ¾ inch diameter rods, with 80 pounds air pressure, at the rate of fifty lineal feet per minute. The bottom of the cabinet forms a hopper for abrasive storage. The blast action is of the suction type, and individual feed-hoxes, in plain sight of the operator, feed each blast projector. Connection to an exhaust system removes disintegrated material. The cabinet is adaptable for use with either sand or the metal abrasives and occupies a floor space of but 45 by 51 inches and is 69 inches high.

COLD-SAW CUTTING-OFF MACHINE

A recent development in cold-saw cutting-off machines for cutting large ingots and heavy forgings, known as the U-96 machine, has been recently brought out by the Newton Machine Tool Works, Inc., 23rd and Vine Sts., Philadelphia, Pa. This saw is equipped with an inserted-tooth saw blade 76 inches in diameter which has a capacity for cutting stock 24 inches in diameter in one cut. The saw blade (which is not shown in the illustration) is held in place by the flanges *A* on the saw arbor.

A main work-table *B*, 56 inches long in the direction of the feed of the saw and 48 inches wide, is bolted to the machine base. To this table is bolted a platen *C*, 60 inches long, 56 inches wide, and 12 inches deep, which is provided with suitable T-slots. On this platen there is a clamping block *D* which is 18 inches wide at the base and 12 inches wide at the top. The top of this block is in line with the top of the main table *B*. Two V-blocks are fitted to the main work-table and one V-block is fitted to the block *D* as shown.

A swivel arch clamp is supplied for each of the V-blocks and the clamps are so arranged that they will hold work 32 inches in diameter. The drive of the machine is from a belt-connected motor through a solid bronze worm-wheel and hardened steel worm fitted with roller thrust bearings. Both the worm-wheel and the worm are encased and run in an oil bath. A pinion cut in the solid steel shaft of the worm-wheel transmits power to the spindle driving gear. The feed motion is obtained from the driving shaft through gearing to an oil-tight feed-box in which the change-gears are mounted on a sliding sleeve controlled by latched levers in the cover. From this box the motion is transmitted to the saddle feed-screw through a feed-worm and worm-wheel which is positively clutched.

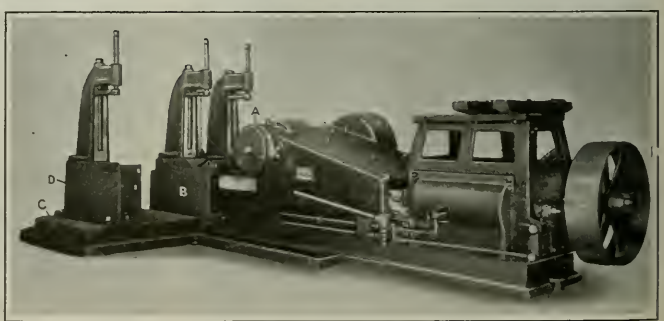
The machine is controlled from the rear; and forward feed with automatic stop, and rapid traverse forward and back with automatic stop are also provided. The feed and rapid traverse mechanism is enclosed with curtain covers, and a positive safety release is provided for each extreme position of traverse. The oil and chip pan is cast on the base, thus permitting the lubricant to drain back into the reservoir. A loose chip pan is fitted between the tables which conducts the oil to the pan on the base.

GABRIELSON MILLING MACHINE

The Gabrielson Mfg. Corporation, 318 First Trust and Deposit Co., Bldg., Syracuse, N. Y., has developed the manufacturing milling machine that is shown in the accompanying illustrations. In designing the Gabrielson miller the object kept in view was a machine that would do comparatively heavy-duty milling and still maintain accuracy of size and finish. Attention is called to the very small number of parts, a feature which makes for strength and rigidity. The machine shown in this article is known as the 6-inch machine because six inches is the maximum distance between arbor and table.

At a glance it will be seen that this miller differs quite noticeably from the conventional design. The frame casting, including the section that supports the table and also the section supporting the arbor, is made in one piece and very heavy so as to absorb the strains of cutting and to afford ample support for the spindle, arbor and table. Inasmuch as the table is mounted in the main casting, no vertical or lateral adjustment is possible, and the cutter movement with relation to the work is secured by moving the entire spindle with its bearings and arbor support. Not only is this true of its vertical adjustment but provision is also made for moving the arbor in or out of the machine to obtain lateral adjustments of the cut.

The main frame casting is mounted on a sub-base, the bottom section of which is used as an oil supply tank for the cutting lubricant. Power is received from the main driving pulley at the back of the machine and thence up to the spindle through gearing. As this machine is intended for manufacturing operations and is usually kept on the same



Cold-saw Cutting-off Machine built by the Newton Machine Tool Works, Inc.

class of milling, the feeds and speeds are seldom changed. Therefore, the machine is furnished with but one pair of feed gears which provide two changes of feed. However, extra feed gears may be ordered, so that any desired speeds and feeds may be selected, varying with the class of work to be done.

From the sectional view of the machine, Fig. 2, the construction of the spindle, spindle carrier and adjacent mechanism may be studied. The spindle is made of tool steel and hardened and ground. It is mounted in straight bearings, the outer parts of which are tapered, and fitting-in sleeves may therefore be closed in to take up wear and permit adjustment. The spindle and its bearings are eccentrically mounted in the large diameter spindle carrier, and by turning this carrier, the spindle and cutter are raised or lowered with relation to the table. This method of adjustment is a feature of the Gabrielson milling machine. The total vertical travel of the spindle is one inch and this travel is used only for the final movement of the cutter. The work is mounted approximately to the right height by means of the fixtures on the table, and this one-inch vertical movement is for the final cutter adjustment.

In making this vertical cutter adjustment, the tumbler gear that connects the gearing with the spindle driving gear is dropped down out of mesh by releasing a lever that may be seen at the front of the machine, beneath the spindle carrier. Then the spindle carrier locking bolt is loosened as well as the arbor support lock. After this it is only necessary to turn the handle at the front end of the spindle, and the desired vertical travel of the spindle and arbor is secured through a worm and worm-wheel. During this operation the arbor support travels with the arbor, and at the end of the adjusting operation the arbor support and spindle carrier are locked, the tumbler gear is thrown in mesh, and the machine is ready to run. Graduations on the end of the spindle carrier make exact adjusting easily performed.

To secure any necessary longitudinal arbor adjustment, the crank at the rear of the spindle mounting is used. By its means a movement of one-half inch is available for adjustments after the approximate location of the cutters on the arbor have been made. The table is very heavy and mounted as it is, directly on the massive frame casting, chattering is practically impossible. The table has a travel of 31 inches and has a working surface 7 by 34. Three T-slots are provided for mounting fixtures, and at the outer edge of the table there is a deep trough to carry away the cutting lubricant. The lubricant runs back to the supply tank in the base of the machine by means of a channel cut through the frame. The table feed is provided with a trip that may be seen at the front, and hand traverse and reverse may be had through the large operating wheel at the front.

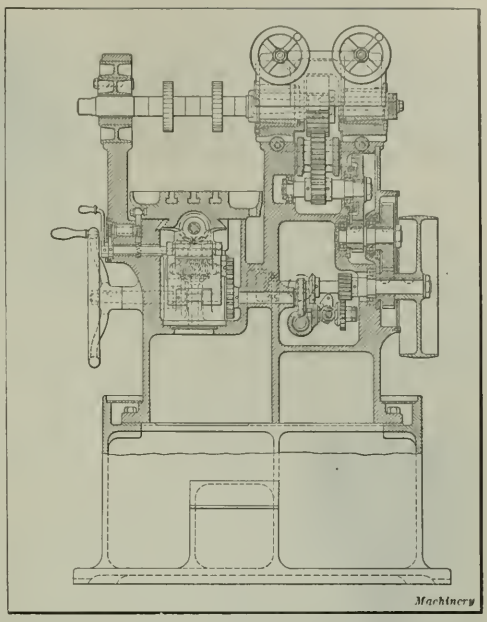


Fig. 2. Cross-sectional View through the Gabrielson Miller showing Arrangement of the Mechanism

The machine will carry cutters up to 10 inches in diameter and they are mounted on the arbor by removing the arbor support bushing and passing them through the hole at this end of the frame casting. After the cutters are correctly spaced on the arbor and held by the nut, the arbor support bushing is fitted and locked into the frame casting. The machine is arranged so that motor drive may be easily applied.

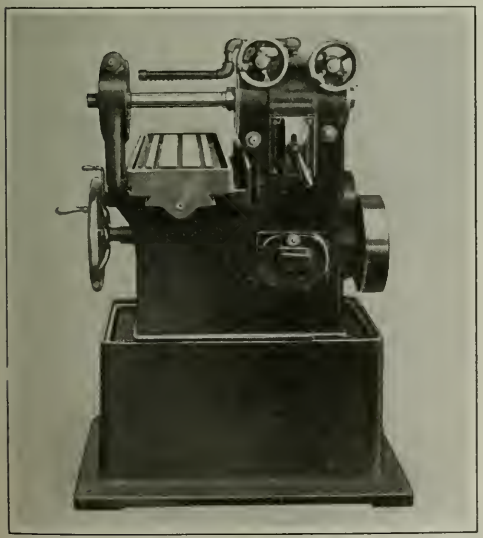


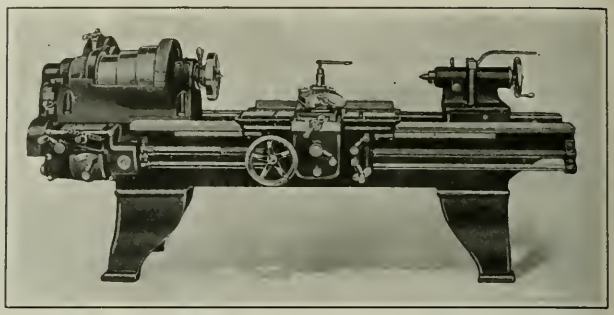
Fig. 1. Manufacturing Miller recently developed by the Gabrielson Mfg. Corporation

MORRIS ENGINE LATHES

In the accompanying illustration there is shown an engine lathe with what is known as a semi-enclosed headstock, which is built in 16-, 18- and 22-inch sizes by the Morris Machine Tool Co., Court and Harriet Sts., Cincinnati, Ohio. This machine is equipped with a quick-change-feed box that provides forty-five changes of feed; and threads ranging from 2 to 60 per inch, including the 11½ pipe thread, can be cut. The feeds are positive geared and twice the number of threads. When so desired, a semi-quick-change-feed box can be furnished through which four positive changes of feed are instantly obtained. With even gears on the stud and screw these feeds are 8, 16, 22, and 32 cuts per inch, and threads ranging from 2 to 30 per inch, including 11½, can be cut on a machine that is so equipped.

A complete set of change-gears is provided with each box to cut these threads. The quick-change and semi-quick-change boxes are interchangeable, and provision is made for the use of change-gears to cut special pitches or metric threads. A chasing dial is furnished as a standard equipment. For use on these machines an improved type of taper attachment can also be provided, which is said to give very satisfactory service under heavy cuts. This attachment is graduated to express tapers in degrees or in inches per

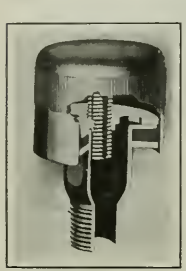
foot. It can be applied to any Morris lathe as all machines are arranged for the use of this auxiliary equipment. Provision is made for handling work up to a maximum taper of 4 inches per foot, and at a single setting of the work the 16- or 18-inch lathes will turn pieces 22 inches long, and the 22-inch lathe will turn pieces 25 inches long.



Engine Lathe built in 16-, 18-, and 22-inch Sizes by the Morris Machine Tool Co.

GARRISON GREASE CUP

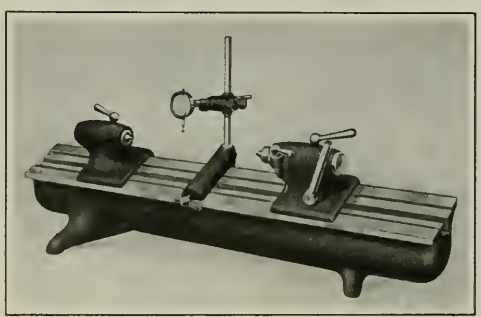
The Garrison Co., 348 George St., Bridgeport, Conn., is now manufacturing what is known as a center-thread grease cup which is made in three different sizes. This cup is adapted for use on any class of machine shop equipment where satisfactory lubrication can be accomplished with grease. Reference to the accompanying illustration will make it apparent that the actuating screw of this grease cup is contained at the center, the screw being attached to the middle of the cover so that it may enter a tapped hole in the top of the cup. In using this grease cup, the grease is placed in the cover around the screw and the cover is then pushed over the top of the body, a leather packing being provided to prevent grease from leaking out of the cup. When the cover is screwed down the grease is forced through three holes, and down through the center feed tube into the bearing. It is claimed that these cups are easy to refill, that there is a positive feed of grease to the bearing, and that there is no danger of crossing or jamming the threads on the cup.



Center-thread Grease Cup manufactured by the Garrison Co.

AMERICAN GAGE CO.'S BENCH CENTERS

The American Gage Co., Dayton, Ohio, has recently developed a set of bench centers shown in the accompanying illustration. The bed is made of box section and rests on three feet to assure a steady support, and the top face of the bed is inclined to prevent this accurately finished surface from constituting a convenient place for laying wrenches and other tools that would be likely to mar the bearing. A fine adjustment is provided for setting the indicator. These



Bench Centers made by the American Gage Co.

bench centers are made in two sizes, namely, 6 by 24 inches and 8 by 36 inches, and they are regularly furnished with an indicator reading to 0.001 inch.

* * *

A few minutes spent in properly sharpening drills saves many a broken tool, and much expense for new drills.

NEW MACHINERY AND TOOLS NOTES

Cherrying Attachment: Jackson Machine Tool Co., Jackson, Mich. An attachment for No. 5 and No. 6 Jackson duplex die-sinking machines which adapts them for the performance of cherrying operations. This attachment was developed by redesigning one originally developed for the No. 10 die-sinker of this company's manufacture.

Metal Melter: General Electric Co., Schenectady, N. Y. An electrically operated device for use in melting lead, babbitt, and similar metals. It is designated as a 25-pound electric bench pot and is intended to eliminate the loss of time and material and danger of fire, incident to the melting of metal under some conditions that are quite commonly used.

Shaper: Davis Machine Tool Co., Inc., Rochester, N. Y. Until recently the shaper built by this concern was only made with a gear-box drive, but a model has now been placed on the market which is equipped with a four-step cone pulley and double back-gears, giving eight speeds which are in geometric progression and cover a range from 10 to 115.

Double Toolpost: Connery Machine & Tool Co., 56 Harrison Ave., Springfield, Mass. A device known as the P.M.B. double toolpost which is built of heavy steel and made of simple and durable parts. A broad solid jaw clamps two tools, and an irregular hexagon-headed clamping bolt provides for securing the toolpost to the T-slot in the cross-slide of any lathe.

Direct-reading Cylinder Gage: American Machine Products Co., Marshalltown, Iowa. A cylinder gage adapted for the use of garage mechanics which serves as a substitute for an inside micrometer. While measuring a cylinder bore with this device, it is merely necessary to find one of 9 blades which fits the bore and then read the size that is stamped on that blade.

Universal Joint: R-S Mfg. Co., Kansas City, Mo. In this universal joint there is a flexible member having six lugs arranged to engage a like number of rollers mounted on the inner portion of the case. It is claimed that this arrangement combines the universal action of a ball and socket joint with the anti-friction qualities of a roller bearing. Both the rollers and the curved surfaces of the lugs are hardened and ground.

Hinge Forming Dies: Service Machine Co., Elizabeth, N. J. Dies for use in applying a new method of forming hinge members on sheet metal stamped parts. Dies of this type are applicable in automobile sheet metal shops and in numerous other establishments. Two sets of dies are used, the first of which is an ordinary blanking die while the second provides for the performance of a combination drawing and forming operation on the work.

Cut-off Slide for Screw Machine: Millholland Machine Co., Indianapolis, Ind. A power cut-off slide for screw machines of this company's manufacture. It is intended for use when the necessity arises for facing or forming while the turret tools are in operation. This cut-off slide has a simple and powerful friction drive, and an automatic stop is provided which may be tripped by either of two adjustable dogs. When necessary a hand-trip lever can also be utilized.

Grinding Machine Spindle Construction: Badger Tool Co., Beloit, Wis. A ball-bearing spindle mounting for use on the grinding machines of this company's manufacture, in which one radial bearing is employed in each housing together with an additional double row of ball thrust bearings in the left-hand housing. The bearings are fitted into indi-

vidual housings made detachable from the main body of the machine in order to obtain a high degree of accuracy.

Rolling Mill: Standard Machinery Co., Auburn, R. I. A rolling mill designed for use in producing wire and thin-gage flat metal stock. The steel rolls are hollow, and after hardening they are ground to a smooth surface. Herringbone gears transmit power to the rolls, these gears being enclosed and arranged to run in a bath of oil. A water cooling system circulating through the bodies of the rolls keeps their surfaces cool, even while the machine is running at high speed.

Round Master Blocks: Wilton Tool & Mfg. Co., 84 Linden Park St., Boston, Mass. A series of round master gage-blocks that are put up in sets comprising different combinations. For instance: One set consists of blocks varying from 0.100 to 2.000, the variations being such as to give dimensions by thousandths from 0.400 inch to 8 inches. Other sets give dimensions from 1/16 inch to 1 15/16 inches by intervals of 1/16; from 0.10 to 2.10 by tenths; and from 1 to 41 millimeters by millimeters. It is claimed that these gages are accurate to within 0.000015 inch.

Flexible Shaft: N. A. Strand & Co., 549 W. Washington Blvd., Chicago, Ill. A link-type of flexible shaft which is claimed to be so designed and constructed that wear on the joints is reduced to a minimum. Shafts of this type are made with links 1 inch in diameter, while the diameter over the case is 1½ inches. The standard length of these shafts is 7 feet and they are adapted for a maximum speed of 1750 revolutions per minute. At 400 revolutions per minute, 2-horsepower can be transmitted, and these shafts will drive a grinding wheel up to 10 by 1½ inches in size.

Inverted Drilling Machines: Foote-Burt Co., Cleveland, Ohio. Drilling machines built with inverted spindles in order to assist in clearing the chips from the hole, particularly in the case of deep-hole drilling; to facilitate the drilling of parts which are carried to the machine on a conveyor, and where it is desirable to drill the hole without having to roll over each piece of work; and to avoid difficulties sometimes experienced from breaking drills when the work is unusually tough or difficult to cut for other reasons. Machines in which this principle of design is employed are built in a variety of different styles to handle a number of classes of drilling operations.

Continuous Drilling, Boring, Turning and Facing Machines: Foote-Burt Co., Cleveland, Ohio. On these machines, applications of the so-called "continuous" principle of machining enables the operator to be constantly employed in removing finished pieces from the machine and setting up fresh blanks, while the machine is operating on another piece of work. This reduces idle time of both the machine and its operator, which is a condition of unusual importance at a time when there is an urgent demand for production and when the cost of labor is at an unprecedented level. These new Foote-Burt machines have twelve spindles and they are adapted for a wide range of work. Various machines are built on this principle for performing such operations as drilling, boring, turning, facing, etc.

Plate Bending Rolls: Joseph T. Ryerson & Son, 16th and Rockwell Sts., Chicago, Ill. A set of plate bending rolls of unusually large size, which were built by Kling Bros. Engineering Works of Chicago, Ill., and sold by Joseph T. Ryerson & Son of that city to the General American Tank Car Corporation of East Chicago, Ind. This machine is furnished with steel gears having cut teeth, and all bearings are bronze bushed. The machine measures 34 feet 2 inches between the housings, and it has sufficient capacity for bending ¾-inch mild steel plates. The top roll is 29 inches in diameter and weighs about 40 tons, while the bottom roll is 21 inches in diameter. In addition to these rolls there are two other roller supports. A rigid cast-iron sub-base supports the rolls and they have independent motors for the main drive and for power adjustment of the top roll.

* * *

MASS AUTOMOBILE PRODUCTION IN ENGLAND

English automobile manufacturers are planning quantity production, according to the American Chamber of Commerce in London. A $30,000,000 combine in the British motor industry has been effected. As a result of this combine, a new company will be formed which will be known as Harper, Bean, Ltd., and which will include many leading firms in the automobile field as well as a number of subsidiary manufacturers of electric lighting and starting sets, jigs and tools, radiators, and accessories. The amalgamation gives the new company control of the manufacture of all the component parts of automobiles. It is planned to standardize designs, and production will begin immediately at the rate of fifty cars a week increasing to 300 a week in July, 1920, to 600 in December, and rising ultimately to 2000 a week in 1923.

NON-TECHNICAL INTERESTS OF ENGINEERS

A debatable question no longer exists as to whether engineers of the country should get together in furtherance of their non-technical interests. The attitude everywhere is not whether, but how shall this end be achieved? Some engineers evidently think that a sort of super-organization of the founder societies should be brought into existence, or perhaps a federation of all societies, but an increasing number are coming to the conclusion that the end will be best accomplished by using the well-tried machinery at hand, designed for this purpose, namely that of the American Association of Engineers.

A striking omission occurs in the report of the Joint Conference Committee of the older societies, one which by its absence attracts comment throughout the rank and file of the profession, namely the neglect to refer to the fact that the work proposed to be done has already been undertaken and is well advanced by the American Association of Engineers, with a membership now larger than that of any other national society. From all parts of the United States is coming the question "Why has the Joint Conference Committee's report been silent on this vital question?"

In answer to this question and in the firm belief that the rank and file of the profession are waiting for such an announcement, the secretary of the American Association of Engineers on December 20, 1919, addressed the following letter to the governing bodies of the founder societies:

> The development of the opinion in the founder societies in favor of giving attention to the non-technical side of the engineer's life has led several members of each to ask the American Association of Engineers to write simultaneously to the governing bodies of these societies offering its service in problems of public and professional welfare and asking their cooperation.
>
> We have read the report of the Joint Conference Committee and believe that the American Association of Engineers, a successful going organization, is capable of carrying forward the non-technical activities recommended in the report fully as well and perhaps better than the organization recommended by the conference report. The activities of the American Association of Engineers are confined to social and economic problems such as legislation, employment, compensation, political and civic endeavor. The association takes in everyone of good character in the engineering profession and seeks to mobilize all engineers for joint action. It gets its support from the man back home without any intermediate representation so that it is able to do the things that lie close home and that make living as an engineer worth while.
>
> If the founder societies elect to cooperate with the American Association of Engineers in the work it is doing and in similar non-technical activities, it would be our understanding that such support would not be financial and would in no way interfere with present prerogatives and privileges of the founder societies.
>
> C. E. Drayer
> Secretary, American Association of Engineers, Chicago, Ill.

* * *

GUARANTEES AGAINST DECLINE IN PRICES

The Federal Trade Commission has announced that the question of guarantee against decline in price has been the subject of so many complaints before the commission, and opinions seem to be so diverse, that the commission has determined to go into the whole matter thoroughly. Therefore, producers, manufacturers, merchants, dealers, and consumers are invited to state their opinion in writing to the commission. Later, it is the purpose to call a general hearing at Washington, at which interested people may be present in person or be represented by counsel. Letters have been sent out to various associations and manufacturing concerns, inviting cooperation in determining the policy to pursue in regard to the question of guarantee against price decline.

* * *

A booklet has been published by the National Civil Service Reform League, 8 W. 40th St., New York City, containing recommendations for improvements in the foreign service of the United States, with a view to providing the commerce and industry of the nation with adequate assistance on the part of the Government in establishing and maintaining trade relations on a basis which will make it possible to compete successfully with other nations in the foreign markets. In order to gain this end, it is proposed to require definite standards for eligibility to our consular and diplomatic services and to make the consular service such that the business interests may be adequately served by it.

Terms Used in Export Trade

Owing to the confusion that often arises due to misinterpretation of the terms and abbreviations used in export trade, and the consequent trade disagreements, a conference of leading national trade organizations recently was held in New York City, at which definitions of export terms were adopted and general recommendations made for a standard American export practice. The associations participating in the adoption of these definitions and standards are: the National Foreign Trade Council, the Chamber of Commerce of the United States of America, the National Association of Manufacturers, the American Manufacturers' Export Association, the Philadelphia Commercial Museum, the American Exporters' and Importers' Association, the Chamber of Commerce of the State of New York, the New York Produce Exchange, and the New York Merchants' Association.

THE leading national trade organizations recommended as the most certain means of insuring that no mistakes be made in terms and conditions of sale, that manufacturers and exporters abandon the use of all abbreviated forms in export price quotations and write out the terms in full. It is believed, however, that this recommendation is not likely to be accepted generally at once, and, therefore, in the hope of effecting a simplification of standards of American practice, it has been decided by these national trade organizations to adopt certain definitions of the abbreviated forms in more general use in the export trade.

It is understood that unless a particular railroad or other transportation facility is specified, the shipper will deliver the goods to be sold at the carrier most conveniently located to him. If the buyer desires the goods to be delivered to a carrier further removed from the shipper and entailing a greater cost than delivery to the carrier most favorably situated, the carrier to which the buyer desires delivery of the goods, should be named in the quotation.

There are, ordinarily, ten different conditions upon which the sales contract may be based. Each of these will be taken up in detail and the terms involved under each heading, explained. The following five abbreviations are those most commonly used in export quotations:

F. O. B. ..... Free on board
F. A. S. ..... Free alongside ship
C. & F. ..... Cost and freight
C. I. F. ..... Cost, insurance and freight
L. C. L. ..... Less than carload lot

F. O. B. (Named Point)

This term is used when the price quoted applies only at inland shipping point and the seller merely undertakes to load the goods on or in cars or lighters furnished by the railroad company serving the industry, or most conveniently located to the industry, without other designations as to routing.

Under this quotation the seller must (1) place goods on or in cars or lighters; (2) secure railroad bill of lading; and (3) be responsible for loss or damage until goods have been placed in or on cars or lighters at forwarding point, and clean bill of lading has been furnished by the railroad.

The buyer must (1) be responsible for loss or damage incurred thereafter; (2) pay all transportation charges including taxes, if any; and (3) handle all subsequent movement of the goods.

F. O. B. (Named Point) Freight Prepaid to (Named Point) on the Seaboard

This term is used when the seller quotes a price including transportation charges to the port of exportation without assuming responsibility for the goods after obtaining a clean bill of lading at point of origin.

Under this quotation the seller must (1) place goods on or in cars or lighters; (2) secure railroad bill of lading; (3) pay freight to named port; and (4) be responsible for loss or damage until goods have been placed in or on cars or lighters at forwarding point, and clean bill of lading has been furnished by the railroad company.

The buyer must (1) be responsible for loss or damage incurred thereafter; (2) handle all subsequent movement of the goods; (3) unload goods from cars; (4) transport goods to vessels; (5) pay all demurrage or storage charges; and (6) arrange for storage in warehouse or on wharf where necessary.

F. O. B. (Named Point) Freight Allowed to (Named Point) on the Seaboard

This term is used where the seller wishes to quote a price, from which the buyer may deduct the cost of transportation to a given point on the seaboard, without the seller's assuming responsibility for the goods after obtaining a clean bill of lading at point of origin.

Under this quotation the seller must (1) place goods on or in cars or lighters; (2) secure railroad bill of lading; and (3) be responsible for loss or damage until goods have been placed in or on cars or lighters at forwarding point, and clean bill of lading has been furnished by the railroad company.

The buyer must (1) be responsible for loss or damage incurred thereafter; (2) pay all transportation charges (buyer is then entitled to deduct from the amount of the invoice the freight paid from primary point to named port); (3) handle all subsequent movement of the goods; (4) unload goods from cars; (5) transport goods to vessel; (6) pay all demurrage or storage charges; and (7) arrange for storage in warehouse or on wharf where necessary.

F. O. B. Cars (Named Point) on Seaboard

This term is used when the seller desires to quote a price covering the transportation of the goods to seaboard, assuming responsibility for loss or damage up to that point.

Under this quotation the seller must (1) place goods on or in cars; (2) secure railroad bill of lading; (3) pay all freight charges from forwarding point to port on seaboard; and (4) be responsible for loss or damage until goods have arrived in or on cars at the named port.

The buyer must (1) be responsible for loss or damage incurred thereafter; (2) unload goods from cars; (3) handle all subsequent movement of the goods; (4) transport goods to vessel; (5) pay all demurrage or storage charges; and (6) arrange for storage in warehouse or on wharf where necessary.

F. O. B. Cars (Named Port) L. C. L.

This term is used when the goods, on which a price is quoted covering the transportation of the goods to the seaboard, constitute less than a carload lot.

Under this quotation the seller must (1) deliver goods to the initial carrier; (2) secure railroad bill of lading; (3) pay all freight charges from forwarding point to port on seaboard; and (4) be responsible for loss or damage until goods have arrived on cars at the named port.

The buyer must (1) be responsible for loss or damage incurred thereafter; (2) handle all subsequent movement of the goods; (3) accept goods from the carrier; (4) transport goods to vessel; (5) pay all storage charges; and (6) arrange for storage in warehouse or on wharf, if necessary.

F. O. B. Cars (Named Port) Lighterage Free

This term is used when the seller quotes a price which will include the expense of transportation of the goods by rail to the seaboard, including lighterage.

Under this quotation the seller must (1) place goods on or in cars; (2) secure railroad bill of lading; (3) pay all transportation charges to, including lighterage at, the port named; and (4) be responsible for loss or damage until goods have arrived on cars at the named port.

The buyer must (1) be responsible for loss or damage incurred thereafter; (2) handle all subsequent movement of the goods; (3) take out the insurance necessary to the safety of the goods after arrival on the cars; (4) pay the cost of hoisting goods into vessel where weight of goods is too great for ship's tackle; and (5) pay all demurrage and other charges, except lighterage charges.

F. O. B. Vessel (Named Port)

This term is used when the seller desires to quote a price covering all expenses up to and including delivery of the goods upon the overseas vessel at a named port.

Under this quotation the seller must (1) meet all charges incurred in placing goods actually on board the vessel; and (2) be responsible for all loss or damage until goods have been placed on board the vessel.

The buyer must (1) be responsible for loss or damage thereafter; and (2) handle all subsequent movement of the goods.

F. A. S. Vessel (Named Port)

This term is used when the seller desires to quote a price covering delivery of the goods alongside overseas vessel and within reach of its loading tackle.

Under this quotation the seller must (1) transport goods to seaboard; (2) store goods in warehouse or on wharf if necessary, unless buyer's obligation includes provision of shipping facilities; (3) place goods alongside vessel either in a lighter or on the wharf; and (4) be responsible for loss or damage until goods have been delivered alongside the ship or on wharf.

The buyer must (1) be responsible for loss or damage thereafter, and for insurance; (2) handle all subsequent movement of the goods; and (3) pay cost of hoisting goods into vessel where weight of goods is too great for ship's tackle.

C. & F. (Named Foreign Port)

This term is used when the seller is ready to go further than the delivery of his goods upon the overseas vessel and is willing to pay transportation to a foreign point of delivery.

Under this quotation the seller must (1) make freight contract and pay transportation charges sufficient to carry goods to agreed destination; (2) deliver to buyer or his agent proper bills of lading to the agreed destination; and (3) be responsible for loss or damage until goods have been delivered alongside the ship and clean ocean bill of lading obtained (seller is not responsible for delivery of goods at destination).

The buyer must (1) be responsible for loss or damage thereafter and must take out all necessary insurance; (2) handle all subsequent movement of the goods; (3) take delivery and pay costs of discharge, lighterage and landing at foreign port of destination in accordance with bill of lading clauses; and (4) pay foreign customs duties and wharfage charges, if any.

C. I. F. (Named Foreign Port)

This term is used when the seller desires to quote a price covering the cost of the goods, the marine insurance on the goods, and all transportation charges to the foreign point of delivery.

Under this quotation the seller must (1) make freight contract and pay freight charges sufficient to carry goods to agreed destination; (2) take out and pay for necessary marine insurance; (3) be responsible for loss or damage until goods have been delivered alongside the ship, and clean ocean bill of lading and insurance policy have been delivered to the buyer, or his agent. (Seller is not responsible for the delivery of goods at destination, nor for payment by the underwriters of insurance claims); and (4) provide war risk insurance, where necessary for buyer's account.

The buyer must (1) be responsible for loss or damage thereafter, and must make all claims to which he may be entitled under the insurance directly on the underwriters; (2) take delivery and pay costs of discharge, lighterage and landing at foreign port of destination in accordance with bill of lading clauses; and (3) pay foreign customs duties and wharfage charges, if any.

The National Foreign Trade Council, India House, Hanover Square, New York City, will furnish exporters any further information on this subject upon application.

* * *

POWER TRANSMISSION BY STEEL BELTS

Thin flat steel belts are now being extensively used in England for power transmission purposes, with results, it is claimed, which go to prove that such belts can transmit much more power for the same width than those made of other materials, and that they are not affected to any appreciable extent by temperature changes, or changes in the humidity of the air, which adapts them for use in damp places, as there is little stretching or slipping. It is claimed that power for power the weight is about one-sixth that of leather or rubber belts. The thickness of steel belts varies from 0.2 to 0.9 millimeter and the width from 12 to 200 millimeters.

The material used is a carefully hardened charcoal steel, rough-rolled at a red heat, and then brought up to final size by cold working. The tensile strength of the finished material is about 95 tons to the square inch. The edges are rounded and finely finished, thus enabling the belt to be safely handled. The elasticity remains unimpaired with use, and speeds as high as 10,000 feet per minute are possible. From the foregoing facts it is evident that power transmission by steel belts is a matter for serious consideration, and some discussion regarding its application should prove of interest.

The belts are supplied by Steel Belts, Ltd., Falkland Works, Manchester, England, and during a period of over six years they have fitted a large number of installations throughout the country, in works where steadiness and uniformity in running are essential. They are also being extensively applied in rolling mills and cement works, where great variation in load is encountered. The conditions under which steel belts can be satisfactorily applied are more exacting than those required by rope or leather belt drives, but it is said that a considerable gain in efficiency results. Shafts, bearings and pulleys for steel belts must be of solid construction. The shafts must be parallel and the pulleys must run true. With steel belt transmission, it is necessary that the pulley face be flat; this is owing to the fact that if the pulley were crowned, the center of gravity of the joint clip would be slightly raised from the pulley every time the clip ran on the latter, thus causing an impact, which would become greater as the belt speed is increased or the diameter of the pulley reduced. The stress caused by this blow would be thrown mainly on the middle of the belt, and this would cause gradual deterioration of the material at this point and ultimate fracture. As power for power the steel belt is only one-third the width of an equivalent leather belt, the use of specially designed narrow and correspondingly stronger pulleys enables considerable saving in weight to be made, particularly in the case of large diameters. The material is practically static, the limits of contraction and expansion being only 1/32 inch to the yard, so that the tension for any particular power or width can be exactly determined. Thus, when the belt is properly mounted it should require no further attention.

A typical steel belt drive installed in a large cotton spinning mill near Halifax consists in part of an engine drum, which is an ordinary grooved, rope-driving drum, 16 feet in diameter, adapted at one side for steel belt power transmission. A casing carries the belts to the belt-race, at a center distance of 96 feet. Two belts are employed, each 8 inches in width. These two belts transmit 500 horsepower. The driven pulley is 4 feet 5¼ inches in diameter and makes 300 revolutions per minute. From the driven shaft power is transmitted to four floors by perpendicular drives also employing steel belts.

Adapting Rope-driving Pulleys for Steel Belts

Converting from rope drive to steel belt drive is a comparatively simple matter. The rope-driving pulleys are converted by shrinking a steel band round the pulley rim, which is done in the following manner: A section is cut out across the top of the grooves in the pulley into which a joint plate is placed. The steel band is then prepared, being cut short by an amount suitable to give the requisite tension when jointed. A number of screw holes are drilled and countersunk in each end to correspond with similar tapped holes in the joint plate. Two tapping holes are also drilled at a short distance from each end of the belt, for the purpose of attaching a turnbuckle cramp to draw the ends together round the pulley. The band is placed in position, the cramp attached ready to draw the ends together, which is done after first slightly heating the band below the cramp at each end, using a Bunsen flame for this purpose. The band can then be easily drawn together, owing to expansion taking place, thus allowing the screws to be inserted. Contraction ensues on cooling off, and the pulley is tightly gripped. The cramp is removed, and the heads of the screws and the joint soldered over, thus giving a continuous band.

Steel belts can be run metal-to-metal or on a smooth surface, but after a time there is a tendency to polish the pulley; therefore it is found desirable, in order to prevent any possible slip, to give the pulley rim a friction coating. This is done by cementing a canvas band on the outer face of which thin sheets of cork are glued. To avoid stripping this covering under variable load, the face of the pulley is first prepared with a series of serrations made by a rough file or chisel.

Fitting and Jointing the Belt

The steel belt is now ready to be fitted. Its length is determined by means of a special calibrating instrument. A light steel tape is placed over the pulleys and subjected to a predetermined tension, the overlaps of the ends of the measuring bands are then cut off, the tension being released, and the remaining length is the correct measurement to which the unstrained driving belt must be cut.

A special form of joint is provided which insures durability at that point. It consists of a top and bottom clamping plate curved to suit the pulley profile. The top plate has extension surfaces of suitable curvature, from which the metal belt may ride off on transition from the straight path to the circular path around the pulley; the bottom plate is composed of two short, thin, wedge-shaped pieces. The belt is placed over the pulleys, drawn together by cramps and V-headed screws inserted through suitably prepared holes in the plates and the belt. The screws are, after insertion, soldered over on the heads and riveted on the inside and filed smooth, the drive being thus completed. It is said that the whole conversion of a complete rope drive to a steel belt drive, such as the one described, can be carried out between a Saturday noon and starting time on Monday morning.

The Life of Steel Belts

Steel driving belts have now been in operation for over six years, and tests made of the belts first fitted show no signs of deterioration. It seems evident, therefore, that the life of the steel belt is long. In calculating and constructing metal belt gearing, consideration is given to the fact that the metal belt to be employed is subjected to a flexure constantly varying from zero to a maximum, that is, from the straight path to the greatest amount of curvature when passing over the pulleys. To insure durability with such a demand, it is not sufficient for the belts to be calculated in the usual manner—that is, so that the greatest bending stress which occurs is below the limit of fracture of the material. As a result of extensive researches it is claimed that a fracture of the belt can be avoided, if the varying demand upon its flexibility is kept so low that the maximum demand does not attain half the value of the limit of fracture.

The Efficiency of Steel Belts

An efficiency in power delivery of 99 to 99½ per cent is claimed for steel belts. A steel belt does not stretch by use, as has been proved by six years' experience; and as there is no measurable slip, it naturally follows that the transmission is uniform. These features make the belts particularly suitable for perpendicular drives. The distance of the centers is optional to a great extent, depending on the speed. Where space is cramped and the drives run to various floors, steel belts can often be used to advantage. In cases where the pulleys are limited in size it is often possible to obtain an increase in power transmitted by the substitution of steel belts, without any further rearrangement.

With ordinary care steel belts are safe, as in case of fracture the belts will not fly but fall between the shafts. As the edges are rounded they may be handled while running. It is only in isolated cases that fracture occurs, and this is invariably due to a flaw in the material, which will show itself, should it exist, within the first eight weeks of running; after that time it is a practical certainty that the belt is free from flaw.

* * *

RAILWAY CAR AXLE DESIGN

In the article on the design of railway car axles, in the February number of MACHINERY, it is stated on page 499 that an axle 4¼ by 8 inches, having a load capacity of 22,000 pounds is required. According to the dimensions given in the table, this axle has a section modulus of 16.3. However, the 4¼ by 8-inch axle with a load capacity of 18,000 pounds would be sufficient, this axle, according to the dimensions given, having a section modulus of 12.25. The reason why this latter axle would be sufficient in this case is that the wheel diameter in the problem is only 26 inches, whereas the axle having a capacity of 22,000 pounds is suitable for a wheel 33 inches in diameter. Therefore, while the load is 20,000 pounds, the strain on the axle is lessened by reducing the size of the wheel and thereby the lever arms, so that the strain would not be as great as for a 33-inch wheel.

* * *

The Interstate Commerce Commission reports that the increases in freight and passenger rates during federal control up to July 31, 1919, amounted to $1,835,000,000, while the increases in wages to the employes amounted to $1,774,800,000 during the same period. In other words, 97 per cent of the revenue from the increased rates went to paying increases in wages. The British Railway Administration has announced that new freight rates are to be put into force, showing increases of from 25 to 100 per cent on present charges. These increases are made necessary by the increases in wages granted to the British railway employes.

* * *

The headquarters for the Rhodes scholarship in the United States from now on will be at the Massachusetts Institute of Technology, Cambridge, Mass. Professor Aydelotte of that institution, duly appointed secretary to the Rhodes scholars throughout the United States, will devote all his efforts during the present academic year to the selection of men from the American universities who are to be sent to Oxford College.

PROPOSED MERGER OF THE SOCIETIES FOR STEEL TREATING

If the recommendations contained in a report of the joint committee from the American Steel Treaters Society and the Steel Treating Research Society, become effective, these two organizations will be merged and known as the American Society for Steel Treating. It is proposed to incorporate the organization under the state laws of Ohio, and to establish headquarters in Cleveland. Briefly stated, the object of the new society will be to promote the arts and sciences connected with the treatment of iron and steel. The amalgamation committee which has recommended the proposed merger is headed by Lieutenant-Colonel A. E. White, professor of chemical engineering, University of Michigan. The remaining personnel of the committee is composed of three members of each of the two merging societies.

* * *

GOVERNMENT NEEDS DRAFTSMEN

The United States Civil Service Commission announces that the Government is in need of a large number of draftsmen. It is stated that fully 1000 draftsmen were appointed in the Government service during the last calendar year. During this period of reconstruction technical men are especially needed. Besides draftsmen, there are openings for surveyors and computers, as well as assistant and associate engineers—electrical, mechanical, civil, chemical and ceramic. Further information and application blanks may be obtained from the secretary of the United States Civil Service Board at Boston, New York, Philadelphia, Atlanta, Cincinnati, Chicago, St. Paul, St. Louis, New Orleans, Seattle, and San Francisco, or from the United States Civil Service Commission, Washington, D. C.

* * *

MOTION PICTURES AS AN AID IN SELLING MACHINERY

The Merchants & Manufacturers Exchange of New York has provided a motion picture theater on the tenth floor of the Grand Central Palace for the use of the exhibitors in the permanent international exposition of industries which is housed in the building. After having shown to buyers the machine exhibited on one of the floors of the palace, the exhibitor may ask his visitors to the motion picture theater for a demonstration of the machine in action in a factory. It is expected that the use of motion pictures will be helpful to exhibitors, as the value of motion pictures, especially in the selling of heavy machinery, is well recognized. The industrial applications of the motion pictures are becoming more numerous every day, as their value is being realized.

* * *

MATERIAL HANDLING MACHINERY MANUFACTURERS ASSOCIATION

On page 556 of the February number of MACHINERY it was mentioned that the Material Handling Machinery Manufacturers Association held its annual meeting January 29 and 30. As a matter of fact, the meeting held on those dates was only a meeting of the executive committee and the board of governors of the association, while the annual convention was held February 26 and 27 at the Waldorf-Astoria Hotel, New York City.

* * *

MORSE CHAIN CO. ON PROFIT-SHARING PLAN

The Morse Chain Co., Ithaca, N. Y., has inaugurated a profit-sharing plan according to which the company will pay in October of each year to every worker who has been in the company's employ one year or more, a dividend on his wages, averaged as if the wages had been invested in the company's business and at the same rate as drawn by the stockholders on the company's investment. In addition, the company proposes to establish what is known as a service store where all employes may purchase goods at cost.

PERSONALS

R. L. WILSON, formerly general superintendent of the East Pittsburg works of the Westinghouse Electric & Mfg. Co., has been made works manager.

A. A. SIAMIESKI has been appointed assistant general manager of the Jackson Screw Products Co., Inc., Jackson, Mich., to take the place of V. L. Curren.

E. G. MIDDLETON has been appointed advertising manager of the Colburn Machine Tool Co., Franklin, Pa., manufacturer of vertical boring mills and heavy-duty drilling machines.

E. R. NORRIS has been appointed director of works equipment of the Westinghouse Electric & Mfg. Co., East Pittsburg, Pa., in charge of machinery, tools, and methods in the various plants.

J. D. APGAR, formerly of the Machine Tool Engineering Co., of New York City, has joined the sales force of the Van Norman Machine Tool Co., Springfield, Mass., as a direct representative in the New York office, 320 Fifth Ave.

A. A. ROELOFS, formerly special representative in the Ohio territory, of the Precision & Thread Grinder Mfg. Co., Philadelphia, Pa., manufacturer of the multi-graduated precision grinder, has been made manager of the Chicago office.

DEAN B. COBB has started a drafting and blueprinting business at 265 Main St., West Haven, Conn. Mr. Cobb would like to have his name placed on the mailing lists of manufacturers who are interested in the electrical and mechanical field.

ALEXANDER TAYLOR, for many years manager of works of the Westinghouse Electric & Mfg. Co., East Pittshurg, Pa., has been made assistant to the vice-president in general charge of production, stocks, and stores in all the Westinghouse plants.

W. V. HOUCK, formerly factory manager of the Buffalo Metal Goods Co., Buffalo, N. Y.—a subsidiary plant of the General Motors Corporation—has become vice-president and general manager of the O'Neil Iron Works, Inc., 268 Perry St., Buffalo, N. Y.

JOHN E. HUBBELL, counsellor at law and solicitor of patents, formerly located at Chambers and Hubbell Sts., Philadelphia, Pa., has opened offices at 469 Fifth Ave., New York City, where his practice will be devoted to patent and trademark matters exclusively.

WILLIAM R. GUMMERE, who represented the Independent Pneumatic Tool Co. for a number of years in Cleveland, Ohio, has again become affiliated with the company and is now connected with the Pittsburg branch, which is under the management of Harry F. Finney.

C. J. STILWELL, foreign sales manager of the Warner & Swasey Co., Cleveland, Ohio, sailed for Europe, January 21, with the intention of visiting England, France, Belgium, Holland and other countries in the interest of the company. Mr. Stilwell will be gone about three months.

J. G. MILES has been appointed supply division manager of the Seattle office of the Westinghouse Electric & Mfg. Co., East Pittsburg, Pa., succeeding C. V. Aspinwall who is now located at Spokane, Wash. Mr. Miles has been associated with the supply department of the company for many years.

F. RODGER IMHOFF, New England representative of the Precision & Thread Grinder Mfg. Co., Philadelphia, Pa., has recently been made field engineer. He will make his headquarters in Detroit, Mich., and will cover the entire country in the interest of the multi-graduated precision grinder.

E. R. WOOD, formerly with the selling organization of Sherritt & Stoer, Philadelphia, Pa., has joined the sales force of Alfred Herbert, Ltd., 54 Dey St., New York City, and will represent that company in the New York district in the sale of imported and domestic machine tools and supplies.

C. D. PORTERFIELD, who formerly represented the Colonial Steel Co. in the New York territory, has recently joined the sales force of Alfred Herbert, Ltd., 54 Dey St., New York City, and will handle the steel and small tool lines of the company in the metropolitan district and in New York State.

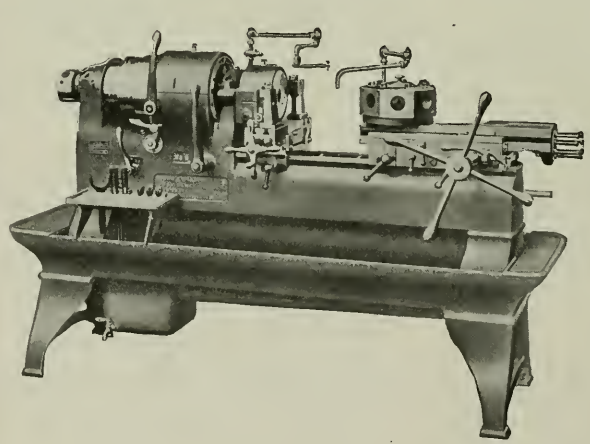
ROBERT G. PILKINGTON has been appointed experimental engineer by the Wahl Co., Chicago, Ill. His duties will consist of the consideration of the methods, materials, and designs to be used in connection with the adding machines, "Eversharp" pencil, and fountain pen made by this company.

B. C. SAUNDERS, who was recently sales manager of the Wilmarth & Morman Co., Grand Rapids, Mich., has purchased an interest in the Grand Rapids Grinding Machine Co. and become associated in the active management of the business. At the last annual meeting he was elected secretary and sales manager.

—the small helps make

Put those small, quick set-up jobs on a reduced time basis—jobs too small to warrant much set-up time, yet requiring rapidity and accuracy in production. The time- and labor-saving features, the real production boosters, are the winning points that speak for

Brown & Sharpe
Wire Feed Screw Machines



We cover a range that is adequate to meet the broad demands of the shop. There are five different sizes from which you can select—our Catalog 22G shows the entire line and describes the many details of construction that interest the manufacturer.

Brown & Sharpe
Providence

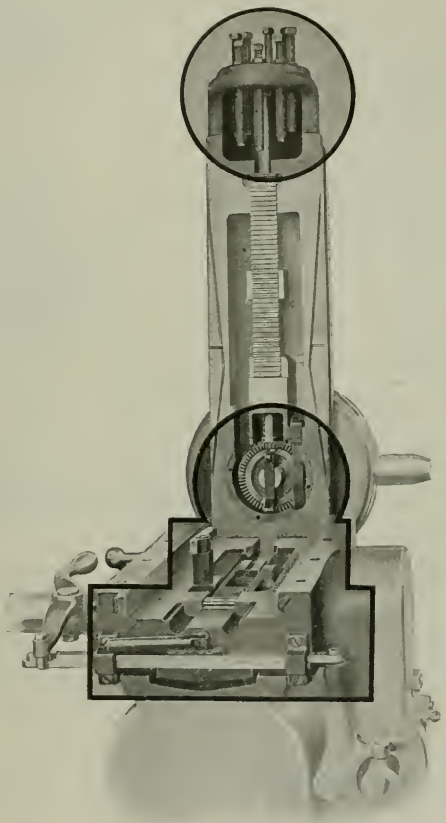
the big savings

Turret Slide Features

The disc shown in circle carrying individual stop screws—one for each turret position, obviates setting each tool exactly. In addition to a positive lock by means of a taper pin which aligns the turret holes with the spindle, the larger machines are automatically clamped as the turret is moved forward by a tapered bushing which is controlled by the rocker arm shown in the centre of the large bevel gear.

The transverse and vertical adjustment for alignment is by means of the adjustable taper gibs shown in cut.

Combine these many small helps and labor-saving features with the rugged construction and practical design and the reason for Brown & Sharpe preference is evidenced.



Mfg. Co.

R. I., U. S. A.

CHARLES EISLER has become associated with the Newark Engineering & Tool Co., Newark, N. J., as consulting engineer and vice-president. Mr. Eisler's specialty is incandescent lamp-making machinery, and he was for many years connected with the Westinghouse Lamp Co. He recently completed a lamp factory for the Save Electric Corporation.

GEORGE W. CHILDS has started a consulting engineering business at 701 Crozer Bldg., Chester, Pa. The field covered by Mr. Childs will include power transmission; rolling mill, cotton mill, and dredging machinery; machine tools; tools, jigs and fixtures; foundry and sand-blast equipment; ship construction; seacoast and artillery material; and the development of inventions.

R. A. DEMEILLERS, formerly chief tool designer with the New Process Specialty Co., Milwaukee, Wis., has become associated with the Gould & Eberhardt Co., Newark, N. J. in the capacity of tool supervisor of all the Gould & Eberhardt plants. Previous to his connection with the New Process Specialty Co., Mr. Demeillers was chief tool engineer of the Wallis Tractor Co., Racine, Wis.

FRANK L. WALTER, for the last eight years head of the designing department and master mechanic of the Dayton Engineering Laboratories Co., and for six years previous in the National Cash Register Co.'s tool designing department, has entered into business at 520-530 Lindsay Bldg., Dayton, Ohio, under the name of Walter Engineering Co., and will design and build special machinery and tools of all kinds.

V. C. KYLBERG, who was formerly assistant chief of the machine tool section of the Office of the Director of Sales, War Department, Washington, D.C., left this position on February 1, and has not yet definitely announced his plans for the future. Mr. Kylberg entered the machine tool section organized in March, 1919, and was largely responsible for many of the policies and practices adopted by this section, which later resulted in large sales of government-owned machine tools.

A. R. PETTERSON, formerly with the engineering department of the Osgood Bradley Car Co., of Worcester, Mass., is now chief engineer and director of production with the Allen Spindle Corporation, Boston, Mass. Previous to his connection with the Osgood Bradley Car Co., Mr. Petterson was president and general manager of the Petterson Engineering & Mfg. Co., designer and builder of special machinery, tools, and jigs.

F. J. MAWBY, formerly with the sales force of Manning, Maxwell & Moore, Inc., New York City, has become a member of the sales organization of the Cincinnati Shaper Co. and the Cincinnati Gear-cutting Machine Co., Cincinnati, Ohio. During the war Mr. Mawby was engaged in engineering work in connection with the equipping of shops for making ammunition, guns, and gun carriages for both the United States and foreign governments, and was responsible for the development of a number of special machines for the rapid production of fuses.

G. M. EATON has been appointed chief mechanical engineer of the Westinghouse Electric & Mfg. Co., East Pittsburg, Pa. C. W. JOHNSON and H. W. COPE have been made assistant directors of engineering; C. H. CHAMPLAIN and E. S. MCCLELLAND, assistant works managers; JOHN E. BONHAM, assistant to works manager; and E. S. BRANDT, supervisor of equipment and methods. A. M. DUDLEY has been appointed manager of the automobile equipment department; R. P. JACKSON, manager of the material and process department; F. E. WYNNE, manager of the railway equipment department, and G. H. GARCELON, manager of the small motor department. C. B. AUEL has been made manager of the employes service department.

JOSEPH E. VINCENT, JR. has been appointed eastern sales representative of the Massillon Steel Castings Co., Massillon, Ohio, manufacturer of all kinds of steel castings, particularly those used in the automotive and railroad industries. Mr. Vincent is the owner and general manager of the Iron, Steel, Metal & Alloy Co., and also represents the Peerless Drawn Steel Co. and the Schwart-Herrmann Steel Works, Inc. He is located at 55 Liberty St., New York City, and in addition to the New York office a branch is maintained at 120 Franklin St., Boston, Mass., in charge of C. H. Dayton. It is the intention to open an office within the near future in Philadelphia to take care of the trade in Pennsylvania, Delaware, and Maryland.

OBITUARIES

JOHN NAZEL of the Nazel Engineering & Machine Works, Philadelphia, Pa., died at his home in Philadelphia, February 16.

PHILIP JOSEPH MCGUIRE, chief production manager of the Walter A. Wood Mowing & Reaping Machine Co., Hoosick Falls, N. Y., died February 14, from pneumonia, after a brief illness. Mr. McGuire had been connected with the company for fourteen years.

HAROLD MCGILL DAVIS, manager of the advertising department of the Sprague Electric Works of General Electric Co., New York City, died February 9 at his home in Brooklyn, N. Y., after an illness of about three weeks. He was born in Jerseyville, Ill., in August 1860. For four years he was advertising manager of a trade paper in New York and afterward became connected with an advertising agency, which he left to take the position occupied at the time of his death.

JOSEPH M. FLANNERY died February 17, at his home in Pittsburg, Pa. Mr. Flannery was one of the earliest users of vanadium in the manufacture of steel, and the first to produce radium in this country. During the war he supplied the Allies with radium for medical and other uses. He was president of the Standard Chemical Co. and of the Vanadium Chemical Co., and was also instrumental in the organization of several other companies, among which were the Flannery Bolt Co., the American Vanadium Co. and the Rosanoff Process Co.

KATHRYNE M. HAUN, treasurer of E. F. Houghton & Co., Philadelphia, Pa., died February 9, at her home in Philadelphia after a short illness from pneumonia. Miss Haun was born in Philadelphia in 1876. She had been associated with E. F. Houghton & Co. for twenty-five years, having entered the employ while still but a girl in a minor capacity, from which she rose by successive stages. When the company was incorporated in 1910 she was selected as the treasurer. She was one of the largest stockholders in the concern, which is engaged in the manufacture of industrial oils and leather goods.

COMING EVENTS

March 6-13—Second annual aeronautical exposition, held by the Manufacturers' Aircraft Association, Inc., 501 Fifth Ave., New York City, in the Seventy-first Regiment Armory, Thirty-fourth St. and Park Ave., New York City.

March 9-11—First Annual New England Industrial Accident Prevention Congress, held at Hotel Bancroft, Worcester, Mass.

March 25—Monthly meeting of the Rochester Society of Technical Draftsmen, in Rooms 131-137 Sibley Block, 328 Main St., E., Rochester, N. Y. Secretary, O. L. Angevine, Jr., 547 Arnett Blvd., Rochester, N. Y.

April 19-22—Convention of the National Metal Trades Association at New York City; headquarters, Hotel Astor. Secretary, Homer D. Sayre, Peoples Gas Bldg., Chicago, Ill.

May 12-15—Seventh national foreign trade convention in San Francisco, Cal. Secretary of the National Foreign Trade Council, O. K. Davis, 1 Hanover Square, New York City.

May 20-21—Spring convention of the National Machine Tool Builders' Association at Atlantic City, N. J.; headquarters, Hotel Traymore. Secretary, Charles E. Hildreth, Worcester, Mass.

May 24-27—Spring convention of the American Society of Mechanical Engineers at St. Louis, Mo.; headquarters, Hotel Statler. Secretary, Calvin W. Rice, 29 W. 39th St., New York City.

October 4-9—Annual convention and exhibit of the American Foundrymen's Association at Columbus, Ohio.

SOCIETIES, SCHOOLS AND COLLEGES

Grove City College, Grove City, Pa. Bulletin containing catalogue for 1919-1920 with calendar and courses of study for the year.

Harvard University, Cambridge, Mass. Official register of the Harvard Engineering School for 1919-1920, containing calendar and courses of study.

United Engineering Society, 29 W. 39th St., New York City. Publication containing report of the Engineering Foundation, covering the organization, by-laws, policies, and work which it has accomplished.

BOOKS AND PAMPHLETS

Annual Report of the Smithsonian Institution for 1917. 674 pages, 6 by 9 inches. Published by the Smithsonian Institution, Washington, D. C.

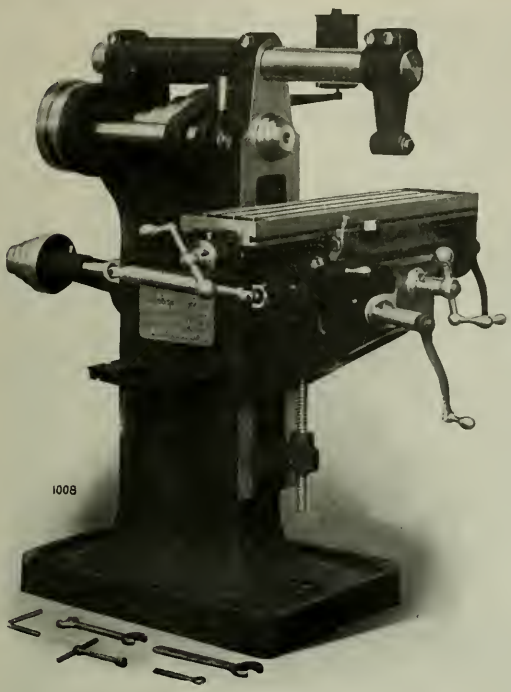
Specifications for the Manufacture and Installation of Railroad Track Scales. 35 pages, 7 by 10 inches. Published by the Department of Commerce, Washington, D. C., as Circular No. 83, of the Bureau of Standards. Price, 5 cents.

Proceedings of the Twenty-seventh Annual Convention of the Traveling Engineers' Association, held in Chicago, Ill., September 16 to 19, 1919. 366 pages, 5½ by 8½ inches. Edited by W. O. Thompson, secretary, Cleveland, Ohio.

Properties of American Bond Clays and Their Use in Graphite Crucibles and Glass Pots. By A. V. Bleiniger. 52 pages, 7 by 10 inches. Published by the Department of Commerce, Washington, D. C., as Technologic Paper No. 144 of the Bureau of Standards. Price, 10 cents.

Developing a Gaging System for Interchangeable Manufacture. 55 pages, 6 by 9 inches; 72 illustrations. Published by the Pratt & Whitney Co., Hartford, Conn.

This book is an abstract of a series of articles by Erik Oberg, published in MACHINERY, describing the principles involved and the procedure followed in the development of a gaging system for interchangeable manufacture, based upon the experience of the Pratt & Whitney Co. in furnishing gaging equipment for small arms and heavy ordnance work. While the gaging systems described were designed particularly for arsenals, it is evident that the principles laid down are applicable to interchangeable manufacture of any kind.



Back Geared.
Screw Feed.
Hand Quick Return.
Crank Handles for All Movements.
Wide Speed Range—21 to 500 r. p. m.
Power Longitudinal Feed.
Range—18" x 6" x 15".

Why Not Get Acquainted!

The 18" Back Geared Cincinnati Plain Miller, for work in its field, will prove equally as profitable as the well-known Cincinnati High Power and Cincinnati Automatic Millers.

Built with
The same painstaking workmanship.
The same complete jigging and tooling.
The same exact gauges and inspection standards.

It will pay to get acquainted. Write now.

THE CINCINNATI MILLING MACHINE CO.
CINCINNATI **OHIO, U. S. A.**

The Helical Gear. 43 pages, 6 by 9 inches. Published by the Fellows Gear Shaper Co., Springfield, Vt.

This is a treatise covering the application of helical or twisted teeth to gears operating on parallel axes. It contains data on the design, application, and methods of cutting gears of this type. The book is divided into four chapters, headed as follows: Principle of the Helical Gear; Design of Helical Gears; Strength of Helical Gear Teeth; and Cutting Helical Gears.

Readjustment and Reconstruction Information. 371 pages, 6 by 9 inches. Published by the United States Council of National Defense, Reconstruction Research Division, Washington, D. C.

The book is the second of a series of reconstruction and readjustment reports compiled by the council's research staff, which is now closing this field of work and directing its activities solely to peace-time national defense research. The subjects dealt with include Americanization; assistance for service men and their families; building activities, including housing; community councils; employment; highways; land settlement; state councils of defense; public works; and vocational education for returned service men.

Safety Fundamentals. 228 pages, 5½ by 8 inches; illustrated. Published by the Safety Institute of America, 261 Madison Ave., New York City. Price, $2.

This book comprises a collection of free lectures given under the auspices of the Safety Institute of America to safety inspectors of New York and New Jersey, to enable them to enlarge their knowledge and broaden their experience. The book also includes the discussions that followed these lectures. The subjects covered are as follows: The Body Which Gets Hurt; the Injured Body and Its Treatment; Protective Clothing for Men; Suitable Work Garments for Women in Industry; Safe Heads and Good Eyes; Guarding Machinery; Arrangement of Machinery and Working Places; Heating and Ventilation; Illumination; Nature's Forces for and against Workmen; and Safety Education and Shop Organization.

Little Known Facts about Grinding and Grinding Kinks. By Howard W. Dunbar. 174 pages, 5 by 7 inches. Published by the Norton Co., Worcester, Mass.

This book contains a series of articles reprinted from "Grits and Grinds," treating of commonplace facts concerning grinding. The scope of the book is indicated by a few of the subjects contained therein, which are as follows: Belting: truing the wheel; lubricant; cam checking; surface grinding; wheel grades; form grinding; wheel speeds; cam grinding; grain size; wheel dressing and truing; wheel balance; soft wheels; wheel feeds; hand grinding and machine grinding; wheel service in cylindrical grinding; depth of cut; diamond holders; piston grinding; valve seat grinding; grinding shells; grinding tubes, etc. The book is well illustrated and should be of interest to all those who are interested in the proper use of grinding wheels and machines.

Mechanical Drafting Manual—Parts 1 and 2. By Charles B. Howe. Loose-leaf sheets, 8¼ by 6½ inches. Published by John Wiley & Sons, Inc., 432 Fourth Ave., New York City. Price, 50 cents for each part.

This work consists of a series of exercises in drawing, arranged in the form of lessons as an aid in teaching the subject. Each lesson is developed as the logical step in advance of the one preceding. The sequence of lessons given by the author is the result of many years of experience and experimentation. Part 1 covers the general principles of drafting and working drawings, including representation of objects by lines and views, lettering, isometric drawing, inking and tracing, etc. Part 2 is devoted to the geometry of drawing, including geometrical constructions of solids; surfaces, points and lines; development of the prism and cylinder, pyramid and cone, prism and pyramid, oblique cone, etc.

Complete Practical Machinist. By Joshua Rose. 547 pages, 5¼ by 7½ inches; 432 illustrations. Published by Henry Carey Baird & Co., Inc., 116 Nassau St., New York City. Price, $3.

This is the twentieth edition of a well-known book embracing lathe work, vise and bench work, drills and drilling, taps and dies, hardening and tempering, making tools, tool grinding, marking out work, lathe attachments and their uses, machine tools, etc. The work has been enlarged and revised in order to include the latest and most improved practice. The most noteworthy feature of the new edition is the introduction of several chapters on machine tools and their attachments, previous editions of the work having treated of the cutting tools only. The book is written for the practical workman in the language of the work-shop. Full instructions are given on the use of all kinds of metal-working tools, both hand and machine. The material is divided into twenty-five chapters, headed as follows: Cutting Tools for Lathes and Planing Machines; Cutting Speed and Feed; Boring Tools for Lathe Work; Screw-cutting Tools; Lathe Dogs, Carriers or Drivers; Turning Eccentrics; Hand-turning; Drilling in the Lathe; Boring-bars; Slotting Machine Tools; Twist Drills; Tool Steel; Taps and Dies; Vise Work—Tools; Fitting Connecting-rods; Milling Machines and Milling Tools; Grindstone and Tool Grinding; Lining or Marking out Work; Machine Tools; Precision Lathe Attachments and Their Use; Fellows Gear Shaper and its Operation; Miscellaneous Attachments and Machinery; To Calculate the Speed of Wheels, Pulleys, etc.; How to Set a Slide Valve; and Pumps.

Hendricks' Commercial Register of the United States for Buyers and Sellers. Twenty-eighth annual edition, 1919-1920. 2703 pages, 7½ by 9¼ inches. Published by the S. E. Hendricks Co., Inc., 2 W. 13th St., New York City. Price, $12.50.

This is the twenty-eighth annual edition of this well-known directory for buyers and sellers. The present volume has been thoroughly revised and contains many new listings. Several new features have been incorporated in this edition, the most noticeable among which is the method of exterior indexing by coloring the front edges of the pages red, white, and blue to facilitate reference to the different main sections of the book. The first section, the pages of which are colored blue on the front edges, contains the trade index, covering 162 pages, in which every product listed in the book is indexed and cross-indexed for ready reference. The red section following, is the main classified trades list, and contains 1813 pages, listing over 18,000 different products. In the present edition there are over 1200 new headings, including many completely covering the chemical industry. The white section of the book, containing 216 pages, lists the trade names under which the products are manufactured and gives names and addresses of the manufacturers. Following the trade names section there is another blue section covering 487 pages which contains an alphabetical list of the names of all the manufacturers in the book, together with a list of their addresses and their main line of business. This is followed by an index to the advertisers of 20 pages, containing a full list of the branch and foreign offices of each firm. The list of trade headings covers all products—from the raw material to the finished article—connected with the electrical, engineering, hardware, iron, mechanical, mill, mining, quarrying, commercial, railroad, steel, architectural, contracting, and kindred industries, and the firms listed include producers, manufacturers, dealers, and consumers. This directory is therefore of the greatest value to purchasing and sales departments, as well as to those who find it necessary to compile lists of manufacturers of various kinds of machinery.

NEW CATALOGUES AND CIRCULARS

Lowell Wrench Co., Worcester, Mass. Catalogue giving dimensions, prices, etc., of reversible ratchet wrenches, die-stocks and drills.

Moline Tool Co., Moline, Ill., manufacturer of multiple drilling machines and cylinder boring machines, is distributing a calendar for 1920 to the trade.

Swan & Finch Co., 165 Broadway, New York City. Calendar for 1920, advertising the oils, greases, and other lubricants produced by this company.

Bowen Products Corporation, Auburn, N. Y. Catalogue 7, of "Empress" oil-cups and grease cups, giving sizes, threads, and list prices for the complete line.

L. S. Starrett Co., Athol, Mass., has issued a pamphlet containing new list prices for the Starrett catalogue 21, superseding the revised list prices dated July 31, 1919.

Whitman & Barnes Mfg. Co., Akron, Ohio, manufacturer of twist drills, reamers, wrenches, and drop-forgings, has issued a calendar for 1920, calling attention to the company's products.

R. S. Stokvis & Zonen, Ltd., of Rotterdam, Holland, dealers in machine tools, whose New York office is at 17 Battery Place, have issued and are distributing to the trade, a calendar for 1920.

Mahr Mfg. Co., Minneapolis, Minn. Circular of the "Jiffy" torch, of the compressed air and self-contained types for cupola lighting, ladle drying, mold drying, preheating, and general foundry purposes.

U. S. Gutta Percha Paint Co., Providence, R. I. Pamphlet entitled "More Light," illustrating factory interiors that have been painted with "Barreled Sunlight," to increase the illuminating efficiency.

Towmotor Co., Bliss Road, Cleveland, Ohio. Bulletin 2, descriptive of the "Towmotor"—a gasoline industrial tractor which has a capacity for heavy loads and at the same time operates economically on light loads.

Wellman-Seaver-Morgan Co., Cleveland, Ohio. Bulletin 49, containing illustrations of a number of types of W-S-M car dumpers, and showing blueprints of these machines. Copies will be sent free upon request.

Walworth Mfg. Co., Boston, Mass. Circular entitled "Some Remarks from Dan McGaan," containing a poem by Edgar A. Guest having Americanism for the theme. The company will furnish copies upon request.

Merchants & Manufacturers Exchange, Grand Central Palace, New York City. Pamphlet containing a classified list of products exhibited at the International Exposition of Industries in the Grand Central Palace.

Automatic Machine Co., Bridgeport, Conn. Circular illustrating and describing the Automatic hob thread milling machine—a machine of the multiple cutter type for producing internal and external threaded work.

Norton Co., Worcester, Mass. Pamphlet entitled "Norton Service," containing a reprint of papers briefly outlining the service, employment, medical, safety, recreation, cooperative gardening, and housing activities of the company.

Dayton Reliance Tool & Mfg. Co., Dayton, Ohio. Circular illustrating the Dayton "Quick-change" chuck, which it is claimed can be reset in one minute and twenty seconds. These chucks are made in two-jaw universal and four-jaw independent styles.

Electric Furnace Co., Alliance, Ohio. Booklet S-B, showing installations of Baily electric furnaces for melting non-ferrous metals, which are built in sizes having electrical capacities from 50 to 1000 kilowatts, and hearth capacities from 300 pounds to 40 tons.

Hall Gas Engine Co., Bridesburg, Philadelphia, Pa. Circular illustrating and describing the Hall planetary thread milling machine for milling both internal and external threads. The machine is made in 6- and 12-inch sizes, and is arranged for either belt or motor drive.

Mehl Machine Tool & Die Co., Roselle, N. J. Calendar for 1920, advertising the company's tool service in jigs, fixtures, dies, gages, special machines, tool and machine designing, and pattern-making, illustrating some of the tools, devices, and machines built by the company.

Westinghouse, Church, Kerr & Co., Inc., 37 Wall St., New York City. Circular entitled "W. C. K. City," which reproduces a composite photograph of some of the many plants erected by the company, indicating the wide scope of engineering and construction work engaged in.

Bristol Machine Tool Co., Bristol, Conn. Catalogue illustrating this company's line of hand milling machines, vertical milling machines, rotary piston ring grinders and rotary precision surface grinders. Specifications are given for the various machines and the construction details are described.

Smalley-General Co., Inc., Bay City, Mich. Circular describing different methods of chucking and chucks in use on Smalley-General thread milling machines. Bulletin G, showing examples of work produced on the Smalley-General thread milling machine, and giving milling time and other related data.

Landau Machine & Drill Press Co., Inc., 19-25 W. 44th St., New York City. Circular descriptive of the Landau combination drill chuck and tapping device, which is equipped with four spindles for performing drilling, tapping, reaming, and countersinking operations without removing the work from the table.

Gisholt Machine Co., 9 S. Baldwin St., Madison, Wis. Circular entitled "Prepare for More Business," illustrating the tooling equipment for machining flywheels on Gisholt turret lathes. Circular entitled "Throw in the Gears with Periodograph Control," advertising the use of the "Periodograph" for making cost records.

George C. McKay & Co., 1046 St. Clair Ave., Cleveland, Ohio. Circular descriptive of the portable electrical screwdriver made by the Automatic Electrical Tool Co., Cincinnati, Ohio. This screwdriver is fitted with right- and left-hand spindles, so that the same machine can be used for driving and removing the screws.

Hauck Mfg. Co., 101-113 Eleventh St., Brooklyn, N. Y. Bulletin 119, illustrating and describing in detail the many different types of oil burners manufactured by this company. The book contains illustrations showing the application of the Hauck burners to various types of furnaces as well as other methods of using the burners. Copies will be sent upon request.

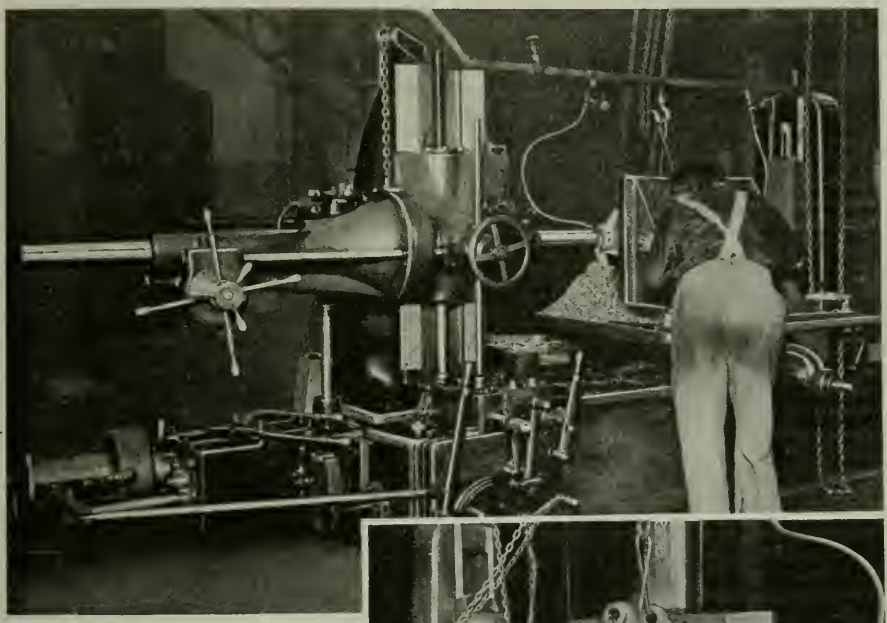
Beaudry & Co., Inc., 141 Milk St., Boston, Mass. Catalogue of Beaudry power hammers of the "Champion" type, which are built in two styles—belt and motor driven—in sizes from 50 to 500 pounds weight of ram. These machines are designed for light and heavy railroad, machine, and general blacksmithing, and for swaging, collaring, drawing, and general manufacturing.

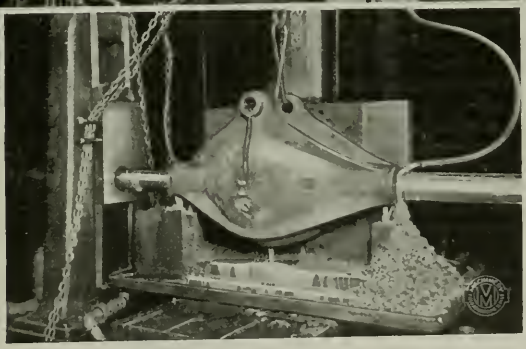
Allied Machinery Co. of America, 51 Chambers St., New York City. Catalogue of metal-working machinery, illustrating and describing milling machines made by the Kearney & Trecker Co., Milwaukee, Wis.; shaping machines made by Gould & Eberhardt, Newark, N. J.; drilling machines made by the Turner Machine Co., Danbury, Conn.; and Grinding machines made by the Gardner Machine Co., Beloit, Wis.

T. C. Dill Machine Co., Philadelphia, Pa. Catalogue illustrating the many uses of the Dill slotter. The book contains a large number of views showing this machine engaged on a wide variety of work from the heaviest machining operations to the lightest. The catalogue also describes the construction of these machines and gives a list of the principal dimensions.

Sherritt & Stoer Co., Philadelphia, Pa. Calendar for 1920, illustrating and briefly describing the important features of the line of machine tools handled by the company, including heavy-duty planers, crank shapers, horizontal boring and milling machines, steam hammers, power presses, drilling machines, vertical boring and turning mills, milling machines, slotters, lathes, and grinding machines.

SIX LUCAS
"PRECISION" BORING MACHINES
On Pierce-Arrow Truck Parts





Accuracy Is of Prime Importance

The six machines referred to are all in one department of the Pierce-Arrow shops at Buffalo, N. Y.—the first having been installed eight years ago. They are used mainly for boring steel castings—gear cases, gear case covers and axle housings such as the one here set up, in which the holes are 4" diameter, 8" long.

Two sizes of boring bars are used—the first roughing out about ¼" of stock around the holes and the second finishing them to plus and minus limits of 3.996" and 3.994". Though accuracy is the important feature of this operation, an output of 19 pieces finished in 8 hours is sufficiently good to further recommend these machines for careful investigation.

Send for the Catalog.

LUCAS MACHINE TOOL CO. NOW AND ALWAYS OF **CLEVELAND, OHIO, U.S.A.**

FOREIGN AGENTS: Alfred Herbert, Ltd., Coventry. Societe Anonyme, Alfred Herbert, Paris. Societe Anonyme Belge, Alfred Herbert, Brussels. Allied Machinery Co., Turin, Barcelona, Zurich. Beoson Bros., Sydney, Melbourne. V. Lowener, Copenhagen, Christiania, Stockholm. R. S. Stokvis & Zonen, Rotterdam. Andrews & George Co., Tokyo.

J. E. Martin Tool & Die Co., 548 W. State St., Springfield, Ohio. Circular illustrating and describing the "Gem" drilling machine vise, equipped with a handwheel which provides for rapid adjustment of the jaws. The vise has an independent swivel jaw, adapting it for holding taper work, and one of the jaws is provided with two V-grooves for holding round or irregular shaped pieces.

Read Small Tool Works, Cherry and Vine Sts., Worcester, Mass., is issuing a new catalogue, No. 4, of 40 pages, 5¼ by 7½ inches in which a revision of list prices is noted. The booklet covers the Reed line of micrometers more fully than the descriptive matter heretofore issued and shows a greatly broadened line. The company is also issuing display cslendars, 11 by 5 inches in size, to the trade.

Electric Furnace Co., Alliance, Ohio, is issuing a new monthly publication entitled "The Electric Furnace," containing information relating to the electric furnace industry and particularly to the Basily type of furnace produced by this company. The aim is to bring to the attention of the public the various operations that lend themselves to electric furnace applications and the commercial economies effected thereby.

Wilton Tool & Mfg. Co., Boston, Mass. Catalogue 22, descriptive of the Wilton master gage blocks which are guaranteed to be accurate within 0.00001 inch. These blocks are made in various sets covering the requirements of different manufacturing shops and conditions. They constitute a complete equipment of standards by means of which any dimensions can be obtsined for laying out, messuring and inspecting work.

E. C. Atkins & Co., Inc., Indianspolis, Ind. Catalogue 18, covering the complete line of saw tools and mill specialities made by this concern, which includes circular saws, wsbble saws, grooving saws, box board, matcher cutters, inserted-tooth saws, band saws, scroll saws, swages, files, punches, mandrels, grinders, knives, metal-cutting machines, cross-cut saws, saw vises, and silver steel saws for use in manual training schools, etc.

James H. Matthews & Co., 3948 Forbes Field, Pittsburg, Pa. Catslogue 85, of Matthews steel dies and stamps for marking products in order to identify them. The pamphlet illustrates the different styles of stamps and dies made by the company and shows their application for marking various types of products. The Matthews "Quantitag" and "Unitag" machines for embossing metal shipping tags are also illustrated and described.

Padrick Tool & Machine Co., 3639 N. Lawrence St., Philadelphia, Pa. Catalogue illustrating and describing a line of time- and labor-saving machinery for use in railway shops, shipyards, general machine shops, and miscellaneous industrial plants. Among the machines shown are portable boring-bars, floor-plate boring-bars, portable floor boring machines, column boring machines, trepanning machines, duplex boring machines, tube boring and facing machines, portable crankpin turning machines, portable milling machines, pipe-bending machines, etc.

Clark Equipment Co., Buchanan, Mich., has published a pamphlet containing a reproduction of the Constitution of the United States. The booklet is illustrated with pen portraits of American patriots and sketches of the plant of the Clark Equipment Co. It is believed that in this period of unrest it would be of benefit to all to become acquainted with the principles of equity and justice upon which our Government was founded. These principles were used as the basis for the system of industrial democracy installed in the plant of the Clark Equipment Co., and described in the February number of MACHINERY.

TRADE NOTES

Aux Forges de Vulcain, 3 Rue St. Denis, Paris, France, announces that its New York office is now located at 21 E. 40th St., and all correspondence should be sent to the new address.

Fenn Mfg. Co., Hartford, Conn., announces its business is now being run as a corporation instead of a partnership as formerly. No change has been made in the management, personnel, or business methods.

Turbine Air Tool Co., 301 Chamber of Commerce Bldg., Cleveland, Ohio, has developed and is making a complete line of pneumatic tools, and solicits catalogues for its purchasing and engineering departments.

Sherritt & Stoer Co., Inc., has opened a new office, store-room and warehouse at 2000-2008 Market St., Philadelphia, Pa., where a permanent exhibition of machine tools, and railway and machioe shop equipment will be maintained.

Sterling Producta Co., manufacturer of drills, vises, and other tools, and the Morgan Vise Co., have removed from Machinery Hall to 35-37 S. Desplaines St., Chicago, Ill., where they have display rooms located on the street floor.

Cincinnati Shaper Co., Cincinnati, Ohio, manufacturer of shapers and gear-cutting machines, is erecting a large addition to its plant, which will double the present capacity. The new building is expected to be ready for occupancy April 1.

Chicago Pneumatic Tool Co., 1060 Fisher Bldg., Chicago, Ill., held a general conference of executives, plant and branch managers, and salesmen, st its Detroit plant, Second Ave. and Amsterdam St., on the occasion of the opening of a five-story sddition.

Precision & Thread Grinder Mfg. Co., 1932 Arch St., Philadelphia, Pa., manufacturer of the "Multigraduated" precision grinder, has appointed the Gardner-Bryan Co., of Clevelsnd, Ohio, as its special representative in Ohio, Indisna, and western Peansylvania.

Puritan Machine Co., 390 W. Fort St., Detroit, Mich., has recently opened s two-story shop, 120 by 50 feet, for the manufacture of automobile parts, and has installed gear-cutting machinery for cutting its own gears. W. H. Robinson is superintendent of the shop.

Willson Goggles, Inc., formerly T. A. Willson & Co., Inc., Resding, Pa., announces that the firm has established a New York branch office on the 19th floor of the Bush Terminal Sales Building, 42nd St., near Broadway. The manager of the New York branch is William Wortman.

Cincinnati Pulley Machinery Co., has changed its name to the Avey Drilling Machine Co. No change has been made in the stockholders, management, personnel, or activities of the organization in sny way. Future communications should be addressed to the new name of the company.

Morris Machine Tool Co., Cincinnati, Ohio, has bought the entire assets of the American Metal Products Co., which will heresfter be known as the Metal Products Department of the Morris Machine Tool Co. The plsnt has been moved into new quarters on the property of the J. B. Morris Foundry Co.

Black & Decker Mfg. Co., Towson Heights, Baltimore, Md., has estsblished a permanent office and show-room at 1436 S. Michigan Ave., Chicago, Ill. The office will be in charge of R. G. Ames, whose territory has been extended to cover the entire Middle West. F. E. Marrion and J. N. LsBelle will assist Mr. Ames.

Thompson Grinder Co., Springfield, Ohio, is erecting a new plant on West Main St. The building is to be 65 by 200 feet, one-story, of concrete and steel ssch construction. One end will be devoted to the office requirements and the remsinder will be given over to the manufacture of the line of precision grinding machines on which this company has specialized for years.

Tacony Steel Co., Tacony, Philadelphia, Pa., is opening s sales office in the Marquette Building, Chicago, Ill. Frank B. Hillwick, until recently with the Crucible Steel Co., is district sales manager. Mr. Hillwick was formerly with the Bethlehem Steel Co., and has had considerable practical experience in machine shops and heat-treating departments. He is a member of the American Steel Treaters Society.

Electrolabs Co., 2635 Penn Ave., Pittsburg, Pa., has decided to consolidate all its offices at the address given in order to obtain closer cooperation between the factory and the sales department. The company requests that all correspondence be addressed to the Pittsburg office and be marked for the attention of the proper department. The firm will maintain a branch office at 30 Church St., Room 313, New York City.

Kearney & Tracker Co., Milwaukee, Wis., has opened a new office and show-room at 738 Superior Ave., N. W., Cleveland, Ohio, in order to take care of its constantly increasing business in the Ohio territory. A representative line of Milwaukee milling machines, attachments, and accessories will be carried at the new office. C. J. Sturgeon, formerly with the W. M. Pattison Supply Co., will be in charge of sales in the Ohio territory.

Production Engineering Co., 212 Center St., New York City, has been organized for the designing and building of tools, gages, and special machinery, thereby aiding manufacturers to increase production by the use of proper tools, gages, and manufacturing equipment. The following men having a long and varied experience as tool-makers, designers, and engineers, are connected with the company: Robert Steinman, John A. Honegger, and H. Allen Hinchcliff.

Plant Engineering & Equipment Co. Inc., 192 Broadway, New York City, manufacturer of Corliss valve steam traps, Mason condensation meters, and other power and heating specialties, announces the opening of its twenty-sixth office, at Newark, N. J., to care for the increasing demand for its product. M. William Ehrlich, consulting and contracting engineer, will be the New Jersey manager with headquarters at Newark and a suboffice at Lyndhurst, N. J.

DeLaval Separator Co., Poughkeepsie, N. Y., has placed a contract with the John W. Ferguson Co. of Paterson, N. J., for the immediate erection of a one-story and basement power machine building, 150 by 150 feet, having a floor area of 48,000 square feet. The new building will have brick walls and steel sash throughout and will have reinforced concrete floor-beams and stairs. The roof will be of the sawtooth type covered with asbestos asphalt.

Walter Engineering Co., 520-530 Lindsay Bldg., Dayton, Ohio, has been started by Frank L. Walter who was formerly connected with the Dayton Engineering Laboratories Co. as master mechanic and previous to that with the National Cash Register Co. in its designing department. The new concern will design snd build special machinery and tools of all kinds, and will operate pattern-making and tool-building shops in connection with its designing department.

W. A. Wilson Machine Co., manufacturer of iron planers and special machinery, which has been located in Rochester, N. Y., for thirty-five years, has been sold to the Morley Machinery Corporation, 215 N. Water St., Rochester. The new company will continue the manufacture of the Wilson planers, and is engaged in installing new equipment to increase its output. The owners are C. F. Morley, formerly vice-president of the Symington Machine Corporation, and J. S. Armstroog, formerly secretary of the W. A. Wilson Machine Co.

Nelson Tool & Machine Co., 253 Norfolk St., Newark, N. J., has recently been incorporated and will move about April 1, to its new plant at 82-88 Lewelyn Ave., Bloomfield, N. J. The constantly increasing demand for the company's products, which include angle-plates, universal sogle fixtures, and work-holding devices, has made larger quarters necessary. New equipment and machines will be installed with a view to securing maximum production on an interchsngeable basis. The totsl floor space of the plant will be 16,000 squsre feet on two floors.

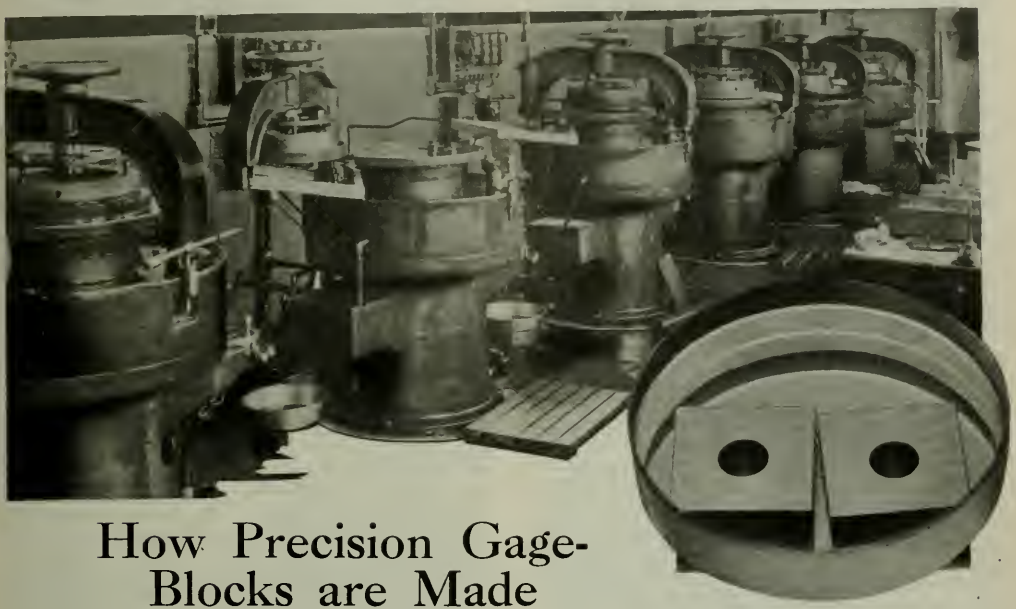
Hauck Mfg. Co., 101-113 Eleventh St., Brooklyn, N. Y., announces that the Hauck Burner Service Station at Pittsburg has moved its office from 2930 Penn Ave. to 105 Wood St., where their enlarged facilities will enable them to give better service to their customers in that vicinity. The Hauck Burner Service Station at Boston has moved from 70 High St. to larger quarters at 149 Berkeley St., corner Columbus Ave. The new office consists of a large display window, store, office, and space for demonstration. The Hsuck Burner Service Station at Cleveland has moved from 2114 Superior Viaduct to 1106 Walnut Ave., where the representative is in a better position to make demonstrations and render more efficient service.

Gage Engineering Service Co., Kellogg Bldg., 1422 F St., N.W., Washington, D. C., has been organized by A. E. Hanson, J. A. Haigh, and I. H. Fullmer, to engage in consulting and contracting service, including the design and installation of limit gaging systems and inspection methods; standardization; interchangeable manufacture; tool and production efficiency; and technical investigations. The firm will contract for gages; inspection equipment; tools and dies; and jigs and fixtures. The personnel of the company has been associated with the Gage Section of the Bureau of Standards since its organization in 1917. The combined experience of these men covers all phases of the work of the Bureau of Standards in administration, research, design, gage manufacture and salvage, and instrument construction.

Frasse Steel Works, Inc., Hartford, Conn., has been incorporated under the laws of Connecticut with a capitalization of $1,000,000, and has taken over the business of the Peter A. Frasse Co., of 417 Canal S., New York City. The new company has completed plans for the reconstruction of the present plant to provide sufficient space to care for the increased business of the company. The additions to the plant will comprise an extension to the present shop building of 25 by 320 feet, and the construction of a three-story building, 90 by 100 feet. It is expected that the expansion will enable the company to increase its output from 26,000 tons a year to 50,000 tons a year. The Frasse Steel Works will handle the sales in New England, while the original New York company—the Peter A. Frasse Co.—will act as sales agent for the remainder of the country.

Square D Co., Detroit, Mich., manufacturer of electrical safety devices, announces the following additions and changes in its sales and advertising departments: E. A. Printz, formerly district sales manager of the Chicago territory, has been made sales manager, A. MacLachlan, continuing in the capacity of secretary and director of distribution; D. M. Stone, formerly district sales-mnnager of the Pittsburg territory, has been made district sales manager of the Detroit territory; J. A. Jsques, formerly in charge of the New York territory as district sales manager, has been given the district sales mnnagership of the Pittsburg territory, and H. W. Spahn, district sales manager of the Buffalo territory, has been placed in charge in New York; D. H. Colcord, formerly of the department of publicity of the Westinghouse Air Brake Co. of Pittsburg, has been appointed director of research engineering.

Springfield Automatic Screw Machine Corporation of Springfield, Mass., has been organized to take over the business of the P.W.V. Automatic Machine Corporation of Fitchburg, Mass. The present officers of the P.W.V. Automatic Machine Corporstion will remain with the new company with the addition of I. T. McGregor, who will become treasurer of the Springfield concern. The other officers are: C. E. Van Norman, president; H. Page, vice-president; M. A. Coolidge, vice-president; Clarence J. Wetsel, general manager, secretsry and assistnnt treasurer; and L. M. Walte, vice-president and sales manager. The board of directors consists of: C. E. Van Norman, F. H. Psge, I. T. McGregor, Clsrence J. Wetsel, and A. J. Skinner, of Springfield, Mass.; M. A. Coolidge and L. M. Waite of Fitchburg, Mass.; and Ashton L. Carr, H. Douglas Williams, Eugene E. Reed, and Alton T. Tupper of Boston, Mass. The company will erect a modern plant in Springfield, Mass., this spring for the manufacture of its line of "Radical" automatic screw machines, and will also cortinue to keep its Fitchburg plant in operation. The main office, however, will be located in Springfield.



How Precision Gage-Blocks are Made

By FRANKLIN D. JONES

A Complete Description Covering Every Essential Detail in the Manufacture of Precision Gage-blocks at the Plant of the Pratt & Whitney Co., Hartford, Conn.

NO manufacturing process has been of greater interest or more puzzling to mechanics in general than the making of precision gage-blocks of the class which are often accurate within one-millionth of an inch. A steel block that is about one inch long is merely a piece of steel, but when, as the result of extremely refined lapping and measuring processes, it has been finished until the length is definitely known to be *one inch* within a limit of one-millionth, what formerly was simply a piece of steel becomes an object of great interest; it is also of considerable practical value as applied in maintaining the standards of accuracy necessary when manufacturing on an interchangeable basis. In fact, the plain block of steel which has been finished to such an extreme degree of accuracy represents a wonderful mechanical achievement and is an example of what can be done by scientific methods.

Now the making of a single block which is exceedingly accurate as to the flatness and parallelism of the end surfaces, is not easy, but, in the development of precision processes, the problem becomes vastly more difficult when it is necessary to produce a block which not only has flat parallel surfaces, but, in addition to this, is so close to a given length that the error—if it may still be considered an error—is frequently not over one millionth of an inch. If as a further requirement, a complete series of blocks is to be produced which progressively increase in size over a certain range of sizes, by steps or increments of only one ten-thousandth inch, the problem assumes even greater proportions. It is because of these exacting requirements that the users of precision gage-blocks, as well as many others interested in mechanical developments, have often wondered how these blocks are produced—especially in quantities—so that practically speaking, all error is eliminated. Just how this extremely accurate work is done at the plant of the Pratt & Whitney Co., Hartford, Conn., where the Hoke precision gage-blocks are made, will be explained in detail, beginning with the raw material, in the shape of steel bars, and taking up the various processes in successive order.

The manufacture of gage-blocks, which are flat, parallel and to a given size within a millionth of an inch—or at most a few millionths of an inch—is the greatest achievement in the art of precision lapping and measuring, as applied to a commercial product, and this article is the first complete illustrated description of a process which has been a mystery to so many men in the mechanical field. The article explains just how precision gage-blocks are made by the Pratt & Whitney Co., and deals with every essential feature, beginning with the kind of steel used, and continuing with the preliminary machining operations; the heat-treatment of the gages; the seasoning of the steel; the ingenious mechanical lapping process—which makes it possible to attain such marvelous accuracy—and the optical method of checking the finished gages.

Exacting Requirements in Gage-block Making

When gage-blocks are made so accurately that the most sensitive test known shows a very close approach to absolute perfection, it

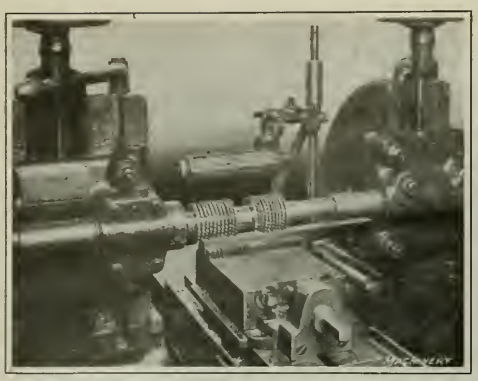


Fig. 1. Cutting a Steel Bar into a Number of Smaller Sections for making Gage-blocks

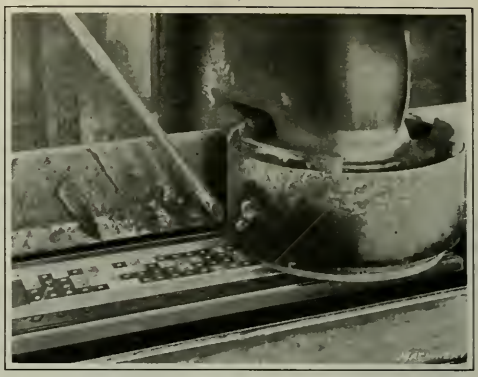


Fig. 2. Rough-grinding the Ends of the Gage-blocks on a Vertical-spindle Surface Grinder

will be realized that, first, there must be some method of forming these flat, parallel surfaces, and second, there must be a test for accuracy which is entirely reliable and not subject to the errors inherent in all forms of purely mechanical measuring apparatus. Before describing how these gages are made, the general requirements that are essential for gages of this kind will be summarized so that the reason for some of the processes to be described and their relation to precision gage manufacture will be more clearly understood.

1. The two gaging surfaces should be true planes.

2. The two gaging surfaces should be parallel to each other.

3. The length of the gage or the distance from one gaging surface to the other, should conform to a required dimension.

4. The gage-blocks of a set should differ in size or length by increments which make it possible to obtain any dimension within the extreme range covered by the complete set of blocks.

5. The difference between the length of any block in a set and the basic or standard length should be so small that even when a number of blocks are wrung together to form a composite gage, the combined error will still be within the limits set for the most accurate work encountered in practice.

6. The finished gage-block should possess the quality of permanence or stability so that it will retain its original accuracy of form and size and not be subject to minute changes. In this connection the steel should resist corrosion and wear as much as possible.

Steel Used for Precision Gage-blocks

As the kind of steel used for making gage-blocks has much to do with the ultimate success of the work, this will be considered first. Experiments were first made at the Bureau of Standards with low-carbon steel, heat-treated by pack-hardening, but precision gage-blocks made of this material lacked the important quality of permanence or stability. After careful investigation it has been found that a special chromium steel has the qualities that are essential for these precision gage-blocks. This steel contains from 1.20 to 1.50 per cent chromium; from 1.00 to 1.10 per cent carbon; from 0.20 to 0.40 per cent manganese; not over 0.03 per cent phosphorus; and not over 0.03 per cent sulphur. The chromium in the steel increases its resistance to corrosion and wear. Such a steel, properly heat-treated and seasoned, is relatively free from the changes in size and shape, which occur in all hardened steel very slowly and continue on an appreciable scale for several months after a gage has been finished. Incidentally, this steel is practically the same as is used for ball-bearing races. Every bar of steel that is to be used for making Hoke gage-blocks is subjected first to chemical and microscopic analysis to see that it conforms to the required composition and condition, and is also tested for hardness by the Brinell method and held within a narrow range. The gage-blocks, after heat-treatment, are again tested for hardness, the scleroscope method being employed.

Rough Machining Operations on Gage-blocks

If the steel bars pass the preliminary tests, they are sawed into suitable lengths. These bars are then straight-

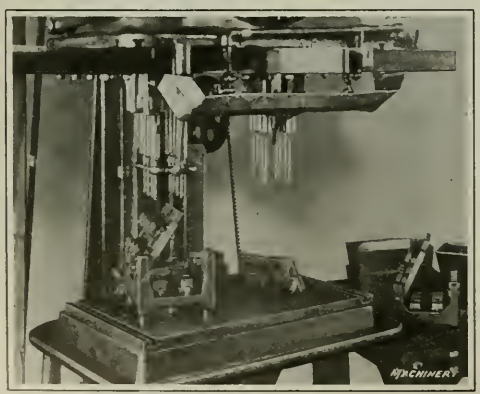


Fig. 3. Multiple-spindle Machine used for drilling Holes in the Shorter Gage-blocks



Fig. 4. Drilling Holes in the Longer Gage-blocks on a Gang Drilling Machine

ened if necessary, after which the four sides are ground on a Pratt & Whitney vertical-spindle surface grinder, the machine being similar to the type illustrated in Fig. 2. A number of the bars are held on a magnetic chuck and they are ground to 31/32 inch square, within 0.002 inch. After this preliminary grinding on the sides, the bars are placed in stock.

When a lot of blocks of given size are to be made, the first operation is that of cutting the bars into small blocks which are about 0.025 or 0.030 inch longer than the basic length. This operation of cutting off is done on a Pratt & Whitney automatic milling machine equipped with a gang of slitting saws as illustrated in Fig. 1. A bar of stock is held between slotted vise jaws, the slots being arranged so as to provide clearance spaces for the various cutters which pass through the slots.

The first operation on the ends or faces, which later are to be finished so accurately, is performed as illustrated in Fig. 2, a vertical-spindle surface grinder being used. Approximately one-hundred gage-blocks are placed in rows upon the magnetic chuck and are ground at the same time. This is a preliminary rough-grinding operation and the gages are reduced until they are about 0.020 inch over the basic length.

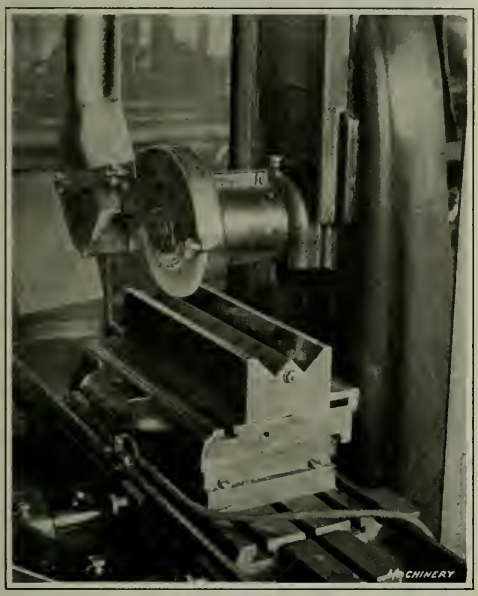


Fig. 5. Beveling the Corners of the Gage-blocks on a Surface Grinder

One of the characteristic features of the Hoke gage-blocks is the hole in the center. This hole, which is just large enough to receive a ¼-inch rod, makes it possible to bind a number of gages firmly together by passing a rod through them and using the clamping screws provided. The multiple-spindle machine on which these holes in the shorter blocks are drilled and reamed is illustrated in Fig. 3. After the drilling operation, the bushing plate, which contains all the drill bushings, is removed and replaced by another bushing plate preparatory to reaming. The longer gage-blocks are drilled on a gang drilling machine, while the lower ends are supported on centers as shown in Fig. 4. The next operation, which is that of countersinking, is performed on a bench lathe, and is followed by a burring operation for removing any sharp edges that may have been left in drilling. After these preliminary operations on the blocks have been completed, the gages are ready for the heat-treating process.

Heat-treatment of the Gage-blocks

As durability and permanence are very important factors in producing good gage-blocks, the heat-treating process is one of the most essential and also most critical operations in their manufacture. Even small variations in the condition or structure of the steel before hardening will result in unsatisfactory blocks unless careful attention is given to every small detail. Furthermore, the thickness or length of the blocks varies from under 0.050 inch to 4 or 5 inches, and a longer block, because of its greater bulk, requires a somewhat different treatment than a shorter or thinner one. Although the steel, as received from the maker, must have a certain specified structure within very narrow limits, the unusually exacting requirements of these gage-blocks make it necessary to "normalize" the steel still more uniformly.

As is common practice in many other cases, in order not to subject the material to a sudden change of temperature, the blocks are always preheated in a gas furnace before the final heating on all heat-treating operations. The normaliz-



Fig. 6. Testing Gage-blocks for Minute Flaws or Surface Cracks

ing process is the same for all blocks as regards their size, but is different according to the slight variations existing in the steel. It consists of heating the blocks uniformly throughout above the critical point in a gas furnace and then quenching in a niter bath. The niter bath is used as a quenching medium because it is less severe than oil would be.

The steel used in these blocks is very similar to the S.A.E. specification number 52100. The hardening and drawing of this steel follows approximately the S.A.E. heat-treatment "P." As these blocks are much smaller than most of the automobile parts for which this heat-treatment was developed, certain modifications are necessary. In hardening, the blocks are heated uniformly throughout, and the smaller blocks are quenched in circulating oil, while the larger ones are quenched in water. Naturally, the larger blocks are kept in the hardening furnace a much longer time than the smaller ones to insure a uniform heating. Furthermore, the temperature of the furnace when heating the larger blocks is slightly lower than when heating the smaller ones. Water is used as a quenching medium for the larger blocks, because a more severe quenching is required than on the smaller. The hardened blocks are next

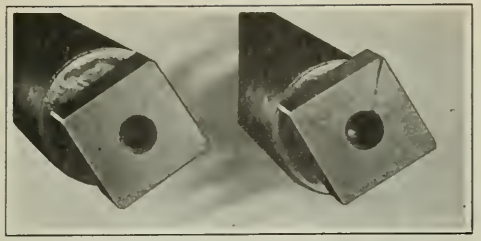


Fig. 7. Gage-block before and after being tested for Surface Cracks—the Right-hand View shows how a Crack is revealed by this Ingenious Test

drawn to 300 degrees F. in oil for a period varying from fifteen to thirty minutes, to relieve the hardening strains. After cooling in the atmosphere they are subjected to a further heat-treatment or special stabilizing process which has been developed at the Pratt & Whitney plant. This treatment, to be successful, must be controlled within an extremely narrow range of temperature, and is responsible, in large measure, for the permanence or stability of the finished gages.

It must not be understood from this that the blocks do not expand or contract with changes of temperature. It does mean that when a block is once made to a predetermined size at a specified temperature, it will always return

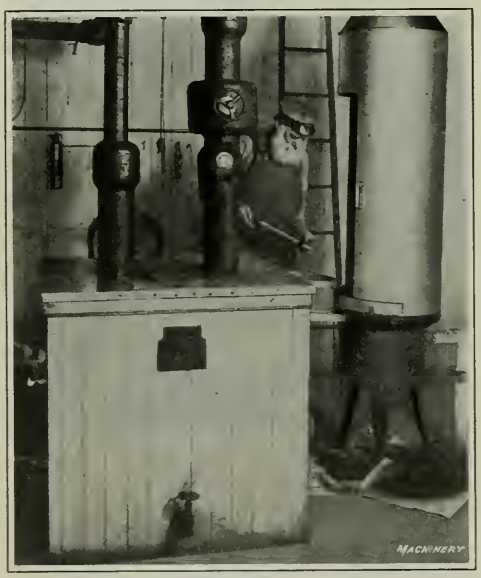


Fig. 8. Apparatus for seasoning the Gage-blocks by subjecting them to Alternate Changes of Heat and Cold

to that size when brought back to the original temperature, provided that it has not been exposed to temperature changes beyond the usual range of a shop. Furthermore, it is desirable to have shop standards which have approximately the same coefficient of expansion as the material being measured. In such cases, accurate measurements are made regardless of temperature, provided that the temperature of both the work and the gage is identical. After heat-treatment, the gages are cleaned by using "oakite" and are ready for the second grinding operation on the sides.

Rough-grinding the Sides and Ends

While no attempt is made to finish the sides of the gages to any great degree of accuracy, they are ground square and equidistant from the hole through the center. This is accomplished by placing a number of gages on a close-fitting rod and clamping them in position with a disk at one end, the diameter of which is equal to the width of the square. This row of gages is then ground on a vertical-spindle surface grinder, the wheel being fed down until it just grazes the disk, which thus serves as a gage for the four sides. The gages, which are now 0.950 inch square, are next tested with the scleroscope for hardness. The hardness should be from 85 to 95 on the scleroscope scale depending upon their length. After this hardness test, the ends are again rough-ground on a surface grinder, the gages being reduced to within 0.005 to 0.007 inch of the basic length. Two kinds

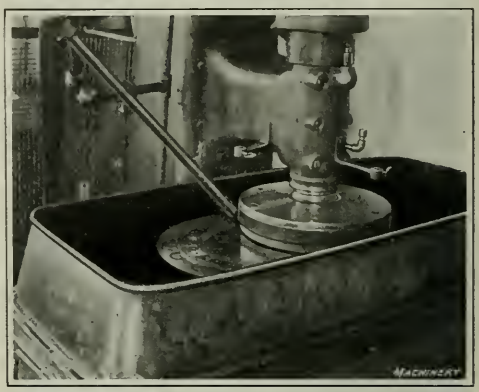


Fig. 9. Final Grinding Operation on the Ends or Faces of the Blocks prior to Lapping

of wheels have been used for this gage grinding with satisfactory results. One is a corundum wheel of 80 grain and ½ grade, and the other is an alundum wheel, made by the silicate process. The grain symbol for this wheel is 3880 and the grade H. A soft free-cutting wheel is used for this work in order to reduce the heating of the gages as far as possible.

The gages are next sand-blasted on the sides and then the corners are beveled slightly by grinding, as indicated in Fig. 5. A number of the gages clamped together are placed in a V-block, formed of steel and brass plates so that it serves as an auxiliary magnetic chuck when placed on the regular magnetic chuck of the surface grinder. The illustration shows how this simple operation is performed.

Detecting Minute Flaws or Surface Cracks

As every gage-block must be a perfectly sound homogeneous piece of steel, it is necessary to inspect each block carefully in order to detect the minute cracks which are liable

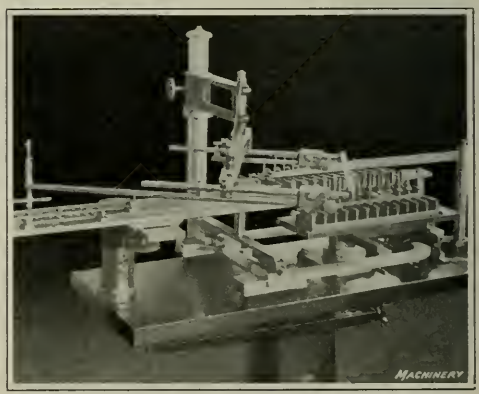


Fig. 10. Machine for marking Gage-blocks preparatory to etching Figures and Letters on the Sides

to form in any piece of steel, especially after it has been subjected to heat-treatment. Any flaws or cracks are detected by a very simple but ingenious method (see Fig. 6). The gage-block is immersed in a bath of kerosene which contains in suspension very fine steel dust, which is attracted by the residual magnetism in the block due to its contact previously with the magnetic chuck. Any minute cracks will be visible, especially when examined under the magnifying glass, because the lines of force interrupted by the crack cause the steel particles to form a dark line on the surface which shows the extent of the flaw. Fig. 7 shows a gage before and after being tested as described. This particular gage had a crack extending from one corner, as may be seen in the right-hand view. This illustration shows the end of an electromagnet which is sometimes used. These blocks are thoroughly demagnetized after the final grinding.

Seasoning the Blocks to Secure Permanence of Form

A precision gage-block, no matter how accurate it may be to begin with, is, of course, useless as a standard unless it retains its original accuracy. When gage-blocks are made so accurately that they can be used for obtaining a range of dimensions varying by only 0.0001 inch, it is evident that changes which ordinarily would not be considered become very important, because errors of only a few millionths are regarded as serious. In order to secure gage-blocks which will "stay put," each block passes through a seasoning process. As is generally known, steel and also castings, if allowed to stand for a long period of time, will gradually settle down to a more or less permanent state. This method of seasoning, however, is slow and usually impracticable as applied to manufacturing, and it is not necessary, as the same results can be obtained by an artificial process which is much more-rapid.

This seasoning process consists in subjecting the gages to alternate changes of heat and cold. The apparatus shown in Fig. 8 is used for this purpose, and since a great deal depends upon this process—which might easily be slighted without detection—an old and trusted employe has charge of the work. A lot of the gages contained in a wire basket, are immersed in a bath, the temperature of which is well below zero, this temperature being maintained automatically by a refrigerating apparatus. After the gages have come to the temperature of this cold bath, they are quickly transferred to a bath which is heated to about 220 degrees F. After heating thoroughly, the gages are again transferred to the cold bath, and this successive heating and cooling is continued for several hours, which completes the artificial seasoning process. The blocks are then stored for a period of several months for aging and relieving any strains that may remain.



Fig. 11. Stoning the Countersink at the Center of the Gage-block to remove All Sharp Edges



Fig. 12. Smoothing off the Corners of the Gage-blocks by means of Revolving Oilstones

Final Grinding and Stoning Operations prior to Lapping

After seasoning and aging, the blocks are removed from storage for the final grinding operation on the ends or faces prior to lapping (see Fig. 9). The gages are reduced to within 0.0010 to 0.0012 inch of the basic size.

Fig. 11 illustrates one of the minor, but nevertheless important, operations on the countersink at the center. It has been found necessary to remove all sharp edges and corners, because such edges are liable to extend above the flat surface, and while this may be a very slight amount, still, it is a source of trouble. The finishing of the countersink is by means of a small conical pointed oilstone, which is shown in use in the illustration. The edges of the gages are next given a dull matt finish by means of a mud blast, and then they are ready for etching.

Etching the Gage-blocks

The size of every gage-block is marked on one edge or side, and on another side there is a special symbol for each gage, which enables it to be positively indentified. In addition to the size mark and symbol, the words Hoke Precision and the name Pratt & Whitney Co. are marked on the two remaining sides. This marking is done by the acid etching process. A coating of resisting material is first applied to the edges, and when this has been dried in an electric oven, a number of gages are placed on the multiple marking machine illustrated in Fig. 10. This machine is of the well-known pantograph type. As the pointer follows the enlarged letters on the brass pattern, marking tools reproduce the lettering, on a small scale, in the resist. A diluted solution of nitric acid is afterward applied and the figures and letters are etched in the steel.

Following the etching operation, all corners are smoothed off slightly by holding the gage-blocks against a revolving oilstone mounted on a bench lathe (see Fig. 12), and the gages are then ready for the final machining operation, which is that of lapping.

Lapping Machines which Finish Gage-blocks Flat and Parallel to a Millionth of an Inch

The gage-blocks, up to this stage, have been ground as flat and parallel as is possible on an ordinary surface grinder, and about 0.001 inch has been left for removal by lapping. Just how these upper and lower surfaces are lapped to the extreme degree of perfection necessary will now be explained. The lapping process, which is the invention of Major W. E. Hoke, from whom all rights have been acquired by the Pratt & Whitney Co., is entirely mechanical. The special lapping machines shown in Figs. 13 and 14 were developed by the Pratt & Whitney Co., and are used for this important work. A battery or row of these machines may be seen in the heading illustration. Each machine has two flat laps of circular form. The lower lap *A* (see Fig. 13) is attached to the base of the machine, and the upper lap *B* is secured to arm *C* by a connection which permits the lap to move freely in any direction but not to revolve. This arm is pivoted at one end so that the upper lap can be swung to one side to expose the lower lap and the work. When a machine is in use, one lap is above the other, as shown in Fig. 14, and the gage-blocks are between them, so that both the upper and lower surfaces of the blocks are lapped simultaneously. When the blocks are to be removed or inserted in the machine, the upper lap is swung out of the way, as shown in Fig. 13.

Between these two cast-iron laps, there is a steel plate or "spider" *D* which contains twenty-four holes into which the blocks *E* to be lapped are inserted. These holes are slightly larger in diameter than the distance across the corners of the blocks, so that the latter are free to move and bear evenly on the faces of the laps. When the machine is closed, as shown in Fig. 14, and ready for use, this spider is about midway between the laps but does not come into contact with them. The function of the spider is to hold the blocks in position and impart to them the motion required for the lapping operation.



Fig. 13. One of the Machines used for lapping Precision Gage-blocks; the Upper Lap is swung to one Side to permit Insertion or Removal of the Blocks

Action of the Mechanical Lapping Apparatus

The upper and lower laps remain stationary, while the spider receives a planetary motion which brings each block into contact with the entire surface of each lap. This motion of the spider is derived from three cranks *F* (see Fig. 13) which are attached to the upper ends of vertical shafts. At the end of each crank there is a pinion which is rigidly secured to the crank so that it cannot revolve about its own axis. These three pinions mesh with an external gear *G*, which is attached to the spider. At the lower ends of the vertical crankshafts there are connecting-rods operated by a central crank enclosed within the base of the machine. With this arrangement the three cranks are caused to rotate in unison, and as they revolve the spider is carried around between the pinions. The motion of the spider is partly indicated by the diagram, Fig. 17, which shows it in the four positions corresponding to 90-degree movements of the cranks. As these cranks revolve, their fixed pinions roll along the spider gear, and the spider itself is given a rotary motion about its own axis, while at the same time this axis follows a circular path having a radius equal to the crank radius. This combined motion carries the blocks inward and outward as the spider revolves. As it is very essential to distribute the wear on the laps as uniformly as possible, the machine is equipped with gears of such ratio that this gearing seldom occupies the same relative position. The result is that the spider and gage-blocks do not follow the same path around the surfaces of the laps, during successive turns. In fact, the cranks make about 300,000 revolutions before a given block in the spider again follows the same path relative to the faces of the laps. The wear is also further distributed by reason of the fact that the blocks themselves revolve with more or less irregularity at first and then quite uniformly and in the same direction, as the surfaces become true. When lapping comparatively long gage-blocks, considerable pressure is applied to the upper lap to prevent the blocks from tipping.

How the Mechanical Lapping Process is Controlled

The lapping process must be carried on so that the gaging surfaces gradually approach flatness and parallelism as the gage is being reduced to the correct size. While it would be relatively simple to lap the upper and lower ends until they are flat, it is very essential to so handle the work that both *flat* and *parallel* surfaces are secured either before or when the gage is finished to the required dimension. When the twenty-four blocks are first placed in the machine, there are sure to be very slight irregularities in regard to the heights of different blocks, as well as slight errors in the flatness and parallelism of their surfaces. As the upper lap is free to adjust itself, it naturally rests upon the three highest points or surfaces on the circular row of blocks, and as the blocks are carried around between the laps, these high areas are soon enlarged. Now if the lapping were continued without changing the blocks, the surfaces might be finished flat, but the plane of the upper surfaces would not be parallel to the plane of the lower surfaces, assuming

that there was some slight variation in height to begin with, as would ordinarily be the case. The problem then is to lap all the blocks flat and parallel while they are being reduced to the same length or height. This is accomplished by changing the relative positions of the blocks at intervals during the lapping period.

Just how the lapping is done will be illustrated by considering an actual example. The card reproduced in Fig. 15 shows in detail the various steps connected with lapping blocks having a nominal size of 0.550 inch. The figures in the column headed Size represent millionths of an inch, and in this particular case, approximately 0.0008 inch had to be removed by lapping. In order to have the lapping periods under accurate control, each machine is equipped with a combination revolution indicator and automatic stop which can be set to stop the machine after a given number of revolutions. This indicator and stop is in the form of a graduated dial and may be seen at *K* in Fig. 13. In the lapping operation, the history of which is recorded on the card, Fig. 15, the machine was first set to make 70 revolutions; then, after transposing the blocks, as explained later, it made 70 more revolutions. As the result of the lapping due to 140 revolutions, the blocks were reduced (as shown by the figures in the left-hand column) from plus 800 millionths of an inch to plus 400 millionths. Sixty additional turns reduced the blocks to within 225 millionths of the required size, and then a number of other lapping periods followed, until the gage-blocks were only 15 millionths over size. The machine in this case was then set to make 50 revolutions, which gave the additional reduction required.

Transposition of Gage-blocks to Eliminate Errors

The transposition of the blocks is a very essential part of the work, and if this were not done, it would be impossible to lap the opposite surfaces of the blocks flat and parallel at the same time. Whenever a set of rough blocks is placed between the laps, the upper lap is sure to rest upon the three highest points or areas, and if the upper lap were in an inclined position to begin with, it would ordinarily tend to remain out of parallel with the lower lap. To avoid this lack of parallelism, the minute errors in heights of different blocks are gradually eliminated by the following method: After the machine has made a certain number of turns, the upper lap is swung out of the way and every other block is moved 180 degrees, or to a position diametrically opposite. For instance, in the example illustrated by the card, Fig. 15, the automatic stop is first set for 70 revolutions and then the blocks are moved. As the result of this shifting of the blocks, either the highest one in the set or the one next to it, is moved across the plate, and owing to these changes of position, height errors are reduced about one-half. Sometimes the blocks are shifted only 90 degrees, thus further dividing and reducing the error, and by repeatedly changing positions, the upper surfaces are finally brought into parallelism with the lower surfaces.

By referring to the card, Fig. 15, it will be noted that there is no fixed relation between the number of revolutions and the amount of reduction by lapping. This is due to the fact that as the blocks are transposed and occupy different relative positions between the laps, the high areas, in some cases, are quickly reduced, whereas for other positions, the surfaces are more nearly in the same plane, and, consequently the laps are in contact with larger areas, and any reduction in the height of the blocks requires much more time. For instance, it will be seen that 20 revolutions served to reduce the blocks from 225 to 200 millionths, and then 30 revolutions more did not result in any appreciable change. The next lapping period, however, of 40 revolutions again reduced the size 25 millionths.

The Laps Used for Precision Gage Work

The laps used for these precision gages are charged with a fine grade of Turkish emery, which has been found superior to artificial abrasives for this particular work. The charging of the laps takes place at the time they are ground in, as explained later. A slight amount of additional abrasive is also applied to the laps during the early stages of the lapping process. This abrasive is mixed with kerosene which is pumped through pipe *J*, Fig. 13, to the upper lap which is provided with a channel *H* extending around the outer edge, and holes through which the oil flows to the space between the laps.

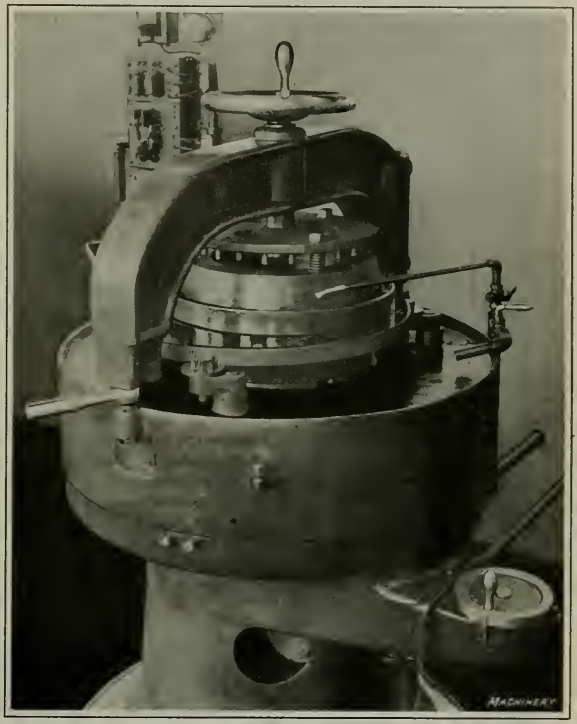


Fig. 14. View of a Lapping Machine, Closed and Ready for Use

Much depends upon the accuracy of these laps; they are made of gray cast iron, which is homogeneous and entirely free from any porous or spongy places. In order to eliminate all internal stresses and prevent subsequent changes, the castings are thoroughly annealed and seasoned. They are next rough-machined and then are further seasoned by the alternate heating and cooling method, using the same apparatus as for the gage-blocks.

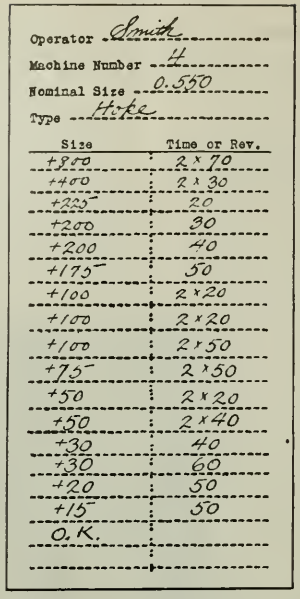
The lapping surfaces which come into contact with the gage-blocks are next planed. The finishing cut is taken with a broad, flat tool and with a fairly coarse feed. After planing, the laps are scraped to a master plate, and then ground together. This grinding-in process is similar to the well-known triple method of making surface plates and straightedges, which is based on the principle that three surfaces cannot fit together interchangeably unless they are true planes. For example, laps Nos. 2 and 3 are first ground in with lap No. 1. Then the order is varied by grinding in lap No. 2 with lap No. 3, and then lap No. 1 with lap No. 2,

and so on. In this way, errors which would be transferred from one plate to another if only two plates were made, are eliminated and plane surfaces are generated.

This grinding in of the laps is done on an ordinary drilling machine (see Fig. 16) equipped with a crank for giving one lap a planetary motion. The fine grade of Turkish emery used for grinding in the laps becomes embedded in the surface, so that when the lap is finished it is also charged and ready for use. The newly ground laps are used on the finishing machines, and those which have become worn slightly through use are applied to the rough lapping.

Measurements of Calibrated Standards or Master Gages

The Hoke precision gages are guaranteed to be flat, parallel, and to the specified lengths within five-millionths of an inch, plus or minus, of basic size up to ½ inch, with a tolerance of ten-millionths of an inch plus or minus, per inch of length for the larger sizes. Incidentally, this tolerance is approximately equal to the expansion of the steel used, with a temperature change of one degree centigrade. The gages are well within these maximum tolerances, and frequently are not more than one- or two-millionths from the exact size. How is it possible to determine when a gage is of a given length within a millionth of an inch?


Operator Smith
Machine Number 4
Nominal Size 0.550
Type Hoke

Size	Time or Rev.
+800	2 × 70
+400	2 × 30
+225	20
+200	30
+200	40
+175	50
+100	2 × 20
+100	2 × 20
+100	2 × 50
+75	2 × 50
+50	2 × 20
+50	2 × 40
+30	40
+30	60
+20	50
+15	50
O.K.	

Fig. 15. Sample Card which shows how Blocks having a Nominal Size of 0.550 Inch were gradually reduced to the Correct Size by the Mechanical Lapping Process

In the production of precision gage-blocks on a manufacturing basis, the gages are compared with master blocks or calibrated standards, by the application of a simple optical principle. But before this can be done, the standards must be calibrated, which requires special optical apparatus and very careful observations, corrections, and calculations. These fundamental measurements of the master blocks used by the Pratt & Whitney Co. were made at the Bureau of Standards. The process, reduced to a few words, involves determining the number of light waves between the planes or faces of the standard or block being measured. In connection with this work, the character of the source of light must be determined, and corrections must be made for various conditions which affect the results, such as atmospheric pressure, humidity, etc. Complicated mathematical calculations are also necessary, so that making one of these fundamental measurements is a scientific undertaking, and considerable time is required to determine the size of a single block. In fact, two men working together can measure only about three blocks in a day.

When the number of light waves between the upper and lower surfaces is known, the length of the gage can be determined with great accuracy, because the length of the standard meter, in terms of light waves, has been determined with such accuracy that the error is negligible. After standards have been measured in this way and their errors are known, they can be used as a direct means of comparison with the gages in process of manufacture. The masters used are generally not absolutely correct, but a table of errors enables the operator to make the necessary corrections.

When the gage-blocks are being lapped to size, an amplifying gage of the type shown in Fig. 18 (made by the American Gage Co., Dayton, Ohio) is used as a means of ascertaining the gradual reductions in size, before applying the more sensitive optical test which is only required for the extremely fine measurements. The indicating dial of this gage is graduated to 0.0001 inch, and the gage is so sensitive that a variation in size of 0.00001 inch can be detected. This gage is first set by using calibrated standards (as shown in the illustration) so that the blocks, as they are being lapped to size, can be compared directly with the standards. The smaller gages are tested in multiple, a number being wrung together so that

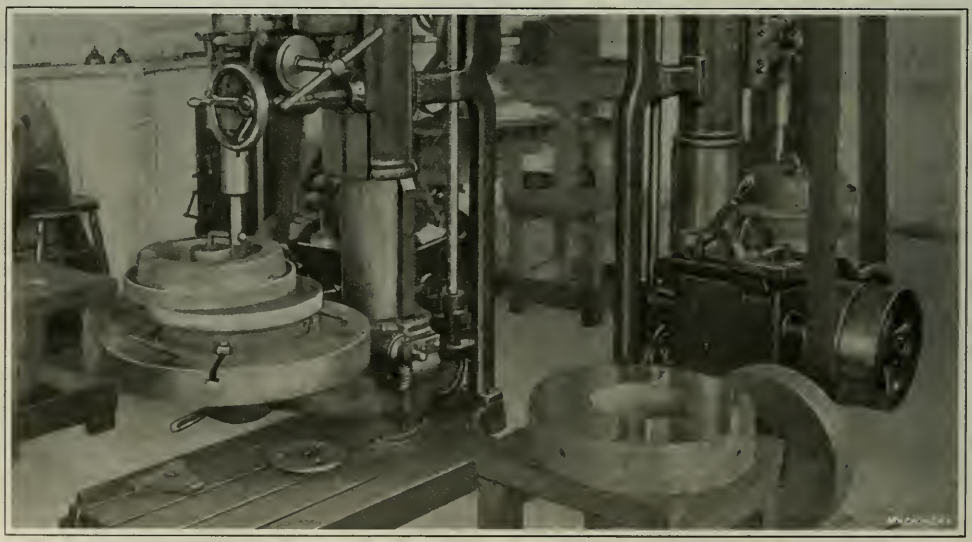


Fig. 16. Machines used for generating Plane Surfaces on the Laps by grinding them together, the Process being Similar in Principle to the Well-known Triple Method of making Surface Plates

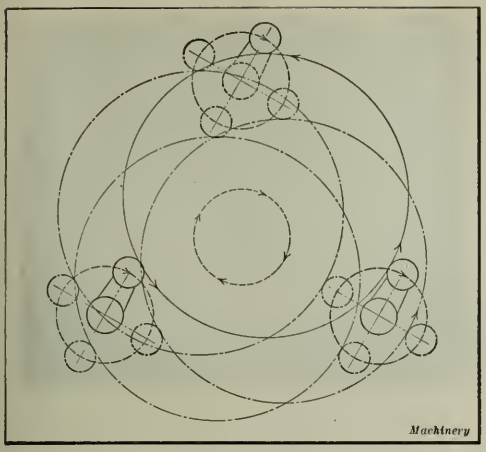


Fig. 17. Diagram illustrating the Planetary Motion of the Plate or "Spider" which moves the Gage-blocks around between the Stationary Lapping Surfaces

a test for height shows the combined error instead of the relatively small error in one block. The amplifying gage or comparator is used until the gages have been lapped practically down to size. Then the optical test is applied to each block to determine whether both end surfaces are flat and parallel and whether the block is of the correct length. As

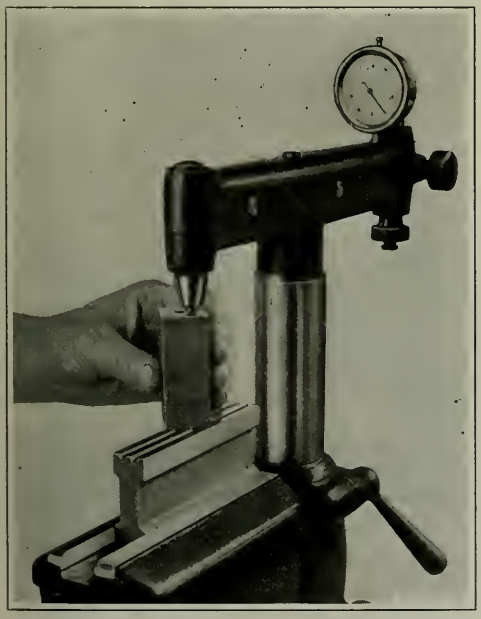


Fig. 18. Amplifying Gage used to show the Gradual Reductions in the Sizes of the Gage-blocks before applying the More Sensitive Optical Test

the lapping operation heats the gages somewhat, it is necessary to allow sufficient time for the blocks to come to the room temperature before measuring.

Optical Method of Testing Gages for Flatness

The apparatus used for the final test of accuracy is shown in Figs. 19 and 20. This apparatus and the method of testing are simple but wonderfully accurate. The equipment consists of a Cooper-Hewitt mercury-vapor lamp; a ground glass beneath the lamp to diffuse the light; and "optical flats" or glass plates which are such perfect planes that errors cannot be detected. If one of these optical flats is placed over a block, the light from above, after passing through the glass plate, will be reflected from the lower surface of this plate and from the upper surface of the gage-block, and as the result of the interference of the light waves (a phenomenon explained in treatises on optics) a series of alternate light and dark bands becomes visible, assuming that the flat is properly applied.

These "interference fringes" or bands would not be visible if a perfectly flat gage were wrung into close contact with the optical flat. In this case, the surface of the block as

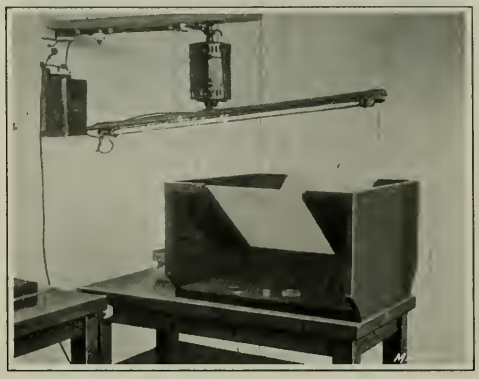


Fig. 19. Optical Apparatus used for testing the Accuracy of the Gage-blocks

seen through the glass beneath the light, would have a steely or grayish hue, wherever there was close contact, and any slight lack of perfect contact would be indicated by a tinge of yellow. If the optical flat were applied to this same block with only one side or edge of the block in close contact, there would be a thin wedge-shaped space or film of air between the flat and the surface of the block and then the interference fringes would be visible. If these bands are parallel and straight or nearly so (as shown in Fig. 21, which illustrates the optical test applied to a toolmaker's "flat"), this indicates that the surface is accurate as to flatness, assuming that the bands remain parallel and straight



Fig. 20. Another View in the Laboratory, showing Gage-blocks being tested for Accuracy by the Optical Method



Fig. 21. The Optical Test applied to a Toolmaker's Flat; the Approximate Straightness of the Bands or Interference Fringes indicates that the Surface is nearly a True Plane



Fig. 22. Optical Test applied to a Toolmaker's Flat which is not Accurate. The Extent of the Error is indicated by the Amount that the Bands curve

after the optical flat is placed in contact with an adjacent edge so that the inclination of the flat is at right angles to the first position.

When testing for flatness, the bands literally form a contour map of the surface of the gage-block. For instance, if the surface is not flat, the extent of the error is indicated by the amount that the bands curve (see Fig. 22); and any one band coincides with that part of the untrue surface which is on the same level. The distance from one band to the next (whether the bands are straight or curved) increases as the optical flat is pressed closer to the gage, owing to the change in the angle of the wedge-shaped space or film; but regardless of what the actual distance is, this space represents about ten-millionths of an inch. Thus if the height of the arc formed by a curved band, within the width of the gage, is equal to the distance between adjacent bands, this shows that there is an error of about ten-millionths of an inch; or, if the height of the arc were only, say, one-tenth of the distance between the bands, this would indicate an error of one-millionth inch.

While straight parallel bands indicate a flat surface, it is necessary to place the flat in two positions with the respective lines of contact along two edges of the block at right angles to each other, in order to obtain an absolute test. This point is illustrated by the application of the flat to a surface which has a very slight curvature but is truly cylindrical. In this case, the bands would be parallel, provided the line of contact with the flat were parallel with the axis of the cylindrical surface, and this would hold true whether the surface were convex or concave. The parallel bands, however, would not be uniformly spaced, as in the case of a perfectly flat surface, although this irregularity of spacing might not be noticeable for very slight curvatures. This curvature would be readily detected if the flat were applied with the contact line at right angles to the first position, because curved bands would then be seen. The bands would be parallel for the first position, because the only effect of the curvature would be to increase or decrease the thickness of the air film, and as any axial surface line would extend squarely across the wedge-shaped space and be parallel to the surface of the flat, the bands would be straight for this one position, and the lack of uniformity in spacing would be the only indication of curvature.

Tests for Parallelism and Length

While the flatness of a surface can be tested by using a single optical flat, as just described, it is necessary to determine whether the two end surfaces of each gage-block are parallel to each other and the right distance apart. In order to do this, two optical flats and a calibrated standard block are used. The standard block and the gage to be tested are wrung upon one of the flats and placed close together. Then the other flat is applied to the upper surface (see Fig. 23) so as to obtain contact at points along the same side of each block. If both upper surfaces are flat and lie in exactly the same plane, a series of continuous parallel bands will extend across the two blocks, but if the bands above the two blocks incline in different directions, this shows that the



Fig. 23. Applying an "Optical Flat" or True Glass Plane to a Gage-block which is being compared with one of the Calibrated Standards or Master Gages



Fig. 24. View of Gage-block (at Left) and Calibrated Standard (at Right) as seen through an Optical Flat which is placed over the Blocks when testing for Accuracy

surfaces are not in the same plane and that the two planes are not parallel. When the surfaces are parallel but not exactly the same height, the bands incline in the same direction, but those over one block will be offset in relation to the bands over the other block. Fig. 24 shows an optical flat applied to two blocks; a calibrated standard is at the right and the gage-block being tested, at the left. In this case the bands show that the upper surfaces are about parallel, although they are not the same height, and the block to the left is not exactly flat, as indicated by a slight curvature of the bands.

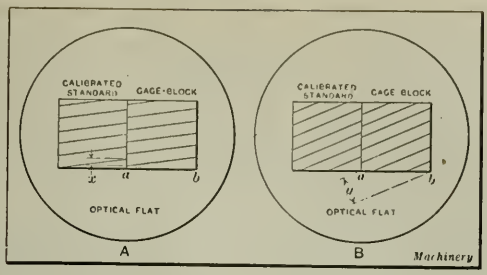


Fig. 25. Diagram illustrating how the Amount of Error is determined

When a flat is first applied to two blocks, if a series of continuous parallel bands extend across both surfaces, this shows that these surfaces are in the same plane; it does not follow that the upper surfaces are parallel with the lower ones which are in contact with the bottom flat. For instance, both upper surfaces might be in exactly the same plane, but inclined slightly in relation to the lower surfaces, although such a condition would be unusual in actual practice. Any such lack of parallelism between the upper and lower surfaces would be readily detected, because after a block is tested in one position, it is turned 90 degrees and the flat is again placed over this block and the standard. Any lack of parallelism between the upper and lower surfaces is revealed by this change of position, because the bands incline in different directions.

How the Amount of Error is Determined

The amount of error, expressed in fractional parts of an inch, is determined by noting the positions of the interference bands relative to each other and to the points of contact between the blocks and the flat. As an example, suppose there is only a slight error in height or thickness, the surface of the gage-block being a few millionths of an inch below the surface of the standard. When the flat is applied, it is placed in contact with the corner of each block as at a and b (see diagram A, Fig. 25), which makes it necessary to tilt the flat slightly. As the result of this slight inclination of the flat, due to the difference in the height of the blocks, the bands extend diagonally across the surfaces, because the wedge-shaped spaces are in a diagonal position relative to the block, and the more the flat is inclined on account of the difference between the height of the two corners, the more the bands will incline; this inclination is an indication of the amount of error when properly interpreted. The diagram A illustrates a difference in height of only about five-millionths of an inch, which is shown by the fact that the bands over one block are offset relative to the bands over the standard block, a distance x equal to one-half the distance between adjacent bands. In this case, the error is indicated directly by the amount of offset x, but if the error exceeded ten-millionths, which is the amount, in round numbers, represented by the distance between adjacent bands, it would be necessary to consider the total amount of offset. For example the difference in the height of corners a and b of diagram B, is about two and one-half interference fringes, as indicated by y, so that the error is approximately twenty-five-millionths inch, and is determined in this case by considering the relation between the bands and the two points of contact.

This simple and extremely accurate method of using optical flats as a means of checking the relative sizes of gage-blocks, was first applied by Dr. C. G. Peters of the Bureau of Standards. If every block had to be measured by using an interferometer, the impracticability of such a slow process in connection with gage manufacture is apparent. The optical-flat method, which is a simple application of the interferometer principle, places the most accurate known method of checking gage-blocks on a manufacturing basis.



Fig. 26. Safe for storing Gage-blocks certified by the Bureau of Standards



Fig. 27. Another View in Department where Finished Gages are stored

Maintaining a Constant Temperature in the Laboratory

In the laboratory where these gage-blocks are lapped and tested for accuracy, it is essential to maintain a constant temperature, as the blocks will change in length as the temperature increases and decreases, so that the size marked on each block must represent the size for some temperature. The standard temperature for the Hoke precision gage-blocks is 68 degrees F. This temperature, as well as the humidity of the laboratory, is automatically maintained by special apparatus. If this standard room temperature were not maintained, difficulties would also be experienced in producing the gage-blocks, because a uniform temperature throughout each block is essential. For instance, if there were decided temperature changes, such as would occur frequently without means of regulation, the temperature of the blocks might change between the lapping and testing periods, and the outside would be slightly warmer or colder than the inside, so that a block which checked with the standard one day would be inaccurate the next. When the blocks are being compared with the calibrated standards, care is taken to avoid heating them by contact with the hands. The optical test is so sensitive that it shows very quickly the increase in the size of a block which is held in contact with the end of a finger. The motors which drive the lapping machines are placed outside of the laboratory so that they will not affect the temperature of the room. These motors are connected with the machines by means of shafts which are provided with a flexible section to prevent any vibrations from the motor being transmitted to the lapping machine.

The Finished Gages

After the gages are finished, they are covered with grease to prevent any corrosion or pitting of the surfaces during storage. A great many of the gages, before being placed on the market, are sent to the Bureau of Standards where they are again carefully tested and certified. Each of these gages is certified by the Bureau of Standards to be within the limits previously mentioned and most of the gages have even smaller inaccuracies. A section of the safe used for storing these certified gages is shown in Fig. 26 which illustrates how the sets are made up. Gages of the same size are grouped together in drawers, which are plainly marked so that it is convenient to make up the different sets. Another view in the department where finished gages are stored is shown in Fig. 27.

The numbers of blocks in the sets of Hoke gages based on the English system of measurement vary from five to eighty-five. The set containing eighty-one blocks is composed of the following sizes: 9 blocks ranging from 0.100 to 0.1009 inch, varying by an increment of 0.0001 inch; 49 blocks ranging from 0.101 to 0.149 inch, varying by an increment of 0.001 inch; 19 blocks ranging from 0.050 to 0.950 inch, varying by an increment of 0.050 inch; and 4 blocks ranging from 1 to 4 inches in length, varying by an increment of 1 inch. With this set all dimensions from 0.200 to over 10 inches, varying by 0.0001 inch, can be obtained, or, in other words it is possible by combining the blocks, to secure over 100,000 different gage sizes.

While all references in this article have been to the Hoke gages, the lapping and optical testing methods previously described are also applied in manufacturing "mike-checks," toolmaker's flats, and all other precision work requiring extremely accurate flat surfaces.

* * *

In the case of an employe who was found in a semi-conscious condition in the wash-room of a factory and who died nearly two weeks later, due, in the opinion of the physician, to brain concussion caused by accident, the Pennsylvania Workmen's Compensation Board ruled that although there were no witnesses nor information as to the nature of the accident, the occurrence of such an accident could be reasonably inferred, and an award should be granted.

JAPANNING METAL ARTICLES

Baking japan, as ordinarily used in manufacturing, consists of two elements, the base and the solvent. The base is usually some variety of asphalt, combined with linseed, or some similar oil, the whole making a hard substance of similar appearance to rubber. This must be liquefied for use, and the common practice is to dissolve it in naphtha or kerosene. The process of japanning various metal articles consists in dipping them in the liquid japan, and then baking them in an oven.

Owing to the volatile and inflammable type of the solvents used, this baking process is somewhat hazardous. After several bakings, the atmosphere in the oven resembles that of the inside of a gasoline engine cylinder, only needing a spark, or even excessively high temperature, to cause an explosion of great force. Occasionally these explosions have been disastrous to human life and have caused fires. This risk has been great enough to cause some of our large municipalities to consider requiring a manufacturer not only to isolate his oven buildings, but also to provide further protection in the form of a fire wall. It also seemed likely that the insurance companies might become interested to the extent of causing increased expenditures on the part of manufacturers who are large users of japan.

The manufacturers consequently became interested in the possibility of developing a type of japan which has a non-combustible solvent. The Research Laboratory of the General Electric Co. was requested to try to find such a product, and the research thus inaugurated resulted in the development of a variety of japan which eliminated the necessity of a solvent possessed of the destructive qualities of the usual kinds. This water japan, as it is called, is an emulsion of the asphalt oil base with water, in which infinitesimal particles of the base are held in suspension in the water instead of being dissolved in it. It was found that this japan had no tendency to settle, even after months of storage, and that, owing to its being suspended in water, losses by evaporation were practically negligible.

The methods of applying the japan are two in number—the electric dip, and the hot dip. The former is appropriate for small articles, and consists in placing them, charged positively, in a negatively charged iron tank of japan. The result is that an even, smooth coating of japan is deposited on the articles, and, since the japan is deposited free from solvent, there is no resultant drip when the lot is conveyed to the baking ovens.

The second method, or the hot dip, which is applicable to large pieces of metal, was found more or less by chance. It had been the custom in the laboratory to preheat the metal before dipping, in order to free it from dirt and grease. This preheating evidently had the same effect of causing the japan to form a deposit on the metal as giving it a positive electrical charge. A third method is also sometimes used which is a combination of the two already mentioned.

The result has been that a kind of japan has been evolved that gives exactly the same effects as the solvent variety. It is cleaner to handle, owing to the absence of drip, and eliminates the danger from explosions and disastrous fires that were such a dangerous feature of the old form.

* * *

The Bureau of Foreign and Domestic Commerce has just issued a booklet on training for foreign trade for the use of those conducting classes in foreign trade in educational institutions and business houses. It will also serve as a guide to business men in their private reading and research. This publication is a manual containing references to text-books and to sources of general and specific information. Copies can be obtained from the Superintendent of Documents, Washington, D. C., or from any of the district offices of the Bureau of Foreign and Domestic Commerce.

The British Machine Tool Industry

Letter from MACHINERY'S London Correspondent

MACHINE tool builders in Great Britain are without exception busy, machines used for repetition work and in the motor car industry being particularly in demand. Moreover, the new projects will result in the installation of much new equipment in the near future, which applies also to the considerable number of works undergoing extension. Normal activity is increased by the attempt to make up for the time lost on account of the prolonged molders' strike, now settled. While this strike hampered finished production, it proved a blessing in disguise to many firms by affording an opportunity of carrying out a much needed rearrangement of plants. Others, again, had accumulated large stocks of castings and at the termination of the strike had only just begun to feel the effects. In a large number of cases activity was concentrated on accumulating stocks of finished steel parts—some firms indeed going so far as to employ molders in the machine shop with a view to keeping the men together. The inflow of castings will probably involve arrangements being made to increase the machinery capacity, to restore the balance of production. At the end, the strike had begun seriously to affect employment in the engineering trades, the Leeds district in particular suffering in this respect, and in the reduction of time worked, which in cases amounted to as much as three days per week; but in the machine tool industry, for the reasons given, employment was not seriously affected. Makers of heavy machine tools also report that their works are busy. Delivery seems to be the chief consideration, price, within limits, being of less moment. The deliveries of some of the larger makers are gradually improving, and in the case of concerns specializing on one type of machine, seven to ten weeks is offered.

Prices of Machine Tools

Prices show an upward tendency, due to increased cost of castings and freight rates, and a general advance of approximately 10 per cent is freely talked of. The price of castings, for instance, in the Halifax district, has advanced from 3s to 6s per hundredweight. The new railway rates will affect more especially makers of small tools, to whom, should the new rates be insisted on, it will mean an increase in cost of 5 per cent. Small tools are usually made at a low price and are very generally despatched by express.

With regard to imported American tools, the low rate of exchange may eventually have a retarding influence on imports. The increase in cost to an English buyer from this cause alone is in the neighborhood of 30 per cent. The fluctuating value of the pound renders quotations difficult—they have always to be made with the reservation "subject to." For the present, however, the demand for American machines is maintained because of the better deliveries that are possible by dealers who can supply from stock.

Swedish Machine Tools Offered in Great Britain

Swedish machine tool makers are beginning a selling campaign in this country. Prior to the war the whole of the Swedish output was absorbed by the Scandinavian countries, Finland, and Russia, but owing to the prevailing conditions in the two latter countries, this outlet no longer exists. An extensive range of machines can be offered from stock, equal in reliability—it is claimed—to the British product, although produced on a quantity basis as in the United States. Furthermore, the Swedish exchange is within 2 per cent of normal and has remained practically constant for the last six months. The export organization handling these machines, which is called the Swedish Machine Tool Makers Export Co., Ltd., follows the lines of our own Associated British Machine Tool Makers, Ltd., in that the constituent firms have come to an agreement among themselves regarding the particular types of machine each should build, and to unify the separate sales departments in joint sales offices. It is not, therefore, a dealer or agency but a part of the constituent works from which the prices and terms are quoted directly. It is yet too early to gage the extent of this competition; no offices appear to have been taken, the present representation apparently being conducted from a residential address.

Little, so far, is heard of German competition in this country, and the hand of the association is still strong upon its members against handling German productions. German salesmen, however, are in the country, and in one case at least, business has been done in plate frame punching and shearing machines. An item of news which may not yet have reached the United States is to the effect that the Export and Import Section of the German Machine Tool Association provides that no machine tools shall be sold for export from Germany at less than seven times the pre-war price, except to countries allied to Germany during the war, in which case it is to be four times the peace price.

New Developments in Machine Tools

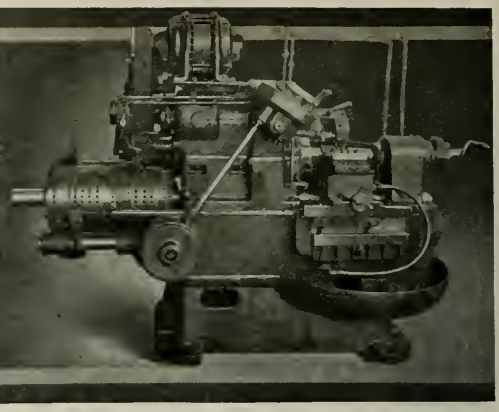
Two Birmingham firms, the Precision Gage Co., and Parsons & Ward have entered the machine tool field; both are placing on the market full screw-cutting engine lathes, of 12 and 15 inches swing, respectively. A new line of plain grinding machines embodying several patented features is being developed by Wadkin, Mills & Co., Nottingham, who are planning to produce these on interchangeable lines in batches of fifty at a time. John Hands & Sons, Birmingham, are introducing a patent power press for manufacturing seamless drawn radiator frame parts. A machine which promises well is an oxy-acetylene blowpipe adapted to a pedestal type of machine-tool frame with positive means for moving the blowpipe in any direction. This tool is introduced by the Godfrey Engineering Co., Wood Green, who has taken up the manufacture in a thoroughgoing manner. A number of the leading plants are engaged in developing new designs or models for the exhibition which is to be held late in the year at Olympia by the Machine Tool Association. This exhibition promises to be a most successful one, as already the main hall and practically the whole of the gallery has been let. Exhibitors are taking the matter very seriously, and are putting up their best efforts so that not a few surprises may be expected.

Small Tools

Jones & Shipman, Leicester, continue to develop their lines of small tools, which in finish closely resemble American products. They are of high quality and sell at a lower figure than American tools. The latest addition is an all-steel drill chuck, made in five parts, which will take drills up to ½ inch in diameter. It appears to be a very serviceable tool and is being produced on the best manufacturing lines. The firm reports a heavy demand for its product in Canada. Another concern, which specializes in twist drills, reports the receipt of many orders for these in America. The plant in question promises in the course of a few months to be the largest in the country.

Machining Automobile Engine Pistons

By RALPH E. FLANDERS
Manager, Jones & Lamson Machine Co., Springfield, Vt.



A Description of the Methods and Tooling Equipments Used in Quantity Production of Automobile Engine Pistons

THE following article contains a description of the various methods used in the quantity production of automobile engine pistons. It deals, however, especially with the tooling equipments used in the various turning, facing, boring, and grooving operations performed on Fay automatic lathes. The simple tooling used on these machines, the small number of separate operations required on the piston by their use, and the automatic performance of the tools, which enables unskilled workmen to be employed for operating these machines, permit the pistons to be machined at a very low labor cost. Although the article describes the machining of only one type of piston, differently designed pistons such as those having domed, beveled, or concaved heads, can also be finished on these machines. In such cases, however, other tooling arrangements must be substituted for the ones employed in the machining of the piston dealt with.

First Machining Operation on the Piston Casting

The first operation performed on the piston casting consists of drilling a center in a boss cast on the outside of the closed end especially for this purpose, in order to permit the casting to be mounted on the centers of the automatic lathes in succeeding operations. This boss should be amply large, so that a deep heavy center can be used on these machines, as a number of cuts are taken at one time and a small center would not prove adequate for the purpose. This centering operation is performed on a drilling machine of the sensitive type, the rough casting being placed over a centering mandrel. By means of this mandrel, the center is drilled true with the rough cored hole in the piston. The combination centering drill and countersink is guided into the work by means of a special bushing.

Roughing Operations

The second operation consists of taking rough cuts over all of the exterior surfaces of the work; this operation is performed on a Fay automatic lathe, as illustrated in Fig. 1. This illustration also shows the set-up of the tooling equipment used in this operation. The piston is mounted on the machine as shown. The work is first slipped over the air-operated expanding and centering mandrel *A*, which is attached to the faceplate of the machine, until stop *B* comes in contact with a small rib on the inside of the wall at the closed end. The piston is centered on the mandrel as the three pins *C* are forced radially outward against the cored hole in the piston by the taper surfaces on push-rod *D*. This occurs when the push-rod is forced toward the tailstock by means of a compressed air cylinder. The ends of pins *C* in contact with the taper surfaces of the push-rod are machined to the same angle as the taper surfaces on the push-rod. When push-rod *D* is returned to its original position, pins *C* are forced back toward the center of the mandrel by means of flat springs attached to the outside of body *A*, which operate upon the outer ends of the pins.

The closed end of the piston is supported by the rotating center *E*, held in an air-operated tailstock, which fits into the center drilled in the preceding operation. The tailstock center is provided with a ball bearing to take up the thrust produced on it. A good view of the air-operated tailstock may be obtained by referring to Fig. 4, which is a top view of the machine used in this operation, taken from the tailstock end. The end of mandrel *A*, Fig. 1, is provided with lugs *F* which come in contact with the bosses provided for the wrist-pin holes, thus causing the piston to rotate as mandrel *A* revolves. By the means just described, the work is well supported, and well driven by a fast air-operated mechanism, one valve operating both push-rod *D* and the tailstock center.

In the operation performed on this machine, surface *G* is rough-faced by tool *H*, grooves *I* are rough-turned by tools *J*.

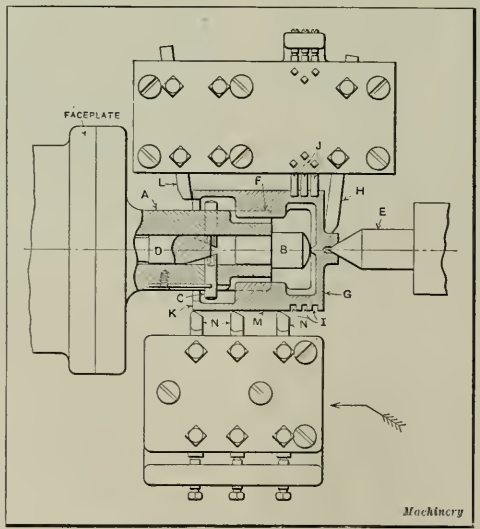


Fig. 1. Tooling Equipment employed in taking Roughing Cuts on Exterior Surfaces of Piston

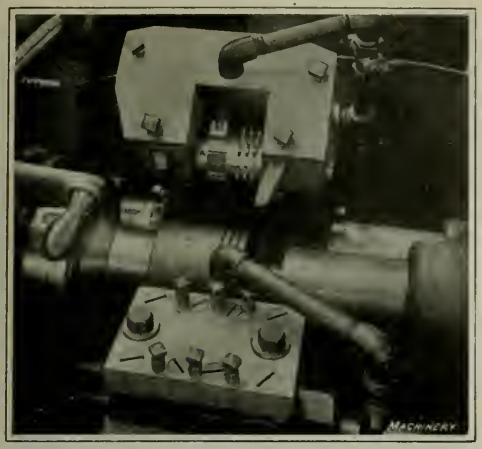


Fig. 2. Machine provided with Circular Cutter for machining the Piston-ring Grooves

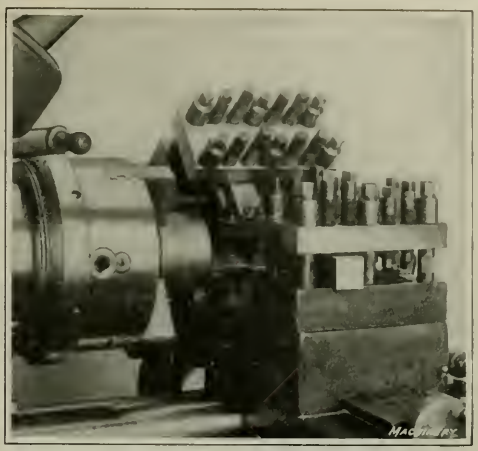


Fig. 3. Set-up of Machine used to take Roughing and Finishing Cuts on Open End of Piston

and surface *K* is rough-faced by tool *L*, all of these tools being mounted on the rear tool-holder. This tool-holder swivels on a round bar at the rear of the machine, and the cuts are taken as the tool-holder is swiveled toward the work; at the same time surface *M* is rough-turned by tools *N*, which are mounted on the carriage at the front of the machine. The carriage is fed toward the work at an angle until the tools take the proper depth of cut, after which it is traversed longitudinally toward the left. The arrow indicates the direction of the carriage traverse. Three tools *N* are provided so that surface *M* can be machined in the same time as surface *G* is rough-faced by tool *H*. Thus, it is apparent that all of the exterior surfaces of the piston are rough-finished in the time consumed in rough-facing surface *G*.

Fig. 2 shows a front view of the tooling equipment on the machine shown in Fig. 4. This equipment is similar to that shown in Fig. 1, the only difference being in the rear tool-holder and the tools employed in producing the three piston-ring grooves. On the machine shown in Fig. 2, a circular tool is used instead of the ordinary tools shown in Fig. 1. This circular tool is ground so as to have six cutting edges equally spaced around its periphery. Any of these cutting edges can be held in the proper cutting position by means of a screw which extends through the rear tool-holder. A locking block is attached to the inner end of this screw, which may be placed in position on any of the steps machined on the lelft-hand end of the cutter, thus preventing the cutter from turning. When desiring to use a new cutting edge, it is only necessary to loosen the screw, thus releasing the locking block, turn the cutter a fraction of a revolution, and then tighten the locking screw again. The advantage of the circular cutter over the tool shown in Fig. 1 is that when the cutting edges become dull, new edges can be readily had without the necessity of the machine being idle while the tools are being reground. One man can operate two machines performing this operation when the production requirements necessitate it.

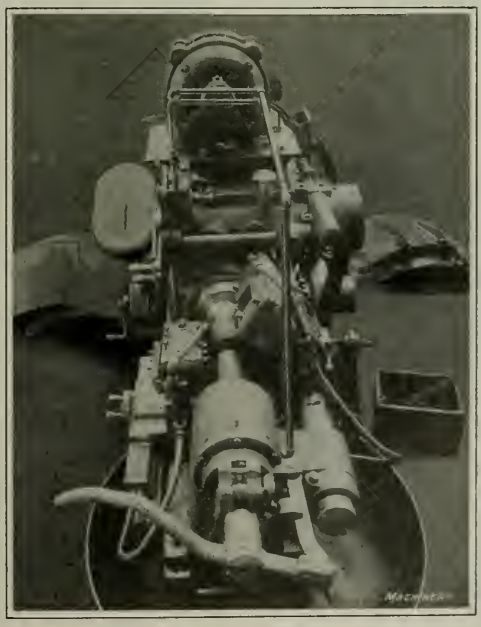


Fig. 4. Top View of Machine shown in Fig. 2, equipped with an Air-operated Tailstock

Drilling the Wrist-pin Holes and Annealing the Piston

The third operation consists of rough-drilling wrist-pin holes *T*, Fig. 5, on a drilling machine. The work is placed in a jig for the performance of this operation, being centered by means of surface *M* and located longitudinally by means of surface *G*. The correct point on the periphery of the piston is brought into the proper position for the operation, by means of the bosses on the inside of the piston through which the wrist-pin holes are drilled. This operation completes the removal of the bulk of the excess material and the scale, and the piston is then ready for annealing.

In the fourth operation, the piston is annealed in order to eliminate all the strains in the metal produced in the preceding operations, and to remove all chances of distortion in succeeding operations. This is the logical time for the annealing operation, because all but one of the roughing cuts have been taken, and so there is not much more metal to be removed from the casting. A modern continuous-feeding automatic furnace was installed in the machine shop so that the rapid production would not be interfered with by the necessity of transporting the work to an outside heat-treating shop. Suitable heat insulation and forced ventilation are provided in order to make the arrangement comfortable even in hot weather.

Finish-facing, and Rough- and Finish-boring Operations on the Open End

Hole *S*, Fig. 5, and surface *K* on the open end of the piston are rough-bored and finish-bored, and finish-faced,

respectively, in the fifth operation, which is performed on a Fay automatic lathe. It may appear to the readers that it would have been better to have machined this end prior to the second operation in order to obtain a finished surface for locating the work on the machine in that operation. However, if these surfaces had been machined at that time, they would have become distorted in seasoning. Because the piston is annealed previous to the machining of this end, there is no danger of further distortion resulting from this operation.

The piston is mounted on the machine as shown in Fig. 5, for the performance of this operation, being held in an air-operated chuck by means of jaws which grip the piston along the previously rough-finished surface *M*. Surface *G* of the work is used to locate the work longitudinally in the chuck. Since these surfaces were machined approximately true with the cored hole in the piston, it is obvious that the surfaces machined in this operation will also be approximately true with the cored hole, because the piston is mounted and located in the chuck by means of surfaces *G* and *M*. This being the case, surfaces *K* and *S* can be used in locating the work in future operations. It will be seen by referring to the illustration that the open end of the piston projects well beyond the chuck jaws, and on this account no distortion results from this chucking.

The following is the manner in which the various surfaces are finished. The rear tool-holder first moves longitudinally along the bar on which it is mounted, and hole *S* in the open end of the piston is rough-bored by tool *O*. It then swivels toward the center of the machine, during which movement surface *K* is finish-faced by tool *P*. This surface was rough-faced in the second operation. The arrow indicates the feeding movements of the rear tool-holder. In the front carriage is held tool *Q* which finish-bores hole *S* as the carriage is fed in a longitudinal direction. When it is desired to bevel the outer end of this hole, another tool can be mounted on the front carriage for the performance of this operation, in the position indicated by the dot-and-dash lines *R*. At the conclusion of the operation, the carriage and the rear tool-holder are withdrawn far enough from the work to permit its easy removal from the machine. The tools are withdrawn in such a manner that they do not score the work. Fig. 3 shows a machine provided with the tooling equipment required for this operation.

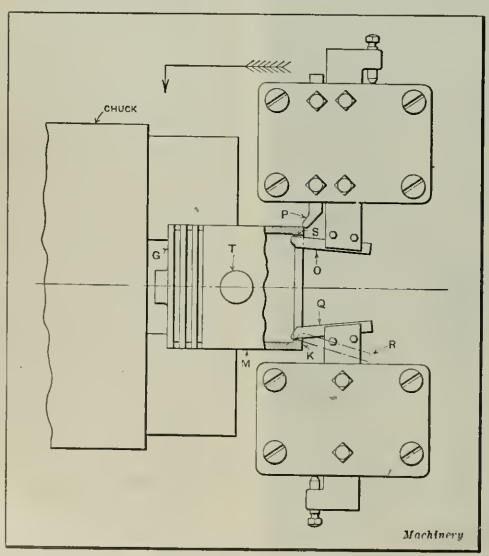


Fig. 5. Lay-out of Tooling Equipment provided on Machine employed to finish the Open End of the Piston

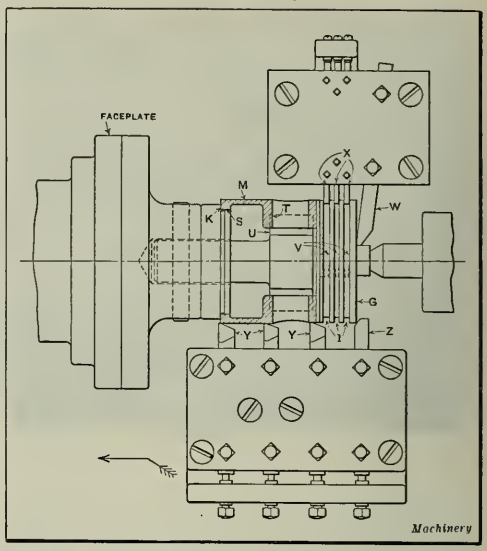


Fig. 6. Tooling Equipment required in taking the Finishing Cuts on the Exterior Surfaces of the Piston

Finishing Operations Performed on External Surfaces

For the performance of the sixth operation, the work is mounted on another Fay automatic lathe as shown in Fig. 6. This operation consists of finish-facing surface *G*, finish-turning surface *M*, and finish-turning grooves *I*. The work is mounted on the machine by means of a hardened and ground plate which is attached to the faceplate of the lathe. The piston is seated on this plate by means of hole *S*, and is located longitudinally by surface *K*. The closed end of the work is supported by a floating center, held in a quick-acting air-operated tailstock. This center is made floating so as to permit it to adjust itself to the position of the center in the boss on the closed end of the piston, which is controlled by the seating of hole *S* on the hardened and ground plate previously mentioned. Otherwise, it would have been necessary to recenter the piston at this end. This method of mounting the work has proved as accurate as the method of holding the work in place by means of a push-rod projecting into the cored hole and attached to a pin placed in the wrist-pin holes. It also avoids a loose piece, and is more rapidly operated. The work is rotated by means of lugs on driver *U*, which engage with the wrist-pin bosses on the inside of the piston. The tailstock center is provided with a ball bearing to take up the thrust.

Three tool-holders are provided for holding the tools used in this operation. The front carriage and rear tool-holder are equipped somewhat similarly to those shown in Fig. 1, but there is another attachment underneath the piston which carries tools *V*. These tools are employed to take a second roughing cut on the piston-ring grooves *I*. The attachment is supported by the tailstock casting, and is operated from the carriage. Surface *G* is finish-faced by tool *W*, and grooves *I* are finish-turned by tools *X*. These tools are mounted on the rear tool-holder and are brought into the cutting position when the tool-holder is swiveled toward the center of the machine. Surface *M* is finish-turned by tools *Y*, which are held on the front carriage, and a bevel is turned on the outer edge of surface *G* by tool *Z*, which is also mounted on the front carriage. All of the tools used in this operation are fed toward or across the work at the same time, so that the entire operation is completed in the time consumed by tool *W* in facing surface *G*. The direction of the carriage movement in this operation is indicated by the arrow. The machine shown in Fig. 7 is provided with

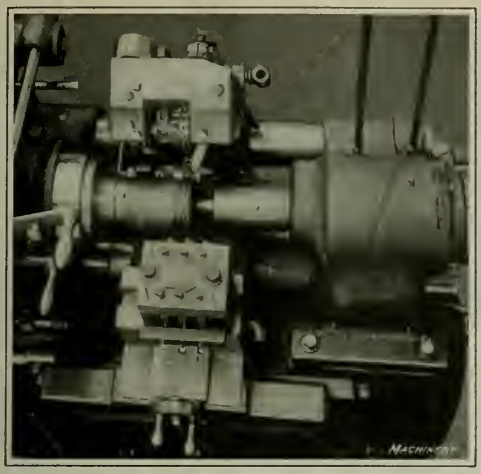


Fig. 7. Machine equipped with Tools required in the Final Lathe Operation

the tooling equipment required for this finishing operation. Because the piston-ring grooves are given two roughing cuts and one finishing cut, great accuracy is obtained in the finished piston. Also because the grooves are finished while the work is placed on centers on which there is no end play, it is unnecessary to perform a final grooving operation on an engine lathe in order to obtain a perfect gas seal when the piston is placed in the automobile cylinder. An operator can readily handle two machines engaged in the performance of this operation.

Final Operations on the Piston

The seventh operation consists of finishing the wrist-pin holes which are rough-drilled in the third operation. The eighth operation is performed on a drilling machine and consists of drilling a number of small holes which are used for oiling purposes, etc. In the ninth operation, the center boss on the outside of the closed end of the piston is sawed off in a hand milling machine, and the rough surface left by this operation is finished on a disk grinding machine. The boss could be entirely removed on the grinding machine if desired. The final operation on the piston consists of grinding surface *M* and polishing surface *G*. The piston is secured to the faceplate of the grinding machine in this operation by means of a draw-rod which projects into the cored hole and is attached to a pin inserted in the wrist-pin holes.

The Fay automatic lathes used in three of the operations described are started by an operator, but are stopped automatically at the completion of the operation by means of a quick-acting brake. On work requiring less accuracy, the operations performed on machines of this type could be somewhat simplified and could be performed a trifle more rapidly.

* * *

An investigation of fatigue phenomena in metals under repeated stress has just been started under the joint auspices of the National Research Council, the Engineering Foundation, and the Engineering Experiment Station of the University of Illinois. The Engineering Foundation is providing $15,000 a year for two years for this investigation, and the Engineering Division of the National Research Council is acting in an advisory capacity, largely through its committee on Fatigue Phenomena in Metals. The experimental work is being done in the laboratories of the Engineering Experiment Station of the University of Illinois under the immediate direction of Professor H. F. Moore, research professor of engineering materials and chairman of the committee mentioned.

WHAT IS ENGINEERING?

The Committee on Development of the American Society of Civil Engineers, in its report to the board of directors presented on October 14, submitted the following definitions of engineering:

1. Engineering is the science and art of directing the great sources of power in Nature to the use and convenience of man.

2. Engineering is an art and a science. It is a science in so far as physical laws are its base, and an art in so far as in the application of these laws the things designed and constructed develop the spirit of progress, the creation of wealth, and the well-being of all peoples. Engineering is generally divided into four major divisions: civil, mechanical, electrical, and mining. The practice of engineering requires knowledge of physical laws, forces, and the materials of Nature. The professional engineer is one who by reason of special training, education, and experience is qualified to design and direct the construction of engineering work in one or more of the major divisions of engineering.

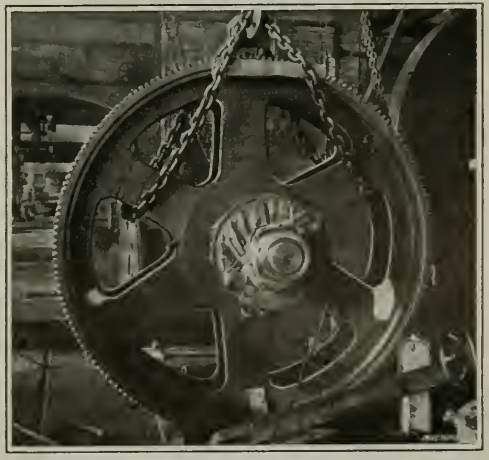
3. Engineering is the creative science and art of applying economically the materials and forces of Nature to the use and convenience of man.

4. Engineering is the science of industrial effort, and the science and art of applying this effort for the welfare of the public. An engineer is one versed in the science and art of industrial effort made for the purpose of public welfare.

* * *

REPAIR MADE ON TURBINE GEAR BY ARC WELDING

The accompanying illustration shows a cast-steel herringbone turbine gear valued at between $7000 and $8000 which was saved from the scrap heap by the "Weldcraft" process of arc welding. This gear, which is part of the equipment of the steamship *Belfort*, is 8½ feet in diameter, has a 24-inch face, weighs approximately 8 tons, and is of double-flange double-spoke construction. This gear was first welded by the ordinary arc-welding process, and broke in the weld. In making the repair, the Electric Welding Co. of America found it necessary to cut out all the welding material that had previously been deposited. This accounts for the unusual width of the welds. It may be interesting to note that this weld was made without preheating. Electric arc welding is becoming of ever-increasing importance in repair work of all kinds, and provides a means for saving many expensive castings as well as the time required for replacement.



Turbine Gear repaired by Arc-welding Process

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THE AGE OF PRECISION

This is the age of the automobile, the flying machine, of electricity, of the turbine-driven ship, and a dozen other important engineering or industrial developments—according to the particular interests and activities of the individual. But the present era in the machine-building and tool-manufacturing fields cannot be defined more accurately than by calling it the Age of Precision. The standards of precision in mechanical work have changed so radically in the last few years that we may well say we have entered upon a new era in this respect. Not more than twenty years ago work that was accurate within one-thousandth of an inch was considered precision work of high character. Ten years ago mechanical men began to speak more frequently of a ten-thousandth inch, and today we are beginning to talk about hundred-thousandths and millionths. Although we all know that mechanical work in general is not produced with any such precision as these small fractions indicate, the fact remains that means are now available for measuring in these terms when it becomes necessary.

The precision gage-blocks which have been developed to the highest accuracy, enabled the mechanical industries, more than any other factor, to attain the present wonderful precision limits. The methods employed in the production of these gages have been surrounded with great secrecy until recently, and it is with considerable satisfaction that MACHINERY publishes, as the leading article in this number, the first complete and detailed account of the methods used in making precision gage-blocks on a commercial basis.

This article on "How Precision Gage-blocks Are Made" will arouse interest wherever mechanical men are found, the world over; for nothing interests them more than an exposition of the ingenious methods whereby such remarkable accuracy is attained.

* * *

A SUBSTITUTE FOR APPRENTICESHIP

Before the departmental method of factory administration came into general use it was usual for boys who wished to become machinists to serve a four-year apprenticeship and thus acquire a comprehensive knowledge of their trade. But this is unfortunately not as common a practice today, although there is still a general demand for the "all-around" mechanic. In fact, the present tendency for boys to avoid signing an apprenticeship agreement has created a scarcity of thoroughly trained mechanics which has placed a premium upon their services. It is difficult now to get boys to become apprentices, because a few weeks of training gives them sufficient knowledge of some specific machining operation to earn what appears to be a satisfactory wage to those who are just entering upon their life's work in the machine shop. Consequently, they are unwilling to agree to spend four years in receiving a thorough training, during which their rate of pay will be only nominal.

One plan for the development of well-trained mechanics that is giving satisfactory results is used at the Willys-Overland plant in Toledo. The features of this plan are fully discussed in an article entitled "Successful Substitute for Apprenticeship" that appears elsewhere in this number. It is explained in this article that the system comprises three distinct functions, but at present we are concerned only with the way in which it serves as a substitute for apprenticeship. A training shop is provided with facilities for teaching one specific machining operation to untrained men; but it does not stop there. Any employe desiring to acquire experience in other operations can obtain a transfer to the training shop for that purpose and while being trained, is paid at a rate 10 per cent lower than the price placed on his labor in a production department where he is familiar with all details of the work. As more than two weeks' training for a new job is seldom required, the loss resulting from the 10 per cent reduction in pay is small.

When a number of applications are received for training in the same kind of work, preference is given to applicants employed on the class of work most nearly allied to the one in which training is desired. This saves time in the training and also provides an incentive for men to gain a thorough knowledge of the machinist's trade, because they are likely to receive preliminary training for a simple job and then return to the training school repeatedly to acquire experience on more skilled work for which they will receive a higher rate of pay. From the employer's viewpoint, this system of training affords a reasonably satisfactory substitute for the regular system of apprenticeship.

* * *

HEAVIER MACHINE TOOLS REQUIRED

During the last fifteen years the weight and size of machine tools of all types have continually increased, the increase having been caused originally by the introduction of high-speed steel. But some users of machine tools still complain that they are not heavy enough to utilize high-speed steel cutting tools to their greatest capacity. Recently a manufacturer of a special product built a machine for his own use in which he incorporated ideas as to weight and size which he had found from experience were applicable to his work, and was able to take from two to three times as heavy cuts as are possible with standard machine tools of the same type. It is doubtful if machine tools as heavy as this would be used generally, because in many instances the standard machines are not required to work to their full capacity, but take cuts for which a lighter machine is adequate. There is considerable demand, however, for very heavy machine tools, especially adapted for heavy, interchangeable manufacture, and it is probable that the future weights and sizes of some standard machine tools will be further increased. The new steels, of which we have recently heard, are said to possess a far greater cutting capacity than the present high-speed steels and may also influence future developments in the direction referred to.

Inches versus Millimeters

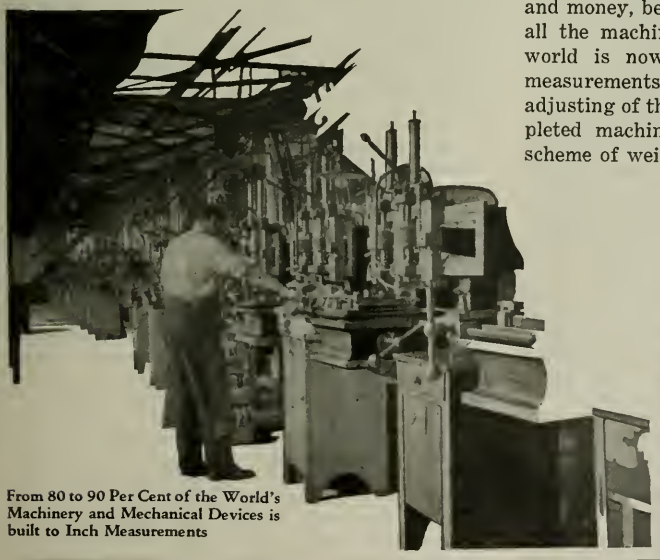
THE controversy between the advocates of the metric system and those who believe that our present system of weights and measures should be retained has apparently passed the academic stage, and the believers in the metric system are now trying to induce Congress to pass laws making the use of that system compulsory in the United States.

MACHINERY has given comparatively little space to this controversy in the past, for as long as it was merely a matter of argument, no practical purpose was served by a rethreshing of opinions. Now, however, the situation has changed, and it appears that great injury may result if Congress is hurried into taking definite action on this question without affording the engineers and manufacturers of the country the fullest opportunity to be heard.

A change in the system of weights and measures is not a question for Congress to decide without hearing the opinions of manufacturers who are vitally interested. Members of Congress, however able, lack the special, practical experience required to pass upon a question of such moment to our industries. The system of measurement used in engineering and industrial work is so closely interwoven with our whole manufacturing and mechanical progress that only engineers and manufacturers possess the definite knowledge, practical experience and judgment to forecast the effect of so profound a change. If the various associations of manufacturers and the engineering societies of the country decide that a change to the metric system is advisable, then these bodies will undoubtedly cooperate to bring it about through the agency of the newly established Engineering Standards Committee.

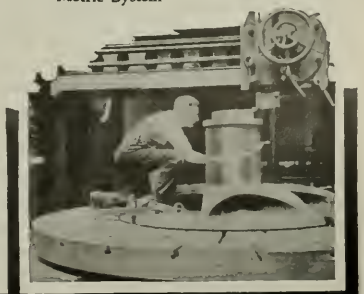
The main question to consider is whether with the present advanced development of our industries, we can afford to make a change. If it is the judgment of a majority of those connected with our manufacturing and engineering interests that it would involve so much confusion and loss and would develop such mechanical difficulties as to completely overshadow any possible gain, then their judgment should prevail. When our manufacturers and engineers can see that the proposed change will benefit those who use their products or increase their sales in countries using the metric system, they will need no urging to adopt it.

Probably the best service MACHINERY can render its readers at this juncture is to place on record the opinions of some of the leading manufacturers and engineers in the machine-building field, and some of these will be found in this number. Their opinions are unanimously for the retention of the present system of measurement. They believe that a change would cause great confusion and loss of time and money, because between 80 and 90 per cent of all the machinery and mechanical devices in the world is now made to the English system of measurements, and a change would necessitate the adjusting of this enormous quantity of already completed machinery and mechanisms into the new scheme of weights and measures.



From 80 to 90 Per Cent of the World's Machinery and Mechanical Devices is built to Inch Measurements

Only from 10 to 20 Per Cent of the World's Machinery is built to the Metric System



What a Change of Measures Would Mean

By JAMES HARTNESS, President, Jones & Lamson Machine Co., Springfield, Vt.
Past President, American Society of Mechanical Engineers

THERE are many reasons why the scientific man should prefer the metric system of measurements, because, being based on the decimal notation, it simplifies scientific and advanced engineering computations. On the face of it, the system is simple and the correlation of the units of weights and the measures for lengths, areas, and volumes unquestionably presents an advantage. In considering the question whether the English system of measurements should be replaced by the metric system, the scientific man however, must, not think only of himself, but he must try to base his judgment upon a broad view of the requirements of the whole scientific, engineering, and industrial world.

In dealing with this subject, I prefer to divide the useful members of the community into two broad groups, which, for simplicity of expression, may be called *word-men* and *work-men*. In the group of word-men I include all those whose usefulness mainly consists in the ideas that they convey to others by the spoken or written word. Hence, this group includes scientists, industrial leaders, designing engineers, the guiding and superintending forces in our industries, as well as the administrative officers of the political state and the law-makers. By work-men is meant that large group which is directly engaged in the actual production of useful things—things necessary for the health, happiness, and comfort of the community—and who perform this work by direct or indirect application of manual effort.

At the bottom of the whole discussion of weights and measures is the understanding on the part of the word-man of the problems that confront the work-man. It must be admitted from the outset that the worker—the actual producer of things—is the most essential man in the world, for without him the work of all others comes to naught. Other members in the community are essential only in the degree to which they cooperate with and aid the producer or work-man in making his efforts more efficient. On the other hand, the directing force in the world is that of the word-man, and to understand the importance of the question of weights and measures, the scientific man must try to obtain the work-man's point of view.

How the Problem Must be Approached

The greatest enemy of a nation in time of war and in time of peace alike is he who misdirects labor, and unfortunately, many have unwittingly been in this class. To make a constructive suggestion with regard to a system of measurements, we must recognize from the start that the man who disagrees with us is undoubtedly imbued with the same sincere purpose toward the welfare of the community at large as we possess. Our contribution toward solving the problem must, therefore, lie mostly in our endeavor to come to a general agreement on the fundamental fact that the work-man's—the producer's—interests must be considered.

The word-man is the natural leader. Often he originally was a work-man who by chance or otherwise has become a leader, and his experience from that point on differs from his experience as a work-man, even though he may not himself realize it. He develops his reasoning facilities, while the work-man develops those powers which enter into the performance of the skilled worker. During this development it becomes quite natural that the word-man should find himself leaning toward the metric system, on account of its apparent simplicity, while the work-man favors the retention of the inch, which possesses some of the elementary principles of simplicity that appeal to the untrained mind.

The greatest problem of the scientist—the word-man—is to obtain a true viewpoint regarding the importance of the work performed by the work-man. Our stumbling block in the past, and our greatest menace at present, lies in the failure of the word-man to understand the work-man. We have reached a point, however, where the relationship of the workers and the leaders must be better understood. In the past, many a time, unfortunately, through a misconception of the workers' attitude, ill-fitting systems of management have been foisted upon the work-man and various blunders have been made that have greatly reduced the efficiency as well as the happiness of the workers. We must be careful that we do not commit a similar error in our consideration of the metric system. Any action on this question should be taken with full recognition of its effects upon production. If a change is made that facilitates the worker's operations, then it is desirable. If it handicaps the worker and reduces the value of the machines and mechanisms already in place in the manufacturing industries and in the hands of mechanics, farmers, etc., it would be harmful.

Basic Facts Guiding Final Decision

The workers who, in the last analysis, produce the things upon which our civilization depends, prefer the old system of measurements because in the binary system it is easier to make the primitive divisions, and they should not be disturbed by imposing on them a new mode of expression.

But why should the worker's preference and convenience be given so much consideration? This question is best answered by considering the fact that the energies of the industrial world are interfered with only by unusual circumstances, such as wars, depressions, or unwise tampering with the systems under which work is performed. The machines and mechanisms produced by labor in the past and which are now in use in every conceivable part of the globe, should remain upon an interchangeable basis as far as possible. If there were an international standard of measurement, it would be preferable; but lacking this, the system to which the greater part of the world's machines and mechanisms have been made must receive most favorable consideration. It is safe to say that of the vast amount of machinery and mechanical devices in the world, from 80 to 90 per cent are made to inch measurements, and only between 10 and 20 per cent to the metric or other systems.

Hence, it is evident that it is essential that the inch should remain the standard length measure in the great machine building industries of the English-speaking world, so as to avoid anything that would handicap the worker or that would depreciate over 80 per cent of the existing machinery.

The difficulty with the men who advocate the metric system is that they do not understand the problems of the industrial world—of the work-man. If there is a misunderstanding of the work-man, however, it is not the scientific man who is to blame, but it is those who are closest to the work by experience and relationship, and this has prompted the writer to say this word for the inch standard. Both a universal language and standard of measure would be desirable. So far as the standard of measure is concerned, there is only one way to solve the problem—by a 40-inch meter.

The place of highest honor in this world should be accorded to those who are beneficial leaders of the worker. Let us all be careful. Let us remember that the worker is the essential man and that we serve well or otherwise as we sense the conditions under which the worker functions.

The Threat of the Metric System

By HENRY D. SHARPE, President and Treasurer, Brown & Sharpe Mfg. Co., Providence, R. I.

In this article, Henry D. Sharpe, the head of one of the leading machine-tool building firms in the United States, points out the reasons why the metric system should not be made compulsory in the United States, calling attention to the importance of uniformity in weights and measures as a national asset and maintaining that such uniformity is insured by retaining the present system, while it would be lost if the metric system were adopted. Mr. Sharpe does not enter into any arguments as to the relative merits of the two systems from a theoretical point of view, but merely points out the practical reasons why at this particular time a radical change in the system of measurements would mean a serious loss to American industries with no corresponding gain.

THE proposal of encouraging a change in the basic standards of weights and measures is a most serious one for any country to contemplate. In the case of a country which has a number of competing systems, such a single system might be embraced with eagerness as well as profit because it would afford relief from complexities long endured. Yet, even here the mere fact of attempted change would be attended with great difficulties. On the other hand, when a country has a substantially uniform system of weights and measures as is enjoyed by the United States, by the British Empire, and by large districts of the world which have traded with these countries for generations, then the project of a change becomes most serious and forbidding.

Facts, Not Theories, Interest the Practical Mechanic

In a mechanical journal one naturally dwells upon the facts of the industry which concern the constituency of the journal itself. The welfare of the mechanical industries prompts a word of warning which cannot be made too strong in the face of suggestions which are persistently and seriously made that the United States should promote, in its usage of weights and measures, a lack of uniformity, after the country has built up its wonderful industrial assets under a system giving substantial uniformity. The encouragement of the metric system means the taking on of a foreign system which cannot possibly supersede, but will inevitably complicate and disturb, the working of a system which we have long been used to.

Practically all American mechanical industries are founded upon the existing system of weights and measures, and these same industries enjoy a real uniformity in the use of such a system. On the other hand, no American mechanical industries of any importance have put out any S. O. S. call for a change in the existing system of weights and measures. While individuals, here and there, some of them connected with great industries, are sometimes sympathetic in a discussion of change, generally speaking, the practical people of our industries almost never speak any words of sympathy—in fact, they are ardently opposed to any change at all. These people know full well the questions which are involved; they know that mechanical practice is inevitably tied to the past because of our system of standardization in manufacture which will prevent the changing of stock parts in every industry where such system has been used.

This American practice of standardization is one of the glories of our industrial development, enabling us to lead the world in much industrial effort; any weakening of its value, such as the promotion of a new system of weights and measures would be the silliest piece of procedure that an intelligent nation could attempt.

Uniformity in Weights and Measures is a National Asset

Uniformity in weights and measures, then, is an invaluable asset to our national industry and must be maintained; there is nothing to promote or to preserve uniformity in encouraging the change which has been proposed. Whether such a change as is seriously proposed would be undertaken by "encouragement," through the passage of a law stipulating that government orders, which are of a large and growing volume in this country, should all be figured in the new system, or by a compulsory law, it would in either case result in confusion and even in a sort of chaotic state in the mechanical industry.

A great many estimates have been made by manufacturers of this country as to the probable cost to a manufacturing business making a change from the existing English system to the metric system by a complete change in fixtures, tools and gages; doubtless these estimates have their value. If manufacturers were to make such changes as these estimates imply, in our opinion the estimates are not exaggerated; yet they do not take account of the handicap placed upon industry following a certain lack of smoothness in running, the certainty of errors in work, and the occurrence of numerous difficulties unforeseen in making such changes.

Our personal opinion, however, is that the favoring of the metric system by Congress, either by "encouragement" or by "compulsion" would not insure a vast majority of concerns attempting to change their tools; for such a change would be altogether too forbidding. Industrial managers, generally, would have to resign themselves to facing a lack of uniformity in weights and measures—to attempt a change would be too difficult and impossible.

We should expect, however, that many new concerns would attempt to use the metric system following the fiat of Congress, which practice in a very short time would produce results of a most troublesome sort to our industries. The effect of such an attempted change upon the people of this country, whose habits of mind and training would be outraged by such government action, would gradually be made evident. As time went on, instead of the substantial uniformity now enjoyed in our industries, a serious lack of uniformity would result. It would be impossible to dislodge from American usage and the American mind the existing system of weights and measures, but the encouragement of the new system would create a dual system making the greatest inconvenience and damage to industry.

Opinions Stated are Based upon Past Experience

The above analysis is based upon attempts to introduce the metric system which have been made by certain shops in time past; bother, confusion, and regret have resulted. Nothing effective has ever been said by the metric enthusiast which will disprove reliable testimony on this subject. The making of metric scales, gages, and other instruments of precision is accomplished in shops using the English system, by using the English system as a basis for measurement. It is all in the day's work and affords no argument in favor of the metric system itself. Where two systems are used in one shop, one system is generally used as the ultimate standard and the other system, if endured, is generally translated into it. With the probable part usage of the new system, owing to government encouragement and

its adoption in some industries by unthinking people, a tax would be placed upon industry in general which would certainly afford a distinct lack of economy in national life.

Without any doubt, this period of growing confusion, owing to the introduction of a system foreign to the habits of our national life, would give this country an education in the errors of Congressional legislation which would make famous, or rather infamous, the people of the present day who had proposed such changes.

To Improve System of Measurements Radical Change is Not Necessary

Let us be fair and admit that the existing system of weights and measures is susceptible to improvement. Without doubt, certain subdivisions of existing units can gradually be done away with by encouragement of a proper sort, if not by the lapse of time. On the other hand, certain new subdivisions of existing units may be introduced; but all this should be done with due regard for the practices of our people, the usages of everyday life, and the thought of the individual. History has shown that changes of this sort are most difficult to make unless they are brought about following the needs of the situation, whatever it may be. Through decades past, American practice and industry have effected improvements of their own in weights and measures. Doubtless, in the years to come organization and need may effect other improvements of importance. The most difficult improvements or changes are in the nomenclature of ordinary life. Can the workman in various industries be induced to make these changes, even should his employer make a serious attempt to teach him? Can the housewife be induced to give up her standards of weight and measure? Can the farmer be educated to yield his standards of purchase and sale? Can the building trades be induced to cast aside names and standards which have been used by them for decades to take over a new nomenclature and standards which mean nothing to them?

The main reasons for opposing the adoption of the metric system are stated by Mr. Sharpe to be the lack of uniformity in weights and measures that would result; the promotion of a system not desired by any considerable number of men in the industries; interference with the habits of thought of the nation; the fact that the metric system is not necessary for successful promotion of foreign trade; and that the practical needs of industry have proved themselves always to be met by the English system.

A great deal has been made of the assumed necessity for the encouragement of the metric system in this country following developments, actual and promised, in foreign trade. Indeed, a report upon this subject has been rendered by the director of the Bureau of Standards in Washington which has achieved wide publicity. The implication of this report is that if the United States is to achieve an added volume of foreign trade it is advisable to make the change in our existing system of weights and measures to the metric system so as to be in harmony with the practices of competing foreign nations. As practical exporters of a large volume of mechanical products whose sale has been the result of intelligent prosecution, we have no hesitation in saying that the implications in this report are misleading and unwarranted.

Summary of Reasons for Opposition to Metric System

We are, accordingly, opposed to the official encouragement or adoption of the metric system for these reasons:

1. It means the promotion of a lack of uniformity in our system of weights and measures, whereas, now the United States enjoys a practical uniformity; such uniformity is one of the assets of American industry.

2. It means the promotion of measures undesired by any considerable number of men in industry whose infliction upon industry as a whole would cause great confusion and waste, and instead of assisting, would greatly hamper us in competition with advanced foreign nations.

3. It means the interference with habits of thought enjoyed by generations among the great mass of our people.

4. It is absolutely unnecessary to the successful promotion of foreign trade; we enjoy a large foreign trade now without the metric system, except where we think it of advantage to use it in our products; its furtherance depends upon the initiation of individuals and not the assumptions of government officials and other theorists.

5. The metric system, while liked by many, has never justified itself as in any way superior to the English system of weights and measures in the practical needs of industry.

6. No better warning against its promotion can be made than by quoting these words of John Quincy Adams in his classic report of weights and measures published one hundred years ago, where he says: "The substitution of an entire new system of weights and measures instead of one long established and in general use, is one of the most arduous exercises of legislative authority. There is, indeed, no difficulty in enacting and promulgating the law, but the difficulties of carrying it into execution are always great and have often proved insuperable. The legislator . . . finishes by increasing the diversities which it was his intention to abolish, and by loading his statute books only with the impotence of authority and the uniformity of confusion."

Concluding Remarks

The agitation for a change in our basic system of weights and measures by force—the force of law—is characteristic of the times. In previous generations the thought running through the minds of our people and its legislators was that government should do the least necessary, and that private industries and private individuals should be untrammeled by government interference of its people trying to live and to get a living. With change of time, however, certain undesirable influences have been evolved which we can easily recognize. Among these influences are the force of organized propaganda, the substitution of the opinion of theory for practice, as the basis of argument of change, whatever it may be, and the growing power of a government bureaucracy.

In the agitation for the metric system, the first influence is exemplified in the conduct of the so-called World Trade Club of San Francisco, an organization which flourishes by virtue of ample and unknown sources of revenue, which issues its advertising matter in editions widely distributed, filled with half truths and misrepresentations.

The second influence is exemplified in the great attention given on this question to the opinions of men of science and theory, instead of listening to the men who conduct the affairs of industry and business in general, these latter having knowledge of theory, it is true, but tempered by the restraint of experience and practice.

Of a third influence—the growing power of government bureaucracy—no better illustration can be given than the influence of years past of the Bureau of Standards in Washington. Without this influence few of the members of Congress would favor the metric system; without this persistent effort to undermine the existing system of weights and measures giving uniformity, the metric system would not have been proclaimed as the basis of the official standards of the government itself.

All of these influences—a widespread propaganda, the recognition of the authority of theory instead of practice, and government bureaucracy—have been the greatest factors in the agitation for the furtherance of the metric system; but the threat of the metric system will not proceed further if the industries and the people of this country can be shown what its enactment would mean.

The English Versus the Metric System

By C. H. NORTON, Chief Engineer, Norton Co., Worcester, Mass.

THE professor and teacher tell us the difference between the metric and inch measure, how beautiful the metric measure is in its arrangement, and how all the different units have so nearly the same name that they all sound alike as they are spoken, whether they refer to solid, liquid, or linear measure. They tell us how easy it is to figure in metric units and how the meter is a certain part of the earth's circumference.

As a boy, without experience, what I read in books and what the teacher said I believed to be not only the simple truth, but the only truth; during that period of life, when experience was unknown, the only knowledge I could obtain was gained from books written by people who obtained their knowledge from reading books that were written by others, who, in turn, had obtained their knowledge from studying books written by others who had obtained their knowledge in the same manner. At that time, when all I knew was taught me by teachers who learned "what had been done and who did it" by studying what others who had written had learned in the same way, I was greatly interested in the very ingenious academic invention known as the metric system and dreamed dreams of the wonders that could be accomplished by its universal adoption.

In his discussion of the proposed compulsory adoption of the metric system, Mr. Norton bases his conclusions upon more than fifty years' personal experience in the machine-building field, which leads him to believe that any change undertaken now would be extremely costly and would, in fact, rock the very foundations upon which our industrial structure is built. He emphasizes particularly the fact that the question of measurements is the concern of those who measure the products of the industries and not of those who merely teach others in the study of measurements. He points out the serious consequences of the proposed change and the difficulties that would be encountered.

But, very early in life I was forced by necessity to earn my own living and the living of others. I was passed on from the society of those who knew "what had been done and who did it" to association with those who knew "what to do and how to do it." Contact with these people, who really measured the products of the world, and association with the men who by their initiative and production have made this country what it is and who have placed it at the head of the world in education, art, comfort, and luxury, taught me, as time went on, that the metric system was not as useful to the men who actually measured, as the inch system.

Those who Use Measurements Know More about them than those who Merely Teach

I have now, during fifty-four years' experience as a mechanic, designer, and engineer, responsible for results, come to know that the men who measure know more about systems of measurement and their usefulness than the men who simply teach measure. In my fifty-four years of dealing with fine measures and calculations to secure the correlation of all the hundreds of thousands of moving elements of machinery, I have come to know that the reason why the metric system has not been adopted in this country is simply because it is not good enough for adoption. If it had been better than the present system, the initiative of the American mechanic would long ago have caused its adoption, and no law could have prevented him from doing so. He always has and always will adopt the system best suited to his success.

To propose the compulsory adoption of it now is an insult to the intelligence and initiative of American mechanical genius. During the fifty years since the metric system was made legal in this country the American mechanic has made all that we have in this country possible, including our institutions of learning, and, therefore, the attitude of a portion of our educators in respect to the metric measure and its proposed compulsory adoption is presumptuous in the extreme.

Practically Impossible to Make a Change Now

It is not because we are all ignoramuses, Mr. Professor, that we do not use the metric measure; it is not that we do not understand the metric measure; it is not that we have not read your books. Whatever the merits or demerits of the system, it is a physical impossibility to compel its use. Moreover, it is now impossible to change, if we would, because such a change would wreck our great industries, built up by so many years of ingenious inventions, and by the work of so many thousands of the best mechanics that the world ever produced.

In a comparatively small organization there are some 400,000 dimensions on many thousand drawings, all used by a thousand workmen who have required years—in fact a lifetime—to learn to read and to understand them. To translate these dimensions into metric, with all the attendant errors, would wreck the business, to say nothing of the task of teaching the thousand workmen to read and apply them.

The Danger of Two Systems Used Simultaneously

Any attempt at compulsion would not stop the use of the English system in the great majority of cases, for the reasons just stated. A few zealots might cause our manufacturers much expense and trouble with the courts for a time, but in the end no change would be made, except that people, starting new industries, would adopt the metric system to avoid the courts. The consequence of this would be that we would have two systems, and the injury to the industries of the United States cannot be computed in dollars and cents. The confusion that would arise would be very great.

Thousands of us have spent a lifetime studying and arranging the necessary clearances and measurements which are correlated in the machinery that has served the people of this country and helped to make its great wealth. Many of us have put a study into the use of these measurements such as few men outside of our industries have any conception of. This study on the part of so many hundreds of thousands of men in this country has made our country what it is, and to ask these men to throw away their work of a lifetime and attempt to translate that work of years into another system of measurements is like asking them to not only learn another language themselves, but also to teach their workmen another language, they being meanwhile held responsible for the consequences. That is a demand entirely unreasonable and equally purposeless.

We are threatened with a law to compel us to use an inferior system. To those who are advocating this law, but who are not responsible for earning the dollars and cents that support our people through our industries, we say: "It is none of your business, but is the business of us who measure the products through which the taxes are paid, and we will fight you to the bitter end."

Industrial Conditions in Italy

By ERCOLE VAGHI, Milan, Italy

IN the May, 1919, number of MACHINERY, in an article entitled "Prospects for American Machine Tools in Italy," the writer reviewed the conditions of the Italian machine tool market as they then existed. The events since that time have confirmed the opinions expressed in that article. The writer has recently made a visit to many of the most important manufacturing plants in Italy with a view to selling American machine tools in the Italian market. The present article contains a summary of his impressions.

German Machine Tool Competition

The competition of German machine tools is still weak in Italy on account of the unstable conditions existing in Germany. German commercial travelers are again covering Italy in order to make business connections, especially for tools and accessories; but their quotations are uncertain as regards both price and time of delivery, and hence no one is inclined to make any deals that involve future conditions. I understand, however, that German manufacturing concerns are making enormous efforts to put their depressed industries on their feet again, and there is no doubt here that they will succeed, in time, in doing so.

The German competition, of course, is made easier by the low value of the German mark, but the German Government, on account of excessive sales abroad at low prices, has intervened, so that export prices must now be made somewhat in proportion to the values in the country where the goods are to be sold. Even with this additional increase in price, present quotations would be very favorable for sales in the Italian market, provided there were a greater certainty as to stability of prices and deliveries.

England, now as before the war, is taking very little interest in the Italian market, and but small efforts are made to gain a foothold in the machine tool trade. As regards small tools, some manufacturers are trying to sell in Italy, and offer much better prices than American manufacturers. No machine tools are offered from France, but France is entering the market with small tools on a small scale.

Italian Industrial Conditions

Italian manufacturers of automobiles, railway cars, locomotives, and electrical machinery, as well as the shipyards, are extremely busy and are anxious to buy new machinery in order to re-equip and expand their plants.

The factories are overcrowded with work for two reasons: First, the country demands products to replenish the depleted stocks exhausted during the war; second, the manufacturers are keeping selling prices much too low under present conditions. The workers in the shops, interpreting the great activity of the factories as an indication of prosperity, are, therefore, pushing their demands for higher wages, and the manufacturers find that the only method in which the situation can be properly met is by the introduction of modern labor-saving machinery. This condition in the Italian market should prove favorable to American machine tool builders if it were not for the fact that the value of the dollar, which was 6.34 lire at the armistice, is now, early in March when this is written, about 18.50 lire. This condition has caused a serious depression in commercial activities and the unfavorable conditions have been further augmented, by the strikes of the post, telegraph, and railway employes in the early part of the year. It might be mentioned that these strikes have been squarely met by the Government, which has known how to separate the just claims from those that were absurd.

The enormously high value of American money has caused a corresponding increase in purchase prices in Italy, so that, expressed in lire, the increase in the price of machine tools in Italy is from 230 to 300 per cent, while the actual increase in a year, in dollars, is only from 17 to 37 per cent.

The Predicament of the Italian Buyer

It is evident that the Italian machine tool buyer faces considerable difficulty under these conditions. If the dealer orders and keeps machines in stock, there is a possibility that, as the exchange conditions become less adverse, the Italian price will drop. Buyers naturally hesitate to conclude a deal at the present time, because they do not want to find themselves in a position of having made heavier investments for the same equipment than their competitors, who are waiting for better times. On the other hand, the buyer must be careful in ordering because of the possibility of a further rise of the dollar. If he orders at the present time, payable against presentation of bill-of-lading, the machines may be dearer than at the moment when they are ordered.

In order to face this serious state of affairs, which seriously threatens the commercial connections between America and Italy, the best suggestion would be for the American manufacturers to grant some terms of payment to the Italian buyer such as would permit him to choose, within a fixed period—say one year—the most favorable moment for paying the invoice. If the American manufacturer would accept the payment at any time within one year, guaranteed by a deposit in an Italian bank of the full amount in lire at the exchange rate at the time of sale, with payment of interest for the period of the deferred payment, it would be possible to find customers for machine tools not otherwise obtainable. If the value of the dollar in Italy drops, as the buyer evidently hopes, he will, under this arrangement, pay a smaller amount in lire than otherwise, while the American manufacturer receives the same amount in dollars. The Italian buyer gains two advantages; he pays a lower price, and he can use the machine at once. On the other hand, if the exchange should rise still further, the buyer nevertheless has the advantage of using the machine that he has bought, which his waiting competitors cannot do, and if he prefers to wait with the payment until a year later, he will have earned a part of the purchase price.

Stability of Italian Conditions

On the part of American manufacturers, the granting of credit to Italian buyers might be dangerous if there were any possibility of a financial crisis, or a threat of Bolshevik disturbances in Italy, but both of these possibilities must be excluded. The demand for manufactured products of every kind is extremely strong; all factories have orders that will keep them busy for a long time to come, and the exportation of products of Italy are increasing, which in time will bring the exchange back to a more normal rate. As regards dangers of disturbances of a revolutionary character, all such trouble in the past has been confined to small centers. Among the people of every country, and therefore also in Italy, there exists an element which uses every occasion to promote disorder, but it should be said for the great majority of Italian workers that they are absolutely against the ideas of the new Russian gospel, because through the war the Italian workman has obtained a higher standard of living, so that he is not so easily disposed to try the adventure of unknown communism.



Fig. 14. Milling Machine equipped for straddle-milling the Flats on Hex-heads of Spark Plugs

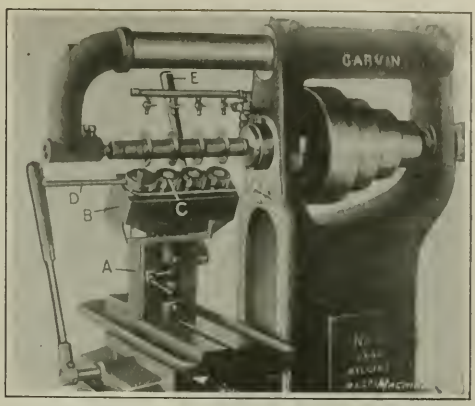


Fig. 15. Milling Machine equipped with Vertical Feed Attachment and Indexing Fixture for castellating Nuts

Indexing Milling Fixtures

Last of a Series of Three Articles on the Use of Indexing Fixtures for Obtaining Increased Production in Milling Practice

IN the first installment of this article, reference was made to the fact that machines equipped with fixtures of this type may be employed for the performance of two general classes of milling operations: First, in order to increase the rate of production through reducing the non-productive time of the machine and its operator, and second, to locate the work in two or more successive positions for milling the pieces to a square, hexagonal, or some other similar form. An example of the latter type of indexing milling fixture is shown in Fig. 14, which illustrates a No. 21 back-geared plain milling machine built by the Garvin Machine Co., New York City, engaged in milling the hexagonal heads of spark plugs for the ignition system on motor car engines. Machines equipped in this way are used at the plant of the Champion Ignition Co., North Flint, Mich.

Four pieces of work are set up in a multiple fixture, and by manipulating a single lever *A*, all four pieces may be indexed to the three successive positions in which they are held for straddle-milling opposite sides of the hex-heads. To obtain these settings of the work, lever *A* is moved into three successive positions, and in so doing it imparts motion to gearing that connects all four of the collet chucks of the fixture. In this way, a great deal of time is saved that would otherwise be lost if it were necessary to index each chuck individually. The chucks are of the double-tapered contraction collet type, and they are tightened or loosened by turning a wrench *B* that fits over a hexagonal collar *C* at the top of each collet.

In operating these Garvin No. 21 millers, the table is fed forward by power until a stop is engaged, which automatically trips the table feed-worm out of mesh with the worm-wheel. The operator then returns the table to the starting point with a handwheel; and after the collets have been loosened by using wrench *B*, lever *D* is lifted to manipulate the ejecting mechanism, which discharges the finished pieces from the fixture. When fresh blanks have been set up and secured in the collets, the machine operator lifts a lever, which re-engages the feed-worm ready to start the next operation. Of course, it will be apparent that it is necessary to make three cuts for each setting of the work. The table carries the work between the cutters, and continues its forward movement until the feed is automatically tripped. Then the operator returns the table to the starting point, and changes the position of lever *A* to index the work ready for the second cut, after which the power feed is re-engaged. This cycle of movements is repeated a third time to finish the work, after which the milled parts are removed and fresh pieces set up as previously described.

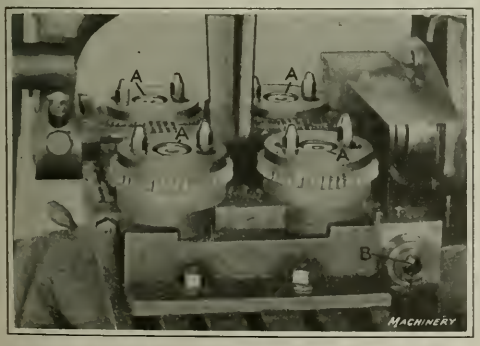


Fig. 16. Milling Machine equipped with Hobbing Fixtures for generating Teeth of Worm-wheels

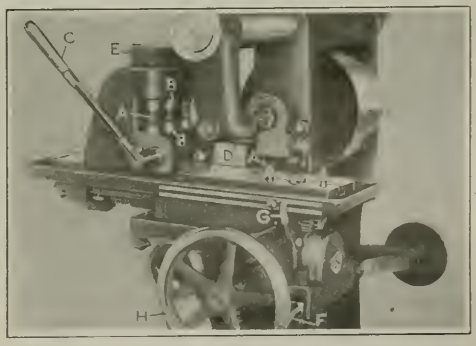


Fig. 17. Milling Machine equipped for generating the Teeth of Small Worm-wheels shown at A

Vertical Feed Milling Attachment

Where the length of a milling cut is quite short, it is often more advantageous to feed the work vertically to the cutter, instead of employing a horizontal feed movement of the table. For handling such classes of work, the Garvin Machine Co. has developed what is known as a "vertical feed milling attachment," and Fig. 15 shows one of these attachments applied to a No. 3 Garvin hand milling machine. The attachment is shown at *A*, and it is furnished with an indexing fixture *B* that provides for holding four hex-nuts to perform a castellating operation on them. It will be seen that four slitting saws are mounted on the milling machine arbor and the work-holding fixture is furnished with four sockets *C*, into which the nuts are dropped. As the work is fed vertically up against the saws, no means for clamping the nuts was considered necessary. It will be evident from the illustration that there is a nut in the left-hand socket while the other three are ready to receive fresh blanks.

In castellating these nuts, three cuts are taken at right angles to the flats. A hand-lever *D* provides for indexing all four pieces into the three successive positions in which they must be held for taking the castellating cuts. The movement of this lever is limited in both directions, and when it is in one extreme position, the first cut is taken; then the lever is moved to an intermediate position to index the work for the second cut; and finally, the lever is swung over to the opposite extreme of its movement, to index the work for taking the final cut. It will be seen that lever *D* is secured to the first work-holding socket; and all of the sockets are so mounted in the fixture that they may be turned by gearing which connects the four sockets. Hand-lever *E* governs the vertical feed movement of the attachment, this lever being pushed down in order to raise the work to the cutters. After the final cut has been taken, the fixture is allowed to drop until stops *F* come into engagement, and operate an ejecting mechanism which lifts the four castellated nuts out of their sockets. It will be seen that provision is made for adjusting the position of stops *F* in order to adapt them for the requirements of various jobs.

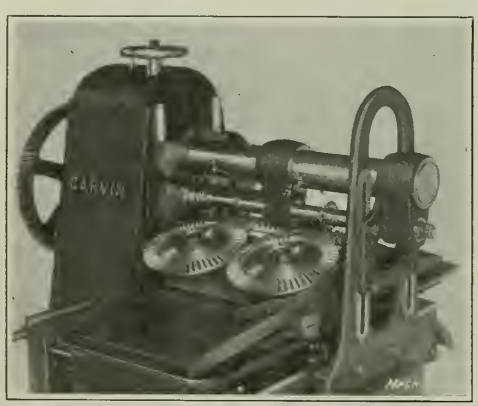


Fig. 18. Indexing Milling Machine equipped with Automatic Fixture for simultaneously roughing out the Teeth of Four Bevel Gear Blanks

Hobbing Worm-wheels on a Milling Machine

During recent years, the trend of machine tool design has been toward the development of special tools for the performance of repetition operations on large quantities of duplicate parts. Most experienced industrial engineers would unquestionably recommend the installation of these special machines, where the volume of work is great enough to enable a satisfactory return to be earned upon the investment in plant equipment. But there are many shops handling a general line of work, which do not have to machine a sufficient quantity of any one part to justify the installation of special machine tools. Consequently, it is necessary for them to adapt standard types of machinery for handling these jobs, and where sufficient ingenuity is displayed by the tool designers, extremely satisfactory results can often be obtained. The No. 13½ Garvin plain milling machine, shown in Fig. 16, equipped for generating the teeth of worm-wheels, is a case in point. The Garvin Machine Co. entered into an agreement to produce a number of these wheels, although the quantity to be cut was not great enough to justify investment in a special hobbing machine. After giving the matter some thought, it was found that a satisfactory equipment for handling the work could be produced by designing a special fixture for use on the milling machine. At the angle from which this fixture is shown in Fig. 16, the illustration is a little misleading, as it might be inferred that the teeth of four worm-wheels are cut simultaneously. As a matter of fact, this is not the case, because a generating operation is being performed on two wheels while the two other finished wheels are being removed from the fixtures and fresh blanks set up ready to have the teeth cut.

It will be evident that a clamping plate *A* is held down on each gear blank by means of two nuts. Considerable time would be required to screw these nuts all of the way off the clamping bolts, and to avoid reducing the output of the machine in this way, holes have been drilled in plates *A*, with slots running out from the holes. After a gear blank has been put in position, the plate is dropped over the nuts on the two clamping bolts, the holes in the plate being of sufficient size to clear these nuts. Then the plate is twisted so that the bolts slide into the slots, which are just wide enough to receive the bolts and allow the nuts to find a bearing surface on the top of the plate. With such an arrangement, it is only necessary to loosen the nuts about one-half turn in order to unload the fixture. For performing a hobbing operation, it is a matter of general knowledge that the work must be rotated while in contact with the hob. This result is accomplished on the fixture shown in Fig. 16 by making connection between the milling machine spindle and the arbors on which the worm-wheel blanks are mounted. A spiral gear is mounted on the spindle nose and engages with a second gear mounted at the middle of a shaft, one end of which can just be seen at *B*. This shaft is held by a bracket secured to the bed of the milling machine, and the fixture is free to slide lengthwise on the shaft, which rotates but does not have any longitudinal movement.

An explanation has already been given of the way in which two wheels are being hobbed while the other two are

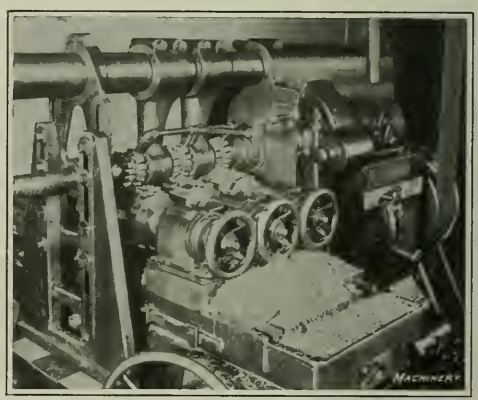


Fig. 19. Plain Milling Machine equipped with Three Sets of Special Single Dial Index-centers for finting Forgings

in the idle position, so that the finished wheels may be removed and fresh blanks set up in the fixture. It is necessary to stop rotation of the finished work, and provision for so doing is accomplished by means of two clutches on shaft *B* which transmit power to the cross-shafts that drive the two pairs of work-holding arbors. When the table is moved over to bring two new blanks into contact with the hobs, one clutch moves out of engagement with the cross-shaft through which power is transmitted to the arbors on which the two finished worm-wheels are mounted. At the same time, the other clutch comes into engagement with the cross-shaft that transmits power to the arbors on which the two fresh gear blanks are carried. In this way, it will be apparent that disengagement and engagement of the drive is automatically accomplished when the table is moved over by hand to bring two fresh blanks into the operating position. The worm-wheels to be hobbed have 48 teeth of 10 diametral pitch, so that they are 4.8 inches in diameter. On this job, the teeth of two worm-wheels were completely cut every seven minutes.

Hobbing Small Worm-wheels on a Milling Machine

Another milling machine equipped for hobbing the teeth of worm-wheels is illustrated in Fig. 17. This is a No. 21 plain miller built by the Garvin Machine Co., and it is used at the plant of the Frank Mossberg Co., Attleboro, Mass., for generating the teeth of small worm-wheels shown at *A*. The equipment of the machine for this job is rather different from the one shown in the preceding illustration. Only one work-holding fixture is mounted on the table, and in order to reduce idle time of the machine as far as possible, especial attention was paid to the provision of a quick-clamping mechanism. It will be seen that a small trunnion projects out at each side of the worm-wheels *A*, and these trunnions are used for holding the work in bushings *B*, which are bored out to receive the trunnions. The three upper bushings occupy fixed positions in the fixture, but the lower bushings have rack teeth cut in them, which mesh with pinions carried by a cross-shaft. Lever *C* is mounted at the end of this cross-shaft, and by pushing the lever down, the three lower bushings are withdrawn so that the hobbed worm-wheels may be removed from the fixture and fresh blanks substituted in their places. Provision is made for rotating the work while the hobbing operation is in progress, by means of a shaft *D* that takes power from the milling machine spindle through a worm-wheel and worm. This shaft transmits power to gears contained in case *E*, which are so arranged that all three spindles are driven simultaneously from the single source of power. After the fixture has been loaded, lever *F* is raised to bring the feed-worm into engagement with the worm-wheel, so that the work is fed to the cutters until the automatic stop *G* is engaged, thus tripping the feed at the time that the hobbing operation has been completed. The table is then returned to the starting point by handwheel *H*.

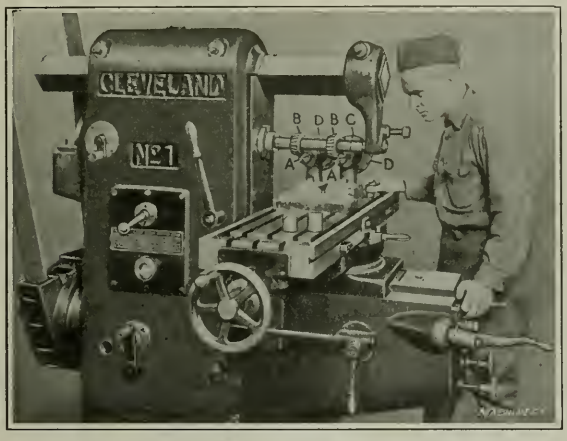


Fig. 20. Universal Milling Machine equipped with Indexing Fixtures for cutting the Teeth in Milling Cutters

Roughing out the Teeth of Bevel Gear Blanks

Experience has shown that in operating various types of bevel gear generators, more satisfactory rates of production can be obtained by performing the operation in two steps—first, roughing out the teeth, and second, performing the final operation of generating the teeth to the required form. Several types of machines have been developed for use in roughing out the teeth of bevel gear blanks which are to be finished on a special generating machine. Fig. 18 shows an automatic machine developed for this purpose by the Garvin Machine Co. This machine is used at the plant of the Reo Motor Car Co., in Lansing, Mich. It consists of a No. 9 indexing miller equipped with a fixture on which provision is made for mounting four gear blanks. It will be seen that two rotary gear-cutters are mounted on the arbor of the milling machine, and the gear blanks are mounted in two pairs, each pair of blanks being held on an inclined plane, so that the portions of the faces in which gear teeth are to be cut are held in a horizontal position. With such an arrangement, each pair of gear blanks can be fed under one of the cutters to provide for milling a tooth space in each of the blanks. After this has been done, the direction of table movement is automatically reversed and the table is returned to the starting point at high speed. Next, each of the four gear blanks is automatically indexed through one tooth space, and after this has been done, the forward feed movement of the table is again automatically engaged to move the work forward for cutting the next tooth space in each of the blanks. With such an arrangement, it is only necessary for the operator to set the blanks up on the machine, after which the work requires no further attention until all of the teeth have been cut. On this job, the work is fed to the cutters at a rate of 9 inches per minute, and there are 40 teeth to be cut in gears having a face width of 1½ inches. The machine completes the operation in 13 minutes, 20 seconds.

Milling Grooves in Steel Forgings

Fig. 19 shows a Brown & Sharpe No. 5B heavy-duty plain milling machine equipped with three sets of index-centers to provide for milling two grooves in six steel forgings at each traverse of the table. The grooves are each 1.17 inches wide by 5/16 inch deep, and two forgings are mounted on the arbor between each pair of index-centers. It will be apparent from the illustration that the cutters are formed in such a way that they mill two grooves and also finish the top of the raised portion of the work between two adjacent grooves. After the cut has been completed, the table is returned to the starting point and the work is then indexed ready for taking the next cut. This is an exceptionally heavy job, and to enable it to be handled, it is necessary to use an arbor possessing ample strength; otherwise, there would be a tendency for the arbor to spring. To avoid trouble from this cause, it will be seen that the cutter-arbor, which is of considerable length, is rigidly supported from the over-arm of the machine by means of two intermediate yokes placed between the cutters. The cutters and work are lubricated with lard oil to prevent them from becoming overheated.

Fluting Hollow-milling Cutters

There are many examples of tool-room work, such as the fluting of various types of cutting tools, where it is neces-

sary to produce a number of pieces of a standard form. For such jobs, the use of an indexing milling fixture will often enable rates of production to be substantially increased. Fig. 20 shows a No. 1 universal milling machine built by the Cleveland Milling Machine Co., Cleveland, Ohio, which is equipped with an indexing fixture to provide for simultaneously fluting two hollow-milling cutters. It will be seen that the cutter blanks *A* are held in collet chucks; and two angular milling cutters *B* are mounted on the arbor of the machine. To save as much time as possible in indexing the work for taking successive cuts, it will be seen that an index-plate *C* is mounted at the rear end of one of the work-spindles, this plate being notched to receive an index-pin which locates the cutter blank held by the fixture in position for milling. A pair of spur gears *D* connects the spindles of the two fixtures together, so that when the spindle that carries the index-plate is turned through the required angle to bring the work into position for taking the next cut, the piece of work carried by the other spindle is simultaneously located. The angular milling cutters *B* are made of high-speed steel, and on this job the cutters were driven at 81 revolutions per minute, which corresponds to a cutting speed of 63.6 feet per minute; and the work is fed to the cutters at 2.15 inches per minute.

* * *

TRAINING OF INDUSTRIAL ENGINEERS

In an article on engineering education, appearing in *Industrial Management*, P. F. Walker, dean of the School of Engineering of the University of Kansas, calls attention to the need for special training of men who are primarily engineers, but whose activities will lie more directly in the production field of organized industries; in short, for industrial or production engineers. Attention to this phase of technical education has been drawn by representatives of the Federal Bureau of Education. Emphasis has been given in this way to the need for men of combined technical and business training, with particular reference to the needs of organizations engaged in the foreign trade. Three conferences have been held, attended by engineering and commercial school representatives, the result of which has been recommendations addressed to the universities and technical schools for greater attention to the business training of engineer students. The plan is to substitute for an amount of technical work, amounting to nearly one year's time out of four, class work in economics and accounting of the same type as that to which major attention is given in the schools of commerce. The result of such changes in existing courses of study should be to turn out men who have the fundamental groundwork of technical engineers and who are also equipped to qualify readily for sales duties and as representatives of exporting firms in foreign territory. Such modified courses of study correspond in many ways with courses in industrial engineering now given in four or five technical schools in this country. To develop such training courses to the best advantage and with a minimum of lost motion, it is essential that firms engaged in foreign trade and needing such men should be in close co-operation with the schools, and should make their requirements known.

SLIDE-RULE FOR CALIBRATING TANK GAGE STICKS

It is common practice to have tanks for holding gasoline and other kinds of oils made of a cylindrical form and mounted with the axis in a horizontal position. Where a tank is set up in this way, special means must be provided to ascertain the volume of oil which remains in the tank at any time, because a determination of the contents from a knowledge of the dimensions of the tank and the depth of the fluid, is a difficult mathematical problem. S. F. Bowser & Co., Inc., of Fort Wayne, Ind., make a specialty of building equipments for the storage and handling of various fuel and lubricating oils, and to enable their customers to easily ascertain the volume of oil contained in a cylindrical tank lying in a horizontal position, this concern follows the usual practice of furnishing a gage stick with each tank. This gage must be calibrated for the tank with which it is to be used, and in accordance with the usual method, each stick is graduated so that it may be dropped into the tank from the top and, by noting the height to which the stick is submerged in the oil, a direct reading can be obtained of the volume of oil in the tank.

To facilitate the work of the engineering department in calibrating these gage sticks, a special slide-rule was designed and made for use in the office of the factory engineer. This instrument is shown set up in the engineer's office in Fig. 1, and Fig. 2 represents a diagram which gives a clear idea of the way in which this slide-rule is used. Referring to Fig. 2, it will be seen that there are two fixed scales at the front and back of the rule, two movable slides designated as the "front" slide and "back" slide, two movable glasses each carrying an index line, designated as "front" and "back" glass, and fixed "side" glasses carrying index lines that coincide with the end lines of the fixed front and back scales. The fixed scale at the front and back, together with scales *D*, *E*, and *F* on the slides are exact duplicates of scales *C* and *D* of the ordinary slide-rule. Scales *A*, *B*, and *C* on the front slide are laid out to give a direct reading of the percentage of the whole diameter of the tank that represents the depth of the liquid in the tank, corresponding to the percentage that the number of gallons on the *D* scale is to the whole capacity of the tank in gallons. This can be done because there is a fixed relation between these percentages, that depends in no way on the diameter or the capacity of any particular cylindrical tank.

In other words, when a number on the *D* scale, corresponding to the number of gallons of oil left in the tank, is placed opposite the number on the fixed front scale which represents the total capacity of the tank in gallons, either scale *A*, *B*, or *C* on the front slide will indicate the required percentage, a direct reading of this result being obtained under the graduation on the side glass. Scale *A* is read when the number of gallons left in the tank is from 0.1 to 1 per cent of the full capacity of the tank; scale *B*, when the result is from 1 to 10 per cent; and scale *C* when the result is 10 per cent or greater. It will be evident that the operation of determining any percentage of the full tank capacity is similar to the familiar process of making a division

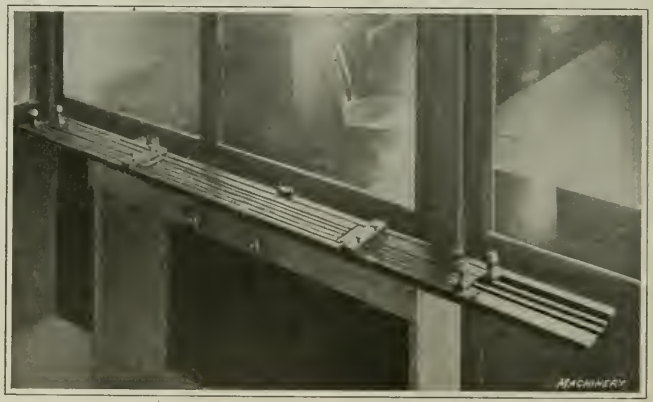


Fig. 1. Slide-rule used in Factory Engineer's Office for Use in calibrating Tank Gage Sticks

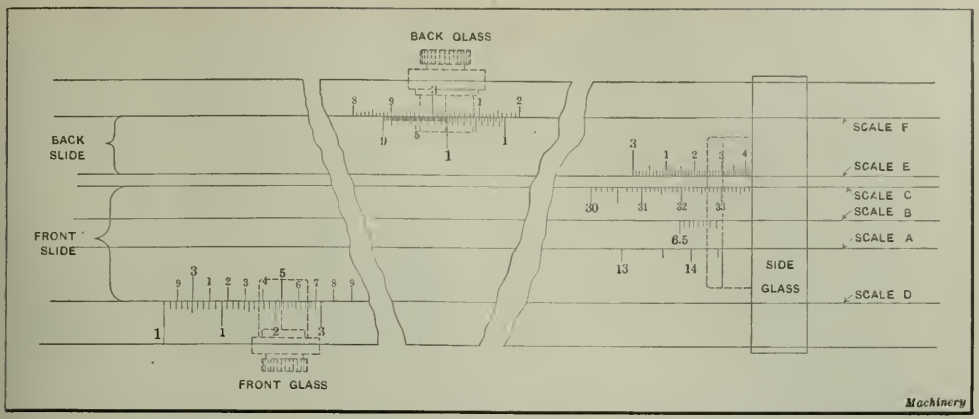


Fig. 2. Diagram showing a Partial Lay-out of the Special Slide-rule for calibrating Tank Gage Sticks

on an ordinary slide-rule, except that scales *A*, *B*, and *C* have been laid out in such a way, and in such a relationship to scale *D*, that the result of the division is expressed directly as a percentage, and is read under the index on the side glass. Scales *E* and *F* and the fixed back scales are, as stated before, logarithmic scales, and for that reason the reading of scale *E* under the side glass is always the percentage that any number on scale *F* is of its corresponding number on the fixed back scale.

In using this slide-rule for calibrating a gage stick, the method of procedure is as follows: First, set the back glass over the number on the fixed scale at the back of the slide-rule, which indicates the diameter of the tank in inches (in this case, 30¼ inches). Second, set the front glass over the total capacity of the tank in gallons (in this case, 121.3 gallons). Third, move the front slide along so that the number of gallons of oil in the tank also coincides with the index line on the front glass (in this case, 35 gallons). Fourth, under the graduation on the side glass read in per cent the ratio of the depth of oil in the tank to the total diameter of the tank (in this case, 33.01 per cent). This result is read on scale *C* because the number of gallons is over 10 per cent of the full tank capacity. Fifth, move the back slide to bring the same percentage reading on the *E* scale under the index line on the side glass as the reading which is located under this index on the *C* scale of the front slide. Sixth, the reading of the height of the required graduation mark from the bottom of the gage stick is then found on the *F* scale under the index on the back glass (in this case 9.99 inches).

In laying out a gage stick, the actual method of procedure is to mark on the stick a height from the bottom equal to the diameter of the tank, and then mark off intermediate points along this diameter distance. The slide-rule will then be employed to determine the number of gallons which correspond to the graduation marks on the gage stick, and each of these numbers of gallons will be marked beside the corresponding lines. Such a stick can be used to dip into a tank partially filled with oil to quickly ascertain the number of gallons which are represented by any specified depth. The scales on the slides were duplicated in lengths in order to be able to read them under either side glass without having to move the slide the whole length of the rule, as is necessary with the common slide-rules, when the results come outside of the fixed scale. The knobs on the slides (see Fig. 1) are used for rapid movement of the slides, while the handwheels (one for each side) shown in front are used to give a micrometer-like movement to the slides. The graduating of the slide-rule was done on a milling machine after the logarithms of the numbers representing the required values had been tabulated.

POINTERS ON SPRING WINDING

By GEORGE C. HANNEMAN

The man who only occasionally has to make a helical wire spring is usually somewhat baffled at first at the seemingly inconsistent action of springs. For instance, it is frequently noticed when a spring of perhaps twenty turns has been made and the turns carefully counted in winding, that after the spring has been made, actually only seventeen or eighteen turns are obtained. It should be remembered that a spring enlarges in diameter when the winding tension is removed, and that a small spring will not increase in diameter as much as a larger one of the same size wire. If the spring is found to be 1/16 inch over size after the first trial, the mandrel should not be turned down a full sixteenth, because if this is done it will be found that the spring wound on this mandrel is too small. The mandrel should be turned down a little less than 1/16 inch as determined by trial, in order to obtain a spring of the desired size.

It should be remembered that a spring made of music wire is subject to an internal strain, tending to enlarge it unless this strain is relieved when the spring is made. This fact may manifest itself after the spring has been allowed to set for several days, and will be apparent by the enlarged diameter, shortened length, and decreased number of turns. This fact may be emphasized by an experience of the writer. A number of springs were made of music wire with an eye bent up on both ends of each spring, the eyes being exactly in line. When an attempt was made to assemble these springs a few days later, it was found that the eyes had changed their relative positions and were more nearly at right angles to each other than in line.

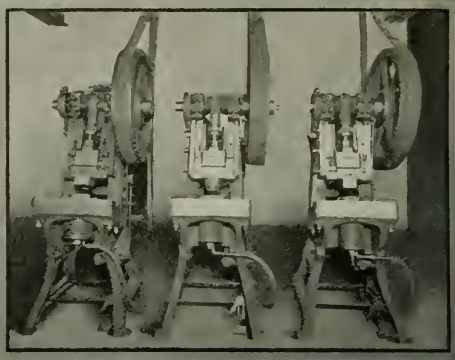
It is good practice in winding springs of tempered wire, which are not to be subsequently hardened, to relieve the internal strain by "backing up" the spring a little. This may be conveniently done, by simply inserting a rod of suitable size in the spring, and turning the ends in a direction tending to enlarge the spring diameter. To allow for subsequent enlargement and shortening, springs should be wound a little under size, and should have two or three extra turns. By observing these precautions, a spring may be obtained that will hold its size.

* * *

Alloys of the aluminum-magnesium-copper series are superior to other aluminum alloys in regard to tensile properties. These properties may also be improved considerably by proper heat-treatment. Alloys of the aluminum-magnesium-nickel series are also improved by heat-treatment, but not to the same degree as the first series mentioned. Alloys of the aluminum-magnesium-manganese series are not improved by heat-treatment.

Pneumatic Cushions in Metal-Drawing Operations

By JOHN NELSON



Description of Various Types of Pneumatic Die Cushions Used in Connection with Punch Presses, and Methods of Installing

ONE of the most vital factors to be considered in the process of drawing various shaped parts from sheet metal is the pressure that must be applied on the metal as the flat blank is drawn into the desired shape. This pressure should be just enough to keep the metal of the shaped part or shell smooth at all stages of the operation. If the metal is unduly strained at any time, its toughness is lessened, which often results in the breakage of the shell during either the first or succeeding drawing operations. An excessive pressure is a waste of power, produces an avoidable strain on the machine, and causes a great amount of wear on the die parts, especially on the drawing ring and the blank-holder. Wrinkles which may be formed on the shell in any of the drawing operations are, of course, a disadvantage, but they are often tolerated when it is not absolutely essential that the finished article be entirely smooth, with the result that die parts also become excessively worn on this account. Thus it is important that some means be employed to produce a uniform pressure while drawing.

Advantages of Pneumatic Die Cushions

The double-action or toggle type of press was designed to produce a uniform pressure on the blank during the operation, and has proved a success in most cases. In some instances, however, this type of press has proved inefficient, and pneumatic die cushions have been developed to remedy conditions. By means of these cushions a uniform pressure can be applied on the shell at all times regardless of the unevenness of the blank or the thickness of the metal during the operation. This is the greatest factor in favor of air cushions for this purpose, but there are others, some of which are as follows: (1) The initial cost of a single-action press equipped with pneumatic cushions, which will perform operations usually performed on double-action presses, is only about one-half that of a double-action press. (2) The equipment is less cumbersome and can be operated at higher speed. (3) A machine provided with this equipment can be used for more than one purpose, whereas an ordinary drawing press is suitable only for a drawing operation. (4)

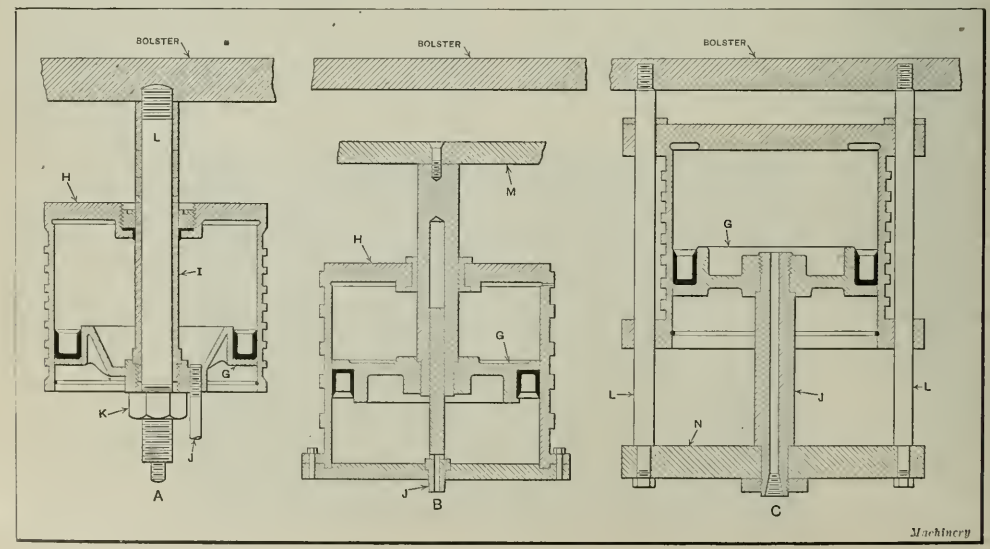


Fig. 1. Construction of Pneumatic Die Cushions

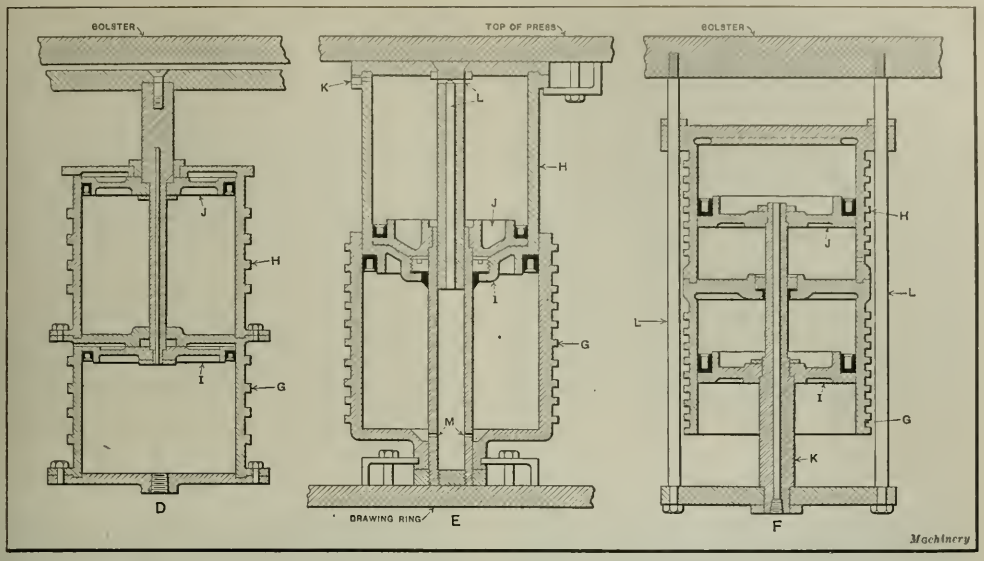


Fig. 2. Various Types of Double-unit Pneumatic Die Cushions

A smaller size machine can be used than when springs or rubber buffers are employed to supply pressure on the blank, because it is not necessary to overcome increasing pressure, and so power is saved and unnecessary strain on the machine is eliminated.

Various Types of Air Cushions Suitable for Punch Presses

It therefore seems apparent that air cushions are the key to the successful and economical solution of many metal-drawing problems. Various types of these cushions have been recently developed by the Marquette Tool & Mfg. Co., Chicago, Ill., to meet a large variety of requirements, the size ranging from cushions having a piston 6 inches in diameter, which are suitable for machines drawing shells to a depth of 2 inches, to cushions which have a piston 20 inches in diameter, which are intended for presses drawing shells to a depth of 8 inches. These cushions can be applied to machines singly or in batteries. Some of these types are illustrated in Figs. 1 and 2. In the type shown at *A*, Fig. 1, piston *G* remains stationary when compressed air is admitted into cylinder *H*, while the cylinder rises vertically on sleeve *I*. The pins that support the drawing ring of the die rest upon the top surface of the cylinder, and thus as the cylinder is forced upward, pressure is applied on the drawing ring. The air is admitted into the cylinder through pipe *J*. Nut *K* permits the various parts of the cushion to be removed from

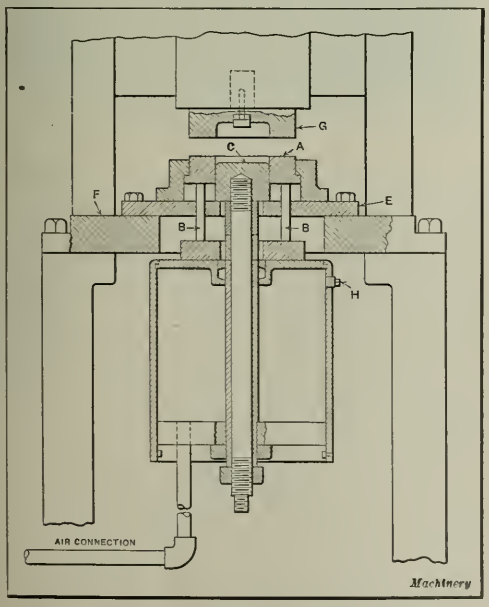


Fig. 3. Air Cushion attached to the Die of a Punch Press

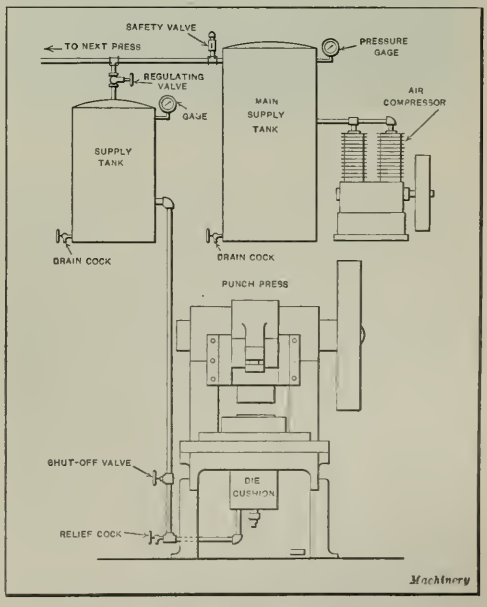


Fig. 4. Method of connecting Air Cushion Equipment

the machine without requiring stud *L* to be disassembled. This cushion design is used singly, as a rule, but it can also be applied in multiples on double- or multiple-crank presses.

In the design shown at *B*, cylinder *H* remains stationary and piston *G* is forced vertically upward when compressed air is admitted into the cylinder through connection *J*. The drawing-ring pins rest upon the pressure-pad *M*. This type of cushion is installed principally in batteries on double- or multiple-crank presses. Another design of cushion in which the piston remains stationary while the cylinder is forced upward when air is admitted into it is shown at *C* in the same illustration. Piston *G* is supported upon fitting *J* through which air is forced into the cylinder. This fitting is mounted in plate *N*, which is attached to the bolster of the press by four rods *L* which also act as guides for the cylinder. The die pins rest upon the top of the cylinder.

The types of pneumatic cushions illustrated in Fig. 2 really consist of two sets of cylinders and pistons in one unit. In the design shown at *D*, cylinders *G* and *H* remain stationary when air enters the cylinders, while pistons *I* and *J* are forced upward. This type of cushion is used chiefly on double- or multiple-crank presses. In the design shown at *E*, air is admitted into cylinder *H* through inlet *K*, and into cylinder *G* through holes *L* and *M*. The illustration shows this cushion applied to the top of a hydraulic press. When there is no air in these cylinders, piston *J* is raised to the top of cylinder *H*, and cylinder *G* telescopes over cylinder *H*, the latter remaining stationary when air is admitted into the cylinders, and piston *I* of cylinder *G* serving as the head of cylinder *H*. This type of air cushion is used principally in batteries, the various units being connected by flexible tubing. They may be placed in any position on the drawing ring so that pressure can be distributed as desired.

In the air cushion shown at *F*, cylinders *G* and *H* move vertically on four guiding rods *L*, which also act as a support for other parts of the cushion. Pistons *I* and *J* are stationary on connection *K*, through which air is brought into the two cylinders. The die pins which support the drawing ring rest upon the top surface of cylinder *H*. Batteries of cushions of the types shown at *B*, Fig. 1, or *D*, Fig. 2, are generally used on large presses such as are employed in drawing automobile fenders, body parts, and radiator fronts; steel barrels, etc. The cushions of the type illustrated at *A* and *C*, Fig. 1, and *F*, Fig. 2, are used on presses employed in drawing automobile lamp bodies, oil-cans, clock cases, cuspidors, enamelware, grease cups, etc. An air cushion that operates on the same principle as the one shown at *A* in Fig. 1 is shown in Fig. 3 connected to the forming die of a machine. In this illustration, *A* represents the drawing ring; *B*, the drawing-ring pins; *C*, the forming die; *E*, the die-shoe; *F*, the bolster plate; and *G*, the punch. Oil can be introduced into the cylinder by removing plug *H*.

Installation of Cushions Singly or in Batteries

Fig. 4 illustrates diagrammatically the method of connecting pneumatic die cushions to the supply tank and air compressor. This method of installation should be used when a number of machines are connected to the same main tank of compressed air, because it is absolutely essential that each press be provided with an individual air tank and air regulator so that a certain pressure may be maintained on any of the machines independently of the rest. When only one machine is supplied from the main tank the cushion can be connected directly to it. A record should be kept of the pressure used on each job so that when a similar operation is performed, experiments will be unnecessary in order to ascertain the correct pressure to be employed for the operation. The total pressure on the drawing ring can be determined by simply multiplying the pressure in pounds per square inch by the area of the piston in square inches.

In order to exert an even pressure on the drawing ring during an entire operation, it is necessary that the individual tank used in conjunction with the cushion be of ample capacity. When the tank is too small, the air pressure will be greatly increased as the air in the cushion is forced back into the tank on the downward stroke of the press ram, and, of course, the pressure on the drawing ring will be subsequently greatly increased. If the tank is large enough, how-

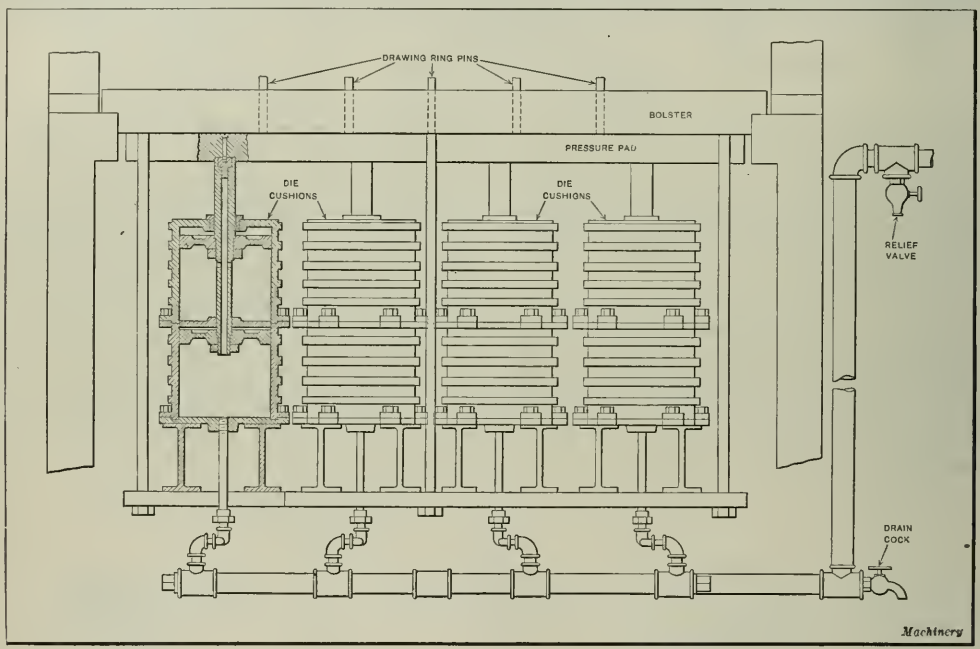


Fig. 5. Large Punch Press equipped with Battery of Double-unit Cushions

ever, no trouble arises from this source. The air cushion should also be of sufficient size so that a high air pressure in pounds per square inch is not necessary in order to obtain sufficient pressure on the drawing ring. One-stage air compressors are generally used in connection with these cushions, but their operation is uneconomical when the air pressure is more than 100 pounds per square inch. Besides this, excessive pressures are detrimental to the cushions. More pressure is required on the drawing ring when a part drawn from a thin-gage metal is being produced than when a thick-gage metal is being used, and so it is evident that a larger cushion is required for drawing light metal than for drawing heavy metal. Fig. 5 shows a large machine equipped with a battery of cushions of the type illustrated at *D*, Fig. 2.

The production of steel helmets for the United States Army was a metal problem which occurred during the recent war. These helmets were drawn from a high manganese steel of about 0.036 inch in thickness. The specifications required that the minimum thickness of the helmet should not be less than 0.030 inch at any point and that the height from top of the crown to the rim should be 4⅛ inches. It was generally thought that two operations on double-action presses were required to produce the part, and this method was used with varied success.

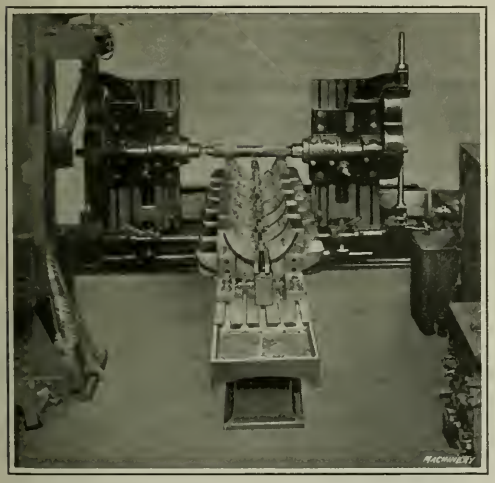


Fig. 1. Milling Top of Marine Engine Bearing Castings

The principal trouble with this method was that when the blank-holder was set close enough to the drawing ring so that wrinkles would not be produced on the shell, the blank would be held so tight that the metal which constituted the crown of the helmet would be stretched to a thickness less than the allowed limit. Hence wrinkles were tolerated so that the minimum thickness would not be less than specified.

The above facts were called to the attention of the firm previously mentioned in this article by a manufacturer who desired to produce helmets on a single-action press. The press was subsequently equipped with pneumatic die cushions, the female part of the die being held in the press ram. A pressure of about 21 tons was applied on the drawing ring by the cushions. The result was an average production of nine helmets per minute, the surfaces of which were smooth and the minimum thickness of each shell not less than 0.032 inch. The reason that the helmets were drawn in this manner without being excessively stretched was that the pressure on the drawing ring was the same during the entire operation regardless of the thickness of the metal. When these helmets were subjected to the shooting test, they were not penetrated by bullets, because the metal had not lost any of its toughness as a result of the drawing operation.

MILLING ENGINE BEARING CAPS

At the Allis Chalmers Mfg. Co.'s plant in Milwaukee, Wis., a planer type milling machine, built by the Pratt & Whitney Co., of Hartford, Conn., is used for performing four consecutive milling operations on large cast-steel bearing caps for marine engines. Rerference to the accompanying illustrations will clearly show the way in which the castings are set up on the machine for performing two of these operations, and also the nature of the work to be done, which consists of face-milling the sides and tops of the castings. It will be seen that seven castings are set up in a row, and that the string fixture, by which they are carried, is furnished with means of locating the work for milling, and straps for holding each casting down.

For the first operation performed on the top of the castings, the plane milling cutters are 5 inches in diameter and they are driven at a speed of 30 revolutions per minute, which represents a cutting speed of 39.5 feet per minute with a feed of 2¾ inches per minute. For milling the sides of the work, the cutters are 9 inches in diameter and they are driven at 17 revolutions per minute, which represents a cutting speed of 40 feet per minute with a feed of 2½ inches per minute. These castings are made of a tough grade of steel, and it is necessary to reset the machine for the next



Fig. 2. Milling Sides of Marine Engine Bearing Castings

operation after the preceding part of the work has been completed. The rate of production obtained is three complete castings per day. Attention is called to the fact that this production is for a total of four operations that are required on the work, there being two additional milling operations to perform on the opposite side to those shown.

* * *

Considerable progress has been made in designing safety devices to protect the eyes of workmen who operate emery wheels as well as other machine tools. Goggles and glass shields have been used for this purpose for some time. Recently transparent sheeting, such as used for automobile curtain windows, and a material known as safety glass have been tried with success. The safety glass is made either by laying a coarse mesh of fine wire in the glass, or by employing hydraulic pressure to weld a piece of transparent sheeting between two sheets of glass. However, for goggles used when operating emery wheels, the transparent sheeting alone has proved effective, and is much cheaper than any form of glass. Either the safety glass or transparent sheeting can also be fitted in a frame and held over the wheel in such a position as to deflect emery dust and metal particles away from the operator's eyes.

Stresses in Bolted and Riveted Joints

By VICTOR M. SUMMA, Engineering Examiner, American Brake Co., St. Louis, Mo.

IN Fig. 1 is represented a bracket A fastened to a channel B by means of bolts or rivets. It is required to find the stresses in the fastenings produced by a load W acting at O as shown. It is apparent that the fastenings, which will be considered to be bolts will be subjected to the following stresses:

1. The shear due to the direct action of W and indicated by the symbol S_s.

2. The shear due to the moment Wa', resisted by the moments of the bolts about their center of gravity as a center of rotation and represented by the symbol S'_s.

3. The tension due to the moment Wa, resisted by the moments of the bolts about edge XX of the bracket as the axis of rotation, and represented by the letter S.

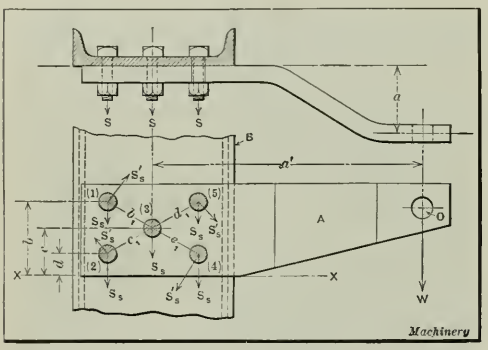


Fig. 1. Bracket attached to Channel, the Fastenings of which are stressed by the Load W

The value of S_s may be readily found, being simply the quotient of W divided by the number of bolts employed N, that is

$$S_s = \frac{W}{N} \qquad (1)$$

The values of S'_s and S are determined in the following manner: Let Q represent the stress produced in a bolt imagined to be located at unit distance from the center of rotation. Then the shearing stress S'_s in each bolt due to the moment Wa' at their actual distances is: Qb_1 for bolt (1); Qc_1 for bolt (2); 0 for bolt (3); Qe_1 for bolt (4); and Qd_1 for bolt (5). In a similar manner, the tension stress S in each bolt due to the moment Wa, with XX as the axis of rotation, may be expressed thus: Qb for bolts (1) and (5); Qc for bolt (3); and Qd for bolts (2) and (4). It follows that the sum of the moments of these forces must equal the moments that produced them. Therefore, by first taking the moments Qd_1, Qc_1 etc., about the center of gravity of the bolts (which obviously is the middle bolt) the equation may be written:

$$(Qb_1 \times b_1) + (Qc_1 \times c_1) + (Qd_1 \times d_1) + (Qe_1 \times e_1) = Wa'$$

$$Q = \frac{Wa'}{b_1^2 + c_1^2 + d_1^2 + e_1^2}$$

Therefore the actual stress S'_s for each bolt is the stress Q at unit distance from center of rotation, multiplied by the distance of each bolt from the middle bolt (3), thus:

$$\left.\begin{aligned} S'_s \text{ for bolt (1)} &= Qb_1 = \frac{Wa'\,b_1}{b_1^2 + c_1^2 + d_1^2 + e_1^2} \\ S'_s \text{ for bolt (2)} &= Qc_1 = \frac{Wa'\,c_1}{b_1^2 + c_1^2 + d_1^2 + e_1^2} \\ S'_s \text{ for bolt (3)} &= Q \times 0 = 0 \\ S'_s \text{ for bolt (4)} &= Qe_1 = \frac{Wa'\,e_1}{b_1^2 + c_1^2 + d_1^2 + e_1^2} \\ S'_s \text{ for bolt (5)} &= Qd_1 = \frac{Wa'\,d_1}{b_1^2 + c_1^2 + d_1^2 + e_1^2} \end{aligned}\right\} \qquad (2)$$

By following the same method for finding the tension stress S, taking the moments Qb, Qc, etc., about the axis XX, the equation of moments may be expressed thus:

$$(2Qb \times b) + (Qc \times c) + (2Qd \times d) = Wa$$

$$Q = \frac{Wa}{2b^2 + c^2 + 2d^2}$$

Therefore the actual stress S for each bolt is the stress Q at unit distance from the center of rotation, multiplied by its corresponding distance from the axis XX, thus:

$$\left.\begin{aligned} S \text{ for bolts (1) and (5)} &= Qb = \frac{Wab}{2b^2 + c^2 + 2d^2} \\ S \text{ for bolt (3)} &= Qc = \frac{Wac}{2b^2 + c^2 + 2d^2} \\ S \text{ for bolts (2) and (4)} &= Qd = \frac{Wad}{2b^2 + c^2 + 2d^2} \end{aligned}\right\} \qquad (3)$$

From the foregoing sets of formulas (2) and (3), the values of S'_s and S may be readily ascertained by observing the following rule: First ascertain the possible axis of rotation of the bracket as a whole and the center of gravity of the bolts. Then divide the moment of the weight W about this center of gravity, by the sum of the squares of the distance of each bolt from the axis of rotation, and finally multiply the result by the distance to this axis (or center), from the bolt under consideration.

Since the two shearing stresses S_s and S'_s are acting in the same sectional plane, they will combine in one resultant force S_{sr} for each bolt, as shown by the diagram Fig. 2. In other words, each bolt is under the influence of but two forces, the tension force S and the resultant force S_{sr}; therefore, remembering that S and S_{sr} are acting perpendicular to each other on every particle in the cross-section of the bolts, their maximum combined effect P_1 in tension and P_2 in shear may be found by the well-known formulas for circular section bars:

$$P_1 = \tfrac{1}{2}\,(S + \sqrt{S^2 + 4S_{sr}^2}) \qquad (4)$$

$$P_2 = \tfrac{1}{2}\,\sqrt{S^2 + 4S_{sr}^2} \qquad (5)$$

The determination of the total combined stress to which the bolts are subjected consists simply of substituting in the foregoing fundamental formulas the respective values for tension stress and resultant shear stress.

Example Illustrating Application of Formulas

A numerical example will graphically illustrate the application of the foregoing principles. Assume that the weight W is 12,000 pounds; the diameter of the bolts ⅞ inch; and that $b = 5\frac{1}{2}$ inches, $c = 3\ \frac{1}{2}$ inches, $d = 1\frac{1}{2}$ inches; also b_1, c_1, d_1, and $e_1 = 6\frac{1}{4}$ inches each; $a = 4$ inches and that $a' = 10$ inches.

By substituting in Formula (1)

$$S_s = \frac{12{,}000}{5} = 2400 \text{ pounds}$$

and from Formula (2)

$$S'_s = \frac{12{,}000 \times 10 \times 6.25}{4 \times 6.25^2} = 4800 \text{ pounds for each bolt.}$$

From the diagram Fig. 2, the resultant shearing force S_{sr} for bolts (1) and (2) = 2500 pounds; and for bolts (4) and (5) = 7200 pounds. Now, since the cross-sectional area of a ⅞-inch bolt is 0.6 square inch, the unit shearing resultant stress for bolts (1) and (2) is 2500 ÷ 0.6 = 4166 pounds per square inch; for bolt (3), 2400 ÷ 0.6 = 4000 pounds per square inch; and for bolts (4) and (5), 7200 ÷ 0.6 = 12,000 pounds per square inch. Having found the resultants of the two shearing forces, the tension stress S is found by substituting in formulas (3) as follows:

For bolts (1) and (5),

$$S = \frac{12{,}000 \times 4 \times 5.5}{2 \times 5.5^2 + 3.5^2 + 2 \times 1.5^2} = 3421 \text{ pounds}$$

For bolt (3),

$$S = 3.5 \times 622 = 2177 \text{ pounds}$$

For bolts (2) and (4),

$$S = 1.5 \times 622 = 833 \text{ pounds}$$

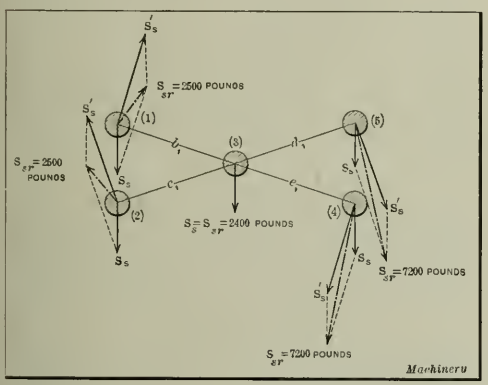


Fig. 2. Parallelogram of Force Diagrams, showing Resultant Shear Forces produced by Application of Load shown in Fig. 1

The unit tensile stress for bolts (1) and (5) is 3421 ÷ 0.6 = 5700 pounds per square inch; for bolt (3), 2177 ÷ 0.6 = 3630 pounds per square inch; for bolts (2) and (4), 833 ÷ 0.6 = 1380 pounds per square inch.

Having now determined the unit stress values for tension and shear, the maximum unit tensile stress p_1 and unit shearing stress p_2 for each bolt may be determined by employing the fundamental equations (4) and (5), as follows:

Unit Stresses in Pounds per Square Inch

Bolt (1)

$$p_1 = \tfrac{1}{2}\left[5700 + \sqrt{5700^2 + 4\,(4166^2)}\right] = 7900$$
$$p_2 = \tfrac{1}{2}\sqrt{5700^2 + 4\,(4166^2)} = 5050$$

Bolt (2)

$$p_1 = \tfrac{1}{2}\left[1380 + \sqrt{1380^2 + 4\,(4166^2)}\right] = 4910$$
$$p_2 = \tfrac{1}{2}\sqrt{1380^2 + 4\,(4166^2)} = 4220$$

Bolt (3)

$$p_1 = \tfrac{1}{2}\left[3630 + \sqrt{3630^2 + 4\,(4000^2)}\right] = 6200$$
$$p_2 = \tfrac{1}{2}\sqrt{3630^2 + 4\,(4000^2)} = 4390$$

Bolt (4)

$$p_1 = \tfrac{1}{2}\left[1380 + \sqrt{1380^2 + 4\,(12{,}000^2)}\right] = 12{,}710$$
$$p_2 = \tfrac{1}{2}\sqrt{1380^2 + 4\,(12{,}000^2)} = 12{,}020$$

Bolt (5)

$$p_1 = \tfrac{1}{2}\left[5700 + \sqrt{5700^2 + 4\,(12{,}000^2)}\right] = 15{,}180$$
$$p_2 = \tfrac{1}{2}\sqrt{5700^2 + 4\,(12{,}000^2)} = 12{,}330$$

The foregoing results show that the bolts upon which the greatest strain is exerted are (4) and (5), while the bolt which sustains the least strain is (2), which emphasizes the importance of carefully calculating the stresses to which fastenings may be subjected.

* * *

INADEQUATE SALARIES OF PATENT OFFICE EMPLOYES

It is almost inconceivable that there are positions in the United States Government requiring highly trained men that pay a salary of only $200 more per year than they did seventy-two years ago. However, such is the case with the positions of examiners, assistant examiners, and clerks in the Patent Office, according to data prepared by Frank L. Walker, Dayton, Ohio. Examiners or assistant examiners must have a liberal general education, and in addition they must be either highly trained engineers, chemists, lawyers, mechanical experts, or specialists in industrial or technical lines. Questions that are encountered and which must be answered by the men holding these positions involve law and technology, and if an error is made in the decision of an examiner due to his lack of knowledge of these subjects, the manufacturer or inventor applying for a patent may later be involved in a long and expensive law suit in order to protect his interests. Thus it will be seen, that the qualifications for work of this nature are of a very high order.

It would seem that positions which require men with such an education and ability would pay a reasonable salary, but the fact remains that the salaries of primary examiners, who are the highest paid examiners in the department, is only $2700 per year. The salary of this position was $2500 per year in 1848, while the salary of an assistant examiner was $1500 per year. The salary of a fourth assistant examiner still remains $1500 per year, the salaries of the other grades of assistant examiners ranging between this and the salary of a primary examiner. Skilled clerks who are responsible for the important records of the department only receive from $720 to $1000 per year. In 1836, when the examining system of the Patent Office was inaugurated, a member of Congress received $8 per day for each day of attendance in Congress; district judges received from $1000 to $1800 per year; and examining clerks in the Patent Office received $1500 per year. The salaries of the latter were increased to $2500 per year in 1848. In 1870 a member of Congress received $5000 per year; district judges received $3500 per year, while primary examiners in the Patent Office received $2500 per year. Today a member of Congress receives $7500 per year and district judges $6000 per year, while primary examiners receive only $2700 per year, the salary of this position having been raised $200 in 1908.

From the foregoing it will be seen that the salaries of members of Congress and district judges have kept pace with the increased cost of living and salaries paid to men in positions requiring similar education and intelligence. The salary of the position of primary examiner, however, is only 8 per cent greater than it was in 1848. It is, of course, impossible for the highest efficiency of any department or organization to be maintained under such unsatisfactory circumstances, and the result in the Patent Office is that valuable men are resigning their positions in order to accept other positions which, although requiring less education and ability, pay a more attractive salary. It is evident that these vacant positions cannot be refilled with men equally qualified on account of the low salary, and there is danger of the Patent Office organization becoming thoroughly disorganized. There is at present a bill pending in Congress to remedy this unfair condition, and it is essential to the welfare of all industries that this measure be passed. Upon the efficiency of this department depends the rapid and lawful granting of patents to the mechanical, chemical, textile, and food-producing industries for labor-saving devices, which mean increased production.

Indicating and Contour Gages

By JOHN E. COLLINS



INDICATING gages, in which the indications are read off by sight, may be divided into five classes: (1) The dial and needle type. (2) Gages employing micrometer screw attachments. (3) Gages having a cross-hair microscope, usually in connection with a micrometer screw. (4) Signal lamp gages. (5) Multiplying-lever type indicators.

Dial Indicators

Dial gages usually employ a train of gears for multiplying the travel of the needle. Sometimes merely a large quadrant meshing with a small wheel carrying the needle is used. Nearly all dial gages have the general appearance of a watch, being usually mounted in a pressed-steel body. Some inspectors discourage the use of the dial type of gage, because of the backlash that develops in the gears when worn, the fluctuations of the needle due to the unbalanced action of the moving parts, and the unequal wear of the different moving parts. This unequal wear is caused by using a gage for gaging one size or one dimension for a long period of time. The fluctuations of the needle retard the inspection of parts, and for this reason the gage is often avoided when high speed is required in inspecting.

Micrometer Screw Type of Gage

The micrometer screw has been applied to many different types of gages because of certain advantages inherent in gages so constructed for work that cannot be easily inspected by a regular snap or plug gage. A micrometer screw may be considered accurate to at least 0.0001 inch, but it must be inspected for wear and to ascertain that the measuring point of the screw and gage are parallel with each other.

Cross-hair Microscopes

The cross-hair microscope is often used in connection with the micrometer screw, and it enables the inspector to obtain very accurate measurements. This attachment is often used for inspecting plug thread gages, but only a limited number of shops use this type of instrument, as it seems to be considered a laboratory appliance only.

Gages Equipped with Electric Signal Lamps

Gages equipped with signal lamps may be of various designs, but are usually built on the plunger principle. A flat surface plate is mounted under two sliding pins which are the "Go" and the "Not Go" points. These pins are connected with dry-cell batteries and are the terminals for one end of the circuit, the surface plate being the other terminal. A colored electric lamp, usually red, is connected with a "Not Go" plunger and a green lamp, with a "Go" plunger. The work is first slid under the "Go" plunger, and if no green light shows it is of the correct size as far as the "Go" operation is concerned. The work is then slid under the "Not Go" plunger, and if the red light shows it indicates that the work is of the correct size.

This class of gages will give very accurate results, and may be used to gage as close as 0.0001 inch. Care must be exercised, however, not to connect the lamps with too strong a battery, for in that case the spark is likely to "jump" the slight distance between the gaging plunger and the surface of the work.

Multiplying-lever Gages

Multiplying-lever gages have several disadvantages, and should not be used in taking measurements requiring great accuracy. The greatest objection to this type of gage is the weight of the moving arms, etc. This condition can sometimes be relieved by the correct proportioning, arrangement, and balance of the various units of the lever. Another disadvantage is the large number of wearing points which necessitate frequent inspection of the gage itself to determine its accuracy. All gages of this type should have a "check" for discovering the wear in the gage itself. The leverage ratio should be 100 to 1 and in no case less than 50 to 1, as this ratio provides for only about 1/16 inch graduations for each 0.0001 inch variation in the work.

Indicator Concentricity Gage

An indicator concentricity gage, which is used for gaging cylinders and other similar work, is illustrated in Fig. 1. It consists of the cast-iron base *A*, a long arm *B* which swings on a boss cast on the base, and the indicating arrangement. The arm *B* is so arranged that the work may be placed in position for gaging without disturbing the setting of the indicator. The cycle of operations necessary for gaging a piece of work consists of raising the indicator pin by means of the knurled nut *F* and swinging the arm *B* back into position; then by turning the work around, its concentricity may be determined by means of the indicator arm. Adjustment of the knurled nuts *H*

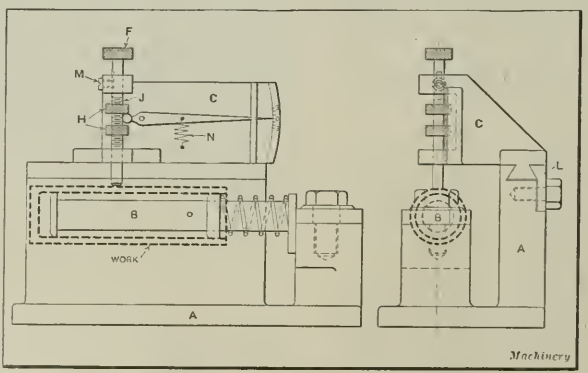


Fig. 1. Indicator Concentricity Gage for gaging Cylinders

will bring the indicator arm into the zero position. A set-screw *M* fits the keyway in screw *J* and prevents it from turning. An inspection of the end view will show that arm *C* is fitted in a dovetail groove in the base *A*, in which it slides to adjust the position of pin *J* longitudinally along the work, after which it is secured in position by means of clamp *L*. All parts except the spring, base, and arm *C* are made of machine steel and are pack-hardened. By designing rollers to take the place of the arm *B*, solid cylindrical work may be inspected on this gage without otherwise changing the design.

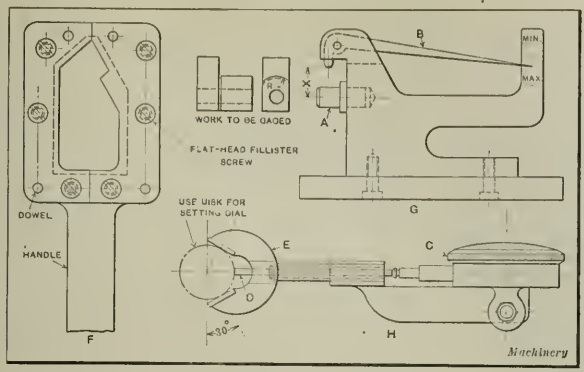


Fig. 2. Outline and Radius Gages

Radius Indicating Gage

The gage shown at *G*, Fig. 2, is designed to inspect work the radius *R* of which is located from the center of a hole. The gage is very simple, the work being slid on the locating arbor *A*, with the bearing point of the indicator *B* resting on the surface to be gaged. Then by slowly turning the work from one extreme point to the other and at the same time observing the position of the indicator point, it may be readily determined whether or not the radius is within the two extreme limits which are allowed on the work. These limits are established by minimum and maximum lines etched on the gage as shown, but if the gage is used as a working gage, another line should be etched midway between these two to represent the ideal conditions, and the operator should work to this line. The gage proper is mounted on a square block so that it may be moved from bench to bench as desired.

Three-point Indicating Gage

The gage shown at *H*, Fig. 2, was designed for use in gaging cylindrical work while it is being rotated. Experience has shown that these gages give the best results on ground work and that the unevenness of turned work causes the needle to fluctuate so that it is impossible to take an accurate reading. Referring to the illustration, *C* is the dial indicator and *D* the gaging pin, which is hardened and lapped and which rests against the work. The gaging pin is centered on the work by the 60-degree V-block *E*, the two hardened and lapped surfaces of which are in contact with the work as it is revolved and gaged. This gage must have a check, a hardened and ground disk of the same diameter as the work being employed for setting the dial before the work is gaged.

Depth Measuring Gage

Another type of indicating gage in which the flush-pin gage is converted into a dial gage is illustrated in Fig. 3. This gage is used for measuring the depth of a bore or the distance of a boss face below the surface from which the measurement is taken. The measuring rod, which may be of any desirable length, is shown at *A*, while *B* represents the bearing body which also supports the spring for the flush-pin. *C* is the bar which rests on the gaging surface, and *D* the indicator support pin. The greatest use for a gage of this type is on milling operations, it being used either as a working or inspection gage. In all cases the gage should have a check to set the dial by, so that the operator can inspect the accuracy of the gage before using it. However, for the inspector's use, a common flush-pin gage would be the most efficient, because the inspector is interested only in whether or not the part is within the limits, and not in the amount that it is over or under these limits.

Gages for Inspecting Irregular Outlines

The receiving gage is a type that is very useful for inspecting irregular outlines of parts, where a very accurate result is not required, the work being considered correct if it passes through the gage. The construction of the receiving gage is very simple, as will be seen by referring to view *F*, Fig. 2. The handle and the support for the gaging plate are made in one piece. This piece has an opening, as shown by the dotted line, of sufficient size and proper shape so that clearance is provided for the work as it is passed through from the top of the gage. The top is made of two pieces which are held in place by means of dowel-pins and screws, as shown. As the gage becomes worn it may be reset by relocating the dowel-pin and screws and adjusting the top plate to the required position.

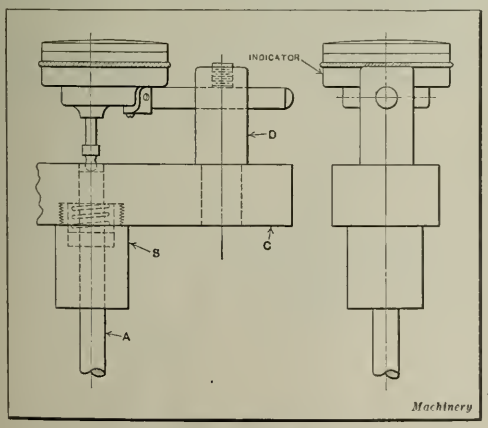


Fig. 3. Dial Type of Depth Measuring Gage

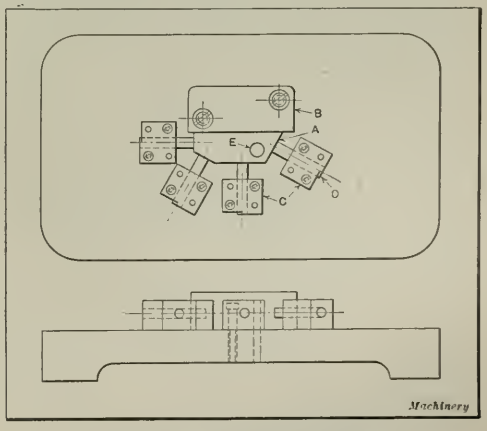


Fig. 4. Flush-pin Type of Profile Gage

The ordinate method of gaging is considered very accurate for use on irregular outlines or profiles. One method of taking measurements by this system employs common flush-pin gages, which are set at the most important points around the profile of the part to be gaged. This type of gage is outlined in Fig. 4, in which the part to be inspected is represented by *A*, and the block against which the work is lined up for gaging by *B*. The blocks *C* carry the flush-pins *D*, while *E* is a pin which is used to locate the work in its correct lateral position. If the limits on the work are known, it is obviously an easy matter to make flush-pins having these limits and to set them in their correct position in relation to the work. In laying out gages of this kind, care must be taken to locate the important points, such as flats and high spots, on the part to be gaged. The flush-pins should be laid out at right angles to flat surfaces, and if located at a corner, the center line of the pin should bisect the angle formed by the two surfaces.

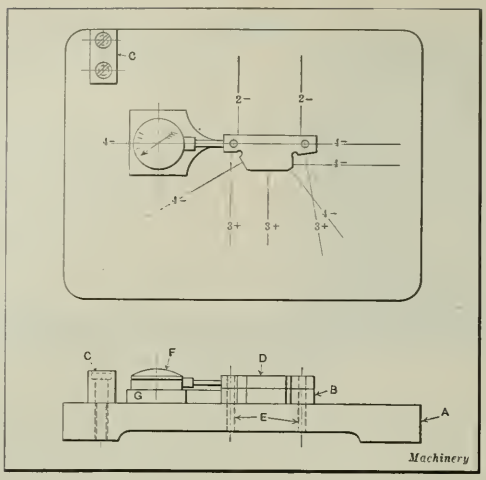


Fig. 5. Indicator Type of Profile Gage

In Fig. 5 another type of gage is shown which employs the ordinate method in connection with a dial indicator. This is often used when the points to be gaged are not accessible with the flush-pin type of gage. The gage consists of a surface plate *A*, on which is mounted a master profile *B*. The master profile should be hardened and lapped to the exact size and outline of the part to be gaged, that is, to its mean dimensions. A hardened, ground, and lapped block *C* located perpendicular to the surface of plate *A*, is used to set the dial indicator, as will presently be explained. The work *D* to be gaged is located in the correct position by means of the pins *E*, which also serve to fasten the master on the surface plate. The dial indicator *F* is securely fastened to the hardened block *G*. The surface of this block resting on block *A* should be ground and lapped, as well as the end surface which bears against the master profile. Of course all work will not have holes which may be used for locating, and in that case, other suitable means must be devised, such as allowing the work to rest against a surface on the side of the piece and gaging on the opposite side, as in Fig. 4.

When using a dial indicator, limits or tolerances on the work must be established in their correct direction. The method of procedure is to place the work directly over the master, which has previously been located in the center of the surface plate. The point of the indicator must be in perfect alignment with the end surface of the holding block *G*, Fig. 5, when the indicator needle is set at zero. This condition is obtained by placing these two extremities against block *C* and adjusting the indicator needle while the block is in this position. With the point of the indicator stem directly above the point on the holding block, the block is then brought into contact with the master and the indicator point into contact with the work, so that it is possible to read off in thousandths of an inch any differences that may exist between the work and the master. The indicator holding block *G* should have a heavy vertical line inscribed on its rear side at the center. This is used to align the blocks and spindle of the indicator with the tolerance lines that are inscribed on the surface plate *A*. These lines on the surface plate are located similarly to the manner employed in placing the flush-pin in position, as described in connection with Fig. 4. The notations 4 —, 3 + and 2 —, in Fig. 5, indicate, of course, the maximum and minimum limits that are allowed on the work at the points indicated.

Snap Plate Gages

Fig. 6 illustrates a type of combination gage that has been developed exclusively for gaging work which is too small to be held conveniently in the fingers. The gage is intended for use on large quantities of work of the type shown in the illustration. The baseplate *B* is ground on its top surface, the guide plate *A* being attached to it, so as to guide the work between the "Go" and the "Not Go" snaps *C*. These snaps should be provided with checks to be used in inspecting the gage for wear. A section of the large guide block *A* is milled out at *E* to allow finger space for pushing the accepted work to one side of the plate. Rejected pieces will pass through the "Not Go" snap, off the plate. This plate is made of sufficient size to accommodate a handful of pieces, so that they may be rapidly inspected by passing them through the runway formed by plates *A*.

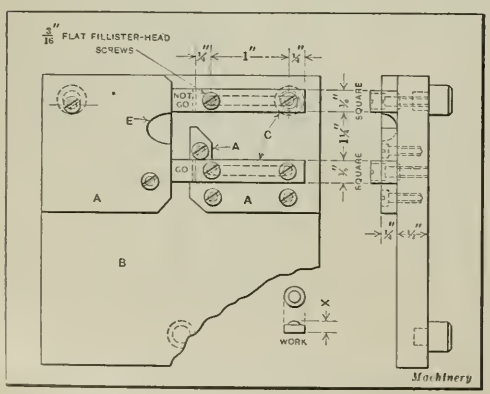


Fig. 6. Snap Plate Gage for gaging Small Work

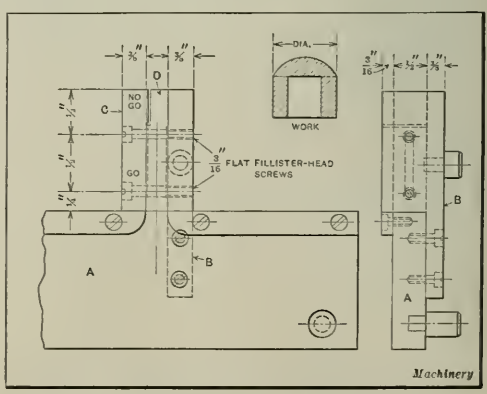


Fig. 7. Snap Plate Gage for gaging Diameters

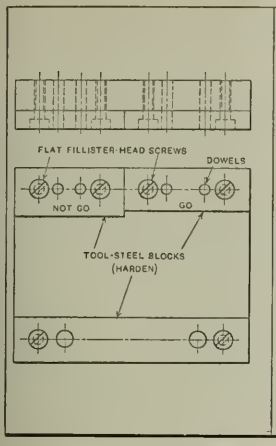


Fig. 8. Bar Type Gage for gaging Diameters

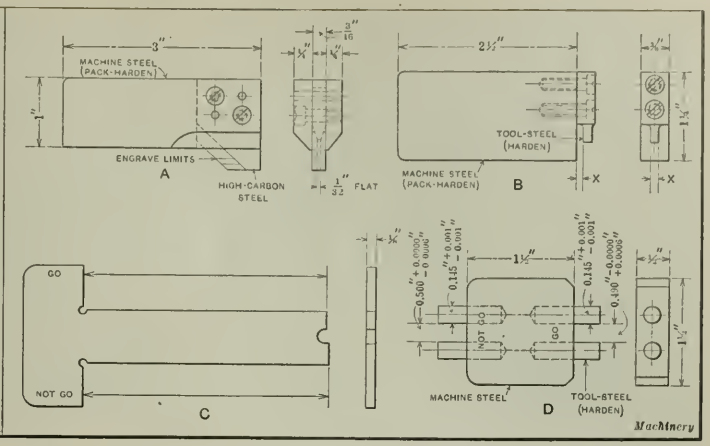


Fig. 9. (A) Gage for testing Bevels. (B) Hole or Groove Locating Gage. (C) Gage for gaging Lengths. (D) Pin Gage for gaging Grooves and spacing Holes

Another special type of snap plate gage and the work for which it was designed are shown in Fig. 7. This gage is intended for inspecting diameters only. The flat plate *A* acts as a table to hold a number of parts at a time. The long narrow piece *B* extends back under the plate *A* and is held to it by means of two screws. Parts *C* and *D* are fastened with screws to *B*, thus holding the complete gaging unit to the base. A few dimensions are given in the illustration so that an idea of the proportion of the gage may be obtained. A piece of work is slid on the plate *A* into the gage; if it passes through both the "Go" and "Not Go" sections it is, of course, rejected, but if having passed the "Go" snap, the part fails to enter the "Not Go" gage it is accepted.

The bar type of gage is designed to supersede the snap gage for inspecting diameters that are measured near the end of the work, the end being flat and bearing on the plate of the gage. This type of gage, which is shown in Fig. 8, is especially adapted for use on flat work, such as ground disks. The "Go" and "Not Go" gage-plates may be relocated to compensate for wear, which involves careful resetting of the blocks.

Unclassified Gages of Various Designs

Bevel Gage—This gage is used for testing bevels, etc., which are dimensioned from a finished surface at the end or side of the work. As may be seen by referring to *A*, Fig. 9, the "built-up" type is used where the chamfer must be tested along its entire length, that is, to the extreme point on both sides of the work. On account of the relief which must be provided for grinding purposes, a "built-up" gage is preferable to the plate type. Limit lines should be engraved on the gage after assembling, as shown in the illustration. The body is beveled to allow free inspection of the work when gaging.

Hole or Groove Locating Gage—A very good design of gage for inspecting the distance of a hole from a finished edge or surface is illustrated at *B*, Fig. 9. The gaging post is made of hardened tool steel and the body of machine steel, pack-hardened. The construction is simple and should be readily understood from the illustration.

Length Gage—At *C* is shown a gage that is used for measuring straight lengths from a shoulder or from the beginning of a taper. In this type of gage, the shortest side is considered the "Go" gage, whereas the longest side would not go in any case if the work is correct. Tolerances for this gage should be applied in the same manner as for standard snap gages.

Pin Gage—The gage shown at *D* is used for measuring diameters of grooves on turned work, etc., as well as for the spacing of holes which must be within certain defined limits. The "Go" side of the gage is chamfered for identification purposes.

Thickness Gage—The gage illustrated in Fig. 10 is used to measure the thickness of walls, which are not accessible when using an ordinary snap or micrometer gage. It is also much cheaper to make than the gages which are sometimes used for gaging work of this nature, such as dial indicator gages, etc. The knurled handle *A* holds the shank of the feeler *C*, to which it is pinned, in such a manner that the feeler may be turned without disturbing the position of the leg *B* against the outer wall of the cylinder. Three-fourths of the boss on leg *B* is milled off and a pin inserted through *C*. The end of this pin rests on the projecting ring quadrant, formed by milling the boss of *B*, so that the feeler *C* may

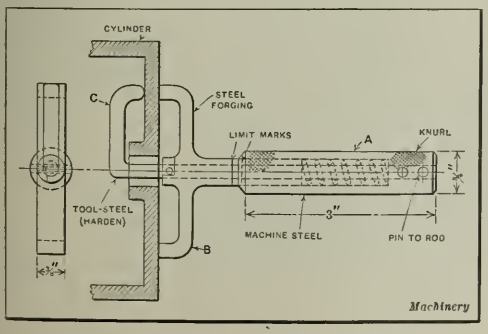


Fig. 10. Gage for measuring Thickness of Walls

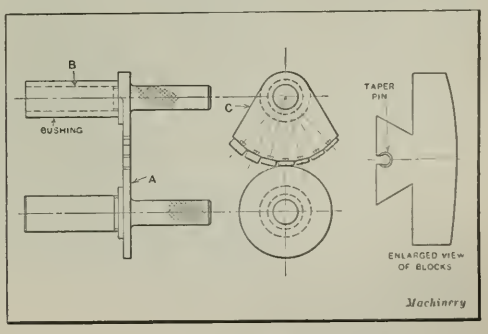


Fig. 11. Center Distance Gage for Spur Gears

be turned at right angles to the position shown in the illustration; and when handle A is pushed in, the coil spring in it will be compressed, thus removing C from contact with the inner wall of the cylinder and allowing the gage to be tilted and withdrawn from the work. The "Go" and "Not Go" limit lines are engraved on the shank of B, and the limits are determined at the beveled end of the handle, at which point any lateral movement of the feeler will be indicated.

Center Distance Gage for Spur Gears—The center distance of spur gears, which must be held to a limit, may be inspected with a gage such as shown in Fig. 11. This gage has removable wearing blocks, shown in the enlarged view, which are ground independently and to various radii. Each block is so ground that one side of its vertical center line represents the plus limits and the other side the minus limits. These plugs are inserted in the quadrant which holds them successively in the order of mean center distances, beginning at the smallest radius; they are also ground in this order while held in the gage body, so that the several radii are ground from the same center. The gage consists of an accurately ground collar A, which is pressed on a plug, and used in the center of one gear, the other center having a plug B with the block-holding quadrant C attached. Bushings may be used with the gage for increasing the center distances, and in all cases the plug which carries the contact blocks should have a bushing to take the wear caused by turning the quadrant when inspecting the work. The collar A is made circular instead of quadrant-shaped so as to give a longer wearing life. By making a set of bushings to fit both plugs, and a set of quadrants of various radii, a compact and complete set of center distance gages may be produced.

* * *

INSPECTING TAPERED FLAT GAGES

By V. E. AYRE

Referring to diagram A in the accompanying illustration, to find the distance Y from the shoulder to the intersection of the taper with the vertical, proceed as follows: First measure angle b on a sine bar. Then set the gage on an angle-plate with the surface, of which Y is the length, perpendicular to the surface plate. Clamp either a try-square or straightedge against this surface and drop in a wire of diameter G, as shown in the diagram. Measure H, the distance from the top of the wire to the shoulder, and finally from the above measurements calculate Y, thus:

$$Y = H - (L + g)$$
$$L = g \cot \tfrac{1}{2} b$$

Therefore

$$Y = H - (g \cot \tfrac{1}{2} b + g)$$
$$= H - g\,(1 + \cot \tfrac{1}{2} b)$$

Another method of determining the dimension is shown in the diagram B, in which the dimension is represented by X. In this case the straightedge is clamped to the end of the gage and dimension L is measured. Measure angle b on the sine bar, then clamp the gage to an angle-plate so that the surface at the tapered end of the gage is in a vertical position. Clamp a small parallel bar against this surface and drop in a wire of radius g, as shown by the full-line circle. Measure the distance H from the top of the wire to the surface of which X is the length, and from these measurements determine the depth D by the use of the following evolution of the formula $D = H + g + W$.

$$W = g \cot \tfrac{1}{2} (90 \text{ degrees} - b)$$

Therefore

$$D = H + g + g \cot \tfrac{1}{2} (90 \text{ degrees} - b)$$
$$= H + g\,[1 + \cot \tfrac{1}{2} (90 \text{ degrees} - b)]$$

If a large-diameter wire is used, as shown by the dotted circle,

$$D = g_1 + W_1 - H_1 = g_1 + g_1 \cot \tfrac{1}{2} (90 \text{ degrees} - b) - H_1$$
$$D = g_1\,[1 + \cot \tfrac{1}{2} (90 \text{ degrees} - b)] - H_1$$

Having found the value of D,

$$X = L - Z$$

But

$$Z = D \cot b$$

Therefore

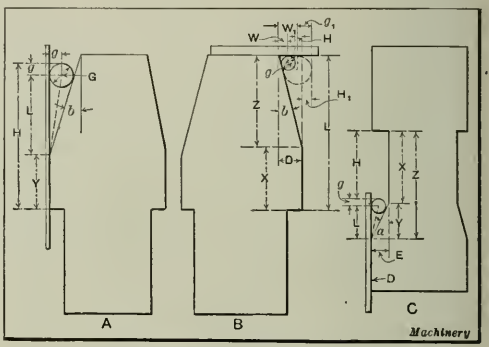
$$X = L - D \cot b$$

Diagram C illustrates the method of inspecting the check for the type of gage shown in the other two diagrams. To find length X, the distance from the shoulder to the beginning of the taper, first measure angle a on the sine bar, and the depth E with a depth micrometer. Set the check on an angle-plate with the surface at D perpendicular to the surface plate. Clamp a straightedge or try-square against surface D and drop in a wire of radius g. Then measure distance H, from the shoulder to the top of the wire. Calculate the distance $L + g$, from the given radius of the wire and the measured angle a, as follows:

$$L + g = g \cot \tfrac{1}{2} a + g$$
$$= g\,(1 + \cot \tfrac{1}{2} a)$$

and then find the values for Y and Z, thus:

$$Y = E \cot a$$
$$Z = H + (L + g)$$



Diagrams illustrating Methods of using Wires in checking Gages. Diagram (C) showe the Check for the Gage

Substituting for $L + g$,

$$Z = H + g\,(1 + \cot \tfrac{1}{2} a)$$
$$X = Z - Y$$

Therefore

$$X = H + g\,(1 + \cot \tfrac{1}{2} a) - E \cot a$$

* * *

NATIONAL FOREIGN TRADE CONVENTION

The National Foreign Trade Convention called by the National Foreign Trade Council, to be held in San Francisco, May 12 to 15, will have as its general theme "The Effect of Being a Creditor Nation." The general object of the convention will be to analyze the conditions now confronting American international commerce, and those it will have to meet in the immediate future; to consider the influence of the results of the war upon our foreign trade; to study the effect of being a creditor instead of a debtor nation; and to endeavor to obtain the thoughtful judgment of American business men upon these problems of vital importance. Further information regarding the convention may be obtained by communicating with the secretary, National Foreign Trade Council, India House, 1 Hanover Square, New York City.

At the trade convention, about thirty foreign nations will be represented. The departure of the National Foreign Trade Council this year in extending an invitation to foreign countries to be represented by special trade advisors is expected to result in a notable attendance of foreign traders. Ten trade advisors are being allotted to each one of the foreign nations whose commercial representatives have been invited to the convention. These special advisors will be chosen by trade organizations in their respective countries.

Manufacturing Krasco Spring Motors



First of Two Articles Describing the "Krasco" Phonograph Motor and the Organization and Arrangement of the Krasberg Engineering & Mfg. Corporation's Plant

By EDWARD K. HAMMOND

OWING to the competition existing among different makers of phonograph motors, the manufacturer who expects a reasonable margin of profit must carefully organize his plant in order to obtain the maximum economy in using materials, and efficiency in handling the work. Visitors who are shown through the plant of the Krasberg Engineering & Mfg. Corporation in Chicago, contract manufacturers, designers and builders of special machinery and tools, will be impressed by evidences of the care which has been taken in perfecting the details of this firm's factory practice. Especial attention has been paid to the arrangement of the manufacturing departments, so that the work is routed in a continuous line from the receiving room through the various work-shops until the finished motors finally reach the department where they are packed for shipment to the consignee. This not only saves time in handling the work and thus reduces direct labor costs, but also cuts down the overhead expense which must be charged against each motor, because it increases the daily output of the plant.

Carrying the idea of efficient production to its logical conclusion many ingenious methods have been developed for the machining operations, which are responsible for effecting economies in the process of manufacture. Although these methods are described in connection with the manufacture of spring motors, most of them are applicable in plants engaged in the manufacture of a great variety of other products. For that reason, the present article becomes one of more general interest than would be the case if it were a mere description of the machinery and methods used in manufacturing a mechanical specialty; but in order to make clearer the reasons for certain practices which are employed, it will be desirable to first give a brief description of the "Krasco" spring motor.

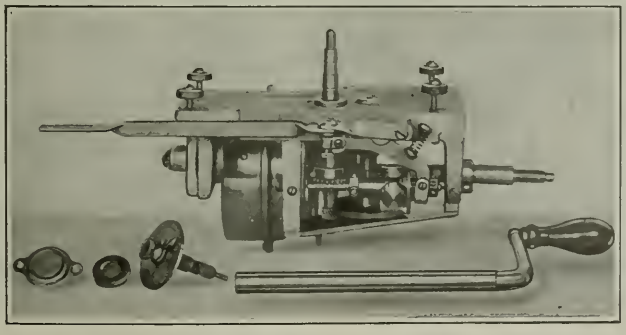


Fig. 1. Two-spring Type of "Krasco" Motor which develope Sufficient Power to play Three Ten-inch Records

The "Krasco" Spring Motor

Figs. 1 and 2 show two types of "Krasco" spring motors, and in starting to explain the way in which a motor of this kind operates it will doubtless be best to first call attention to the two opposite ends of the train of mechanism. At *A* Fig. 2, there is shown the spindle on which the record turntable is carried, the top of this spindle being machined to a taper which fits into a corresponding tapered socket in the hub of the table. The winding crank *B* makes connection with an arbor *C*, which transmits the crank motion to a train of gearing that winds up the springs. To meet the requirements of different phonograph manufacturers, motors are made in two-, three-, and four-spring types. Fig. 1 illustrates one of the two-spring motors, and in Fig. 2 a three-spring outfit is shown. The springs are contained in cases shown at *D*, in Fig. 2, and as the springs are wound up by crank *B*, a ratchet and pawl prevent them from running back. Then when the motor is started, its power is transmitted through bevel gears *E* and spiral gears *F* to the turntable spindle *A*. In order for a phonograph to be universally applicable for playing the great variety of music which is reproduced on an instrument of this kind, it is necessary to provide means of regulating the speed at which the record is rotated. For this purpose a controller dial *G* is provided, and by turning the indicator over this dial, movement is transmitted through link *H* to a sliding member *I*, which makes a suitable adjustment of the centrifugal controller *J*, that automatically governs the speed at which the motor rotates the record.

Organization of Manufacturing Departments

Mention has been made of the way in which the manufacturing departments are laid out in the Krasberg plant in order to reduce lost motion to a mini-

mum and thus increase the efficiency of the manufacturing operations. The same general principles are employed in laying out the manufacturing, assembling, and inspection departments; and as it is proposed to present detailed descriptions of some of the more interesting methods employed in performing machining operations, the part of this article dealing with the arrangement of departments will be confined to those which are engaged upon the inspection of finished parts and assembling of the product. This will give the reader a general idea of the way in which all three classes of operations are

The product from both the press-room and the machine shop is sent directly to the third floor, and when received at this point it first passes through an inspection room, a partial view of which is shown in Fig. 3. Here the various parts receive the necessary inspection to assure having each piece come up to the stipulated requirements of accuracy and perfection of workmanship. In planning both the process of manufacture and the performance of inspection operations, however, a great deal of thought has been given to the actual service which is performed by each motor part, and the

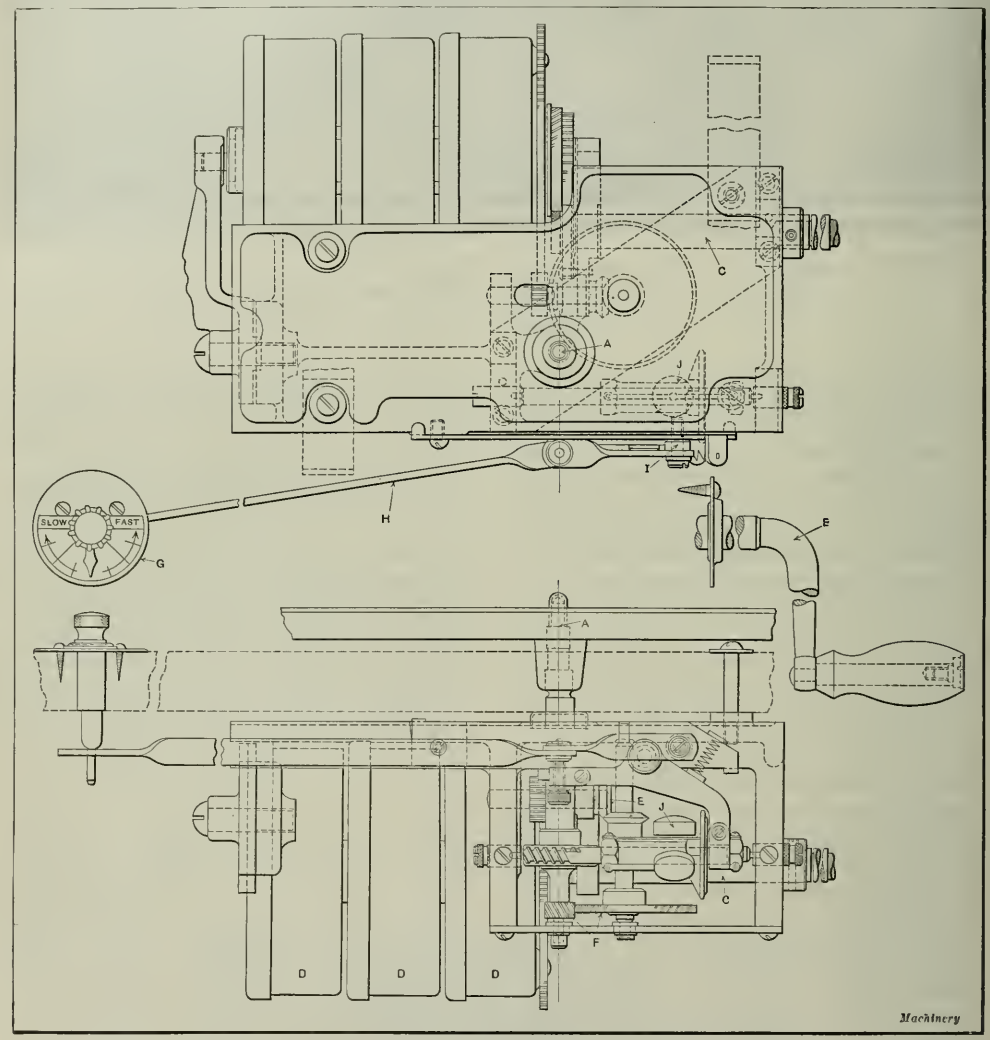


Fig. 2. Plan and Elevation of the "Krasco" Three-spring Phonograph Motor, illustrating its Principle of Operation

conducted. There are three floors of the Krasberg plant devoted to spring motor manufacture, which only represents a portion of the company's business. Whenever possible, power presses are used in making parts of the product, as this type of equipment is unusually well adapted for the attainment of rapid production. The press-room is located on the lowest of the three floors, and on the second floor space is given over to the various types of machine tools which are required for performing machining operations on various spring-motor parts.

requirements which must be fulfilled in making it, in order to assure having the part function properly. Obviously, it would be an unnecessary refinement to hold parts to limits of, say, 0.001 inch, where a more liberal limit of tolerance could be specified and still obtain the desired results. Care given this point has been the means of effecting substantial economies in the process of manufacture without in any way impairing the quality of the product. In fact, the study of proper tolerances constitutes one of the most important details of economical manufacture.



Fig. 3. One End of the Department where all Parts receive a Careful Visual Inspection before they are delivered to the Assembling Department



Fig. 4. A Partial View of the Spring Assembling Department. The Housing is packed with Grease to lubricate the Spring and prevent Rusting

Assembling Operations

Where properly applied, the so-called "unit" system of assembly is not only a convenience when it is required to make repairs on the product after it reaches the ultimate purchaser, but this principle also facilitates the actual work of manufacturing. It is employed in assembling "Krasco" spring motors, the procedure being to have groups of employes make up the different unit assemblies and then to send these units to the final assembling department, where they are put together to form complete motors. Fig. 4 shows a view in the department devoted to assembling the main spring units. This work involves assembling the spring in its case and packing the case with grease that serves the double purpose of lubricating the spring and protecting it from rust.

Progressive Assembly of Completed Motors

The so-called "unit" assemblies delivered to the final assembling department are distributed along transverse benches which are grouped in this department as shown in Fig. 5. Frames by which other parts of the mechanism are supported are delivered at the right-hand ends of these benches, and various unit assemblies are laid out along the benches in the order in which they are required by assemblers. Men working on this part of the process of manufacture take a frame and assemble a gear and shaft unit into place, this happening to be the first piece that is put in position. Then the spring motor frame is slid along the bench to the next man, who mounts the succeeding piece in place and then passes it along to the man at his left. With an arrangement of this kind, there is a continual stream of work going along each bench from right to left, and as each finished motor reaches the left-hand end of the bench, it is pushed off on a belt conveyor which runs along the left-hand end of the benches and carries the finished motors away to the testing department. It will be understood from the preceding description that all of the work of assembling a motor is done on one bench.

Testing Finished Motors

Before shipment, each motor is required to satisfactorily undergo a number of tests, in addition to which expert



Fig. 5. General View of the Assembling Department. Various Partial Assemblies of the Spring Motor are distributed along Transverse Benches, and the Work progresses from Right to Left along these Benches, Finished Motors being carried away by the Belt Conveyor at the Left-hand Side of the Department

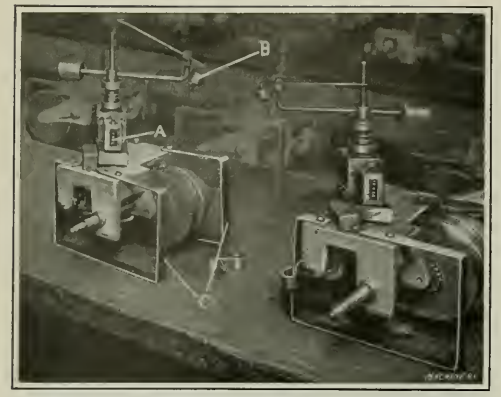


Fig. 6. Each "Krasco" Phonograph Motor receives a Running Test in Order to ascertain that all Parts of the Mechanism function properly



Fig. 7. Testing "Krasco" Phonograph Motor for Quiet Operation. Any Noise produced by the Motor would spoil the Effect in playing a Record

mechanicians observe the operation of each motor and make any adjustments which are found to be necessary. The first test required of the motors depends upon whether they are equipped with two or more springs. In the case of a No. 2 motor, it is required that after being fully wound up, the motor springs shall possess sufficient energy to drive the turntable through at least 750 revolutions at a speed of 80 revolutions per minute, which is equivalent to playing three 10-inch records. Similarly, a No. 3 motor is required to run through at least 1000 revolutions per minute at the same speed, which is equivalent to playing four 10-inch records. A No. 4 motor must make from 1500 to 1800 revolutions per minute at the standard speed, which is equivalent to playing from six to seven 10-inch records. Fig. 6 shows motors set up for conducting the power test. The fixtures used for this purpose are provided with a tapered socket which fits over the nose on the turntable spindle. On each of these fixtures there is an automatic counter *A* that records the number of revolutions made by a motor, and a pivoted indicator which has a counterweight *B* at one end.

When the motor is running at the specified speed of 80 revolutions per minute, there will be sufficient centrifugal force acting upon weight *B* so that the arm of the indicator will be in a horizontal position, as shown at the right-hand side of Fig. 6; but as the springs of the motor relax and approach a condition where the motor is "running down," the speed slackens sufficiently so that centrifugal force will no longer hold the indicator horizontal; instead the indicator will assume the position shown at the left in the illustration. Immediately an indicator arm rises in this way, the girls in charge of the testing bench observe the number of revolutions which the motor has made, and if this number is below the specified limit for the particular type of motor, the cause of the trouble must be corrected. All motors which pass the power test are passed along to a department where final adjustments of the mechanism are made, and "sound" tests are conducted in order to make sure that the motor will not be noisy while in operation.



Fig. 8. Each Motor is packed for Shipment in an Individual Carton, and Twelve Cartons are crated together for Delivery to the Consignee

Conducting the Sound Test

Very little thought need be given to the subject in order to make it apparent that a spring motor which is to give satisfactory service on a high-grade phonograph must run quite noiselessly, for the effect in playing fine records would be ruined if there were any perceptible noise made by the motor. For use in testing the perfection of the motors, in so far as freedom from noise is concerned, use is made of what are known as "sound boxes," on which the motors are placed, as shown in Fig. 7. These sound boxes are made of thin wood and have their joints carefully matched so that each box is completely closed on all sides except at the front. The motor to be tested is placed on the top of the box and allowed to run while the operator places his ear close to the opening at the front of the box. If the motor makes any noise while running, the vibrations which cause this noise will be imparted to the thin top of the sound box. This effect will be magnified by vibrations set up inside the box, thus enabling the man conducting the test to detect noises of such slight magnitude that they could not be heard with the motor standing on an ordinary work-bench. Where a motor does not give satisfactory results from the findings of this sound test, it is necessary to carefully inspect all parts of the mechanism and make the required adjustment to remove the cause of vibration that is responsible for the objectionable amount of noise that is produced when the motor is in operation.

Packing Motors for Shipment

When the work of assembling each motor is completed, two rectangular-shaped bands of iron shown at *C* in Fig. 6 are screwed on the motor frame by means of screws entering tapped holes in the top face of the frame. These two bands of iron serve as supports for the motor during the time that it is receiving power and sound tests, and they are left in place when the motors are transferred to the shipping room. The reason for this practice will be obvious by referring to Fig. 8, where it will be evident that each motor is packed in an individual strawboard carton. The two

bands of metal form a regular outline for the motor so that it slips into place in the carton and is not likely to be damaged in transit to the plant of the consignee. Twelve of these cartons are crated together for shipment, as shown at the right-hand side of the illustration.

Time-saving Methods of Performing Machining Operations

A general description has now been given of the arrangement of departments in that section of the Krasberg Engineering & Mfg. Corporation's plant which is devoted to the production of phonograph motors. Particular emphasis has been laid upon the coordination of the work of different departments, and upon methods of handling the product, which tend to save time and reduce production costs. To supplement the general description of the methods of factory management which are employed by this firm, a detailed description will be presented in the May number of some of the more interesting methods which are used in machining phonograph motor parts.

* * *

IMPORTANCE OF USING LEGIBLE BLUEPRINTS

By JOHN A. MARKSTRUM

Anyone engaged in the manufacture of parts produced according to blueprints made from pencil tracings, is constantly confronted with the problem of reading more or less illegible prints. If the dimensions are not discernible it involves consultation with the drawing-room, which means an unnecessary loss of time. If an error is made through guessing at the probable meaning of the illegible figure, it may result in the scrapping of the machine part and an additional loss caused by holding up production. If the part is being made for an out-of-town customer and the figures on the blueprint are not sufficiently clear so that they can be interpreted, due to the carelessness of the draftsman or the condition of the tracing, a series of communications between the two concerns will necessarily follow. These usually result in considerable delay and represent an unnecessary waste of energy. A common mistake is made by manufacturers in using worn out tracings having the pencil marks obliterated by frequent handling, patches covering important parts, corners torn off, or holes and creases destroying the very dimensions or views desired.

The following experience of the writer is an example of the uneconomical methods sometimes resorted to in order to eliminate the making of a new tracing. A prominent automobile company sent out an order for a small but intricate tool, the blueprints being made from a tracing which had been used so often that the lines and figures produced on the print were too faint to give any information. However, instead of having a new tracing made, the entire tool had been inked in on five copies of these worthless prints. It was the opinion of the writer that this was done in order to get prints ready without much delay, but a duplicate order was received a few days later accompanied by five more of these inked-over prints. The time required to ink in these ten copies was much more than would have been necessary to make a new pencil tracing, and still the firm was without a tracing for future use.

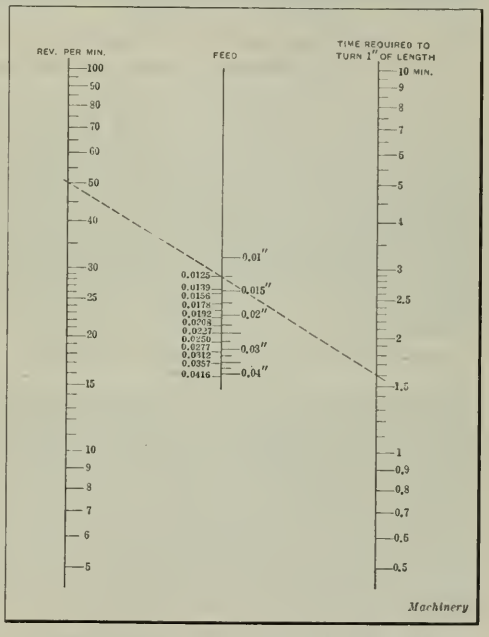
A shortage of draftsmen is generally given as an excuse for using poor tracings, but it is the opinion of the writer that a good method to train inexperienced men to be draftsmen would be to have them reconstruct or re-make the tracings which will no longer produce a good print. It is a known fact that good blueprints can be made from good pencil tracings and so there is no excuse for any poor prints. The importance of skilled labor is appreciated more today than it ever was, and many precautions are taken to safeguard the health and efficiency of employes, but through gross neglect this efficiency is often decreased and the eyesight of the workman impaired by the use of illegible blueprints. Needless to say, this condition should be remedied.

TIME CHART FOR LATHE TURNING

By L. deL. BERO

In the November number of MACHINERY, page 268, a chart was shown in connection with the article "Chart for Estimating Turning Time." The principal objections to the use of a chart of this kind for lathes or similar turning work, are that each individual speed requires a separate curve and that if several speeds are laid out on the chart they are very likely to come close together, and cause confusion.

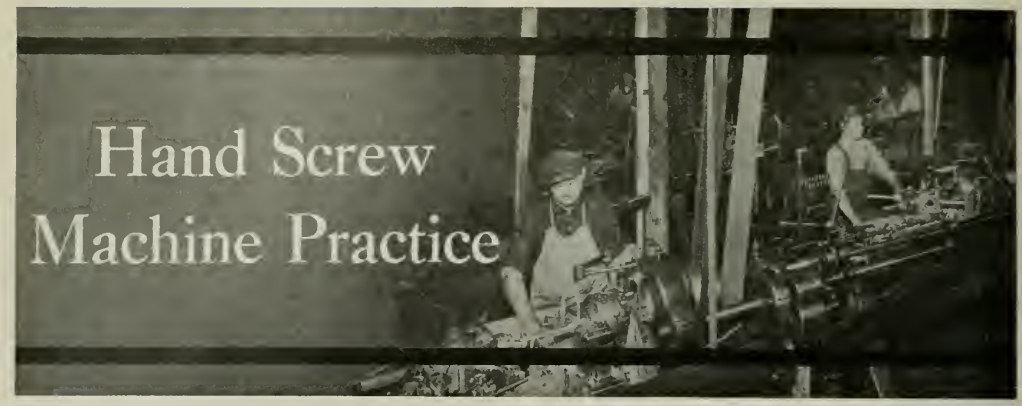
These objections may be easily overcome by using a straight-line logarithmic chart, such as illustrated in this article. From such a chart, any desired turning time can be determined, for any known number of revolutions per minute and amount of feed, within the range of the chart. The right-hand side of the feed scale, shown on the chart is graduated to 0.0025 inch with a range of from 0.01 to 0.04 inch so that practically any feed within these lines can be closely approximated. If desired, special feeds can be



Logarithmic Chart for Use in determining Turning Time

graduated on the left-hand side of the scale, as in the chart shown, and feeds being those for the Hendey lathe as given on the chart in the previously published article.

The chart is used in the regular manner, and is probably generally understood. After determining the proper feed for the class of work at hand and the lathe speed in revolutions per minute, a straightedge, laid so as to intersect these two graduated points on their respective scales, will cut the time scale as shown by the dotted line on the chart. The time obtained is that required for turning one inch of length, and as in the case of the curved-line chart, must be multiplied by the length of the piece to be turned in order to obtain the total time. The case illustrated on the chart shows that 1½ minutes is the approximate time required to turn one inch of metal, using a feed 0.0125 inch and a speed of 50 revolutions per minute. A chart of this nature may be used to determine the output of power presses in gross per day at varying press efficiency; and to ascertain the amount of stock required for screw machines to establish press operators' rates, etc. The writer believes that this type of chart is preferable to a curved-line chart on account of the readiness with which it can be read.



Second Article Describing Tooling Equipments Used by the Warner & Swasey Co., Cleveland, Ohio, in Machining Castings and Bar Stock Parts on Hand Screw Machines

IN the first article dealing with various examples of hand screw machine practice, published in the March number of MACHINERY, a description was given of the tooling equipments used in machining various castings and bar stock parts, together with a detailed account of the sequence of the various steps in each operation or chucking. In the present article a description will be presented of the methods and tools employed in machining an aluminum bowl lined with ebonite, a cast-iron clutch cone, and a stud produced from bar stock, Warner & Swasey machines being used in all of the operations.

Tooling Equipments Used in Machining an Ebonite-lined Aluminum Casting

The bowl illustrated in Fig. 2 is a 99 per cent aluminum casting which has an ebonite lining. This part is finished all over in three chuckings on a No. 16 geared friction-head turret lathe. The aluminum casting is first finished all over in two chuckings, after which it is lined with ebonite as indicated in the illustration. A third chucking is then required to finish the various ebonite surfaces. The total time necessary for the three chuckings is only 12 minutes, which includes the time consumed in placing the work in the chucks, and removing it from the machines. Fig. 1 shows a machine provided with the tooling equipment used in the first chucking, there being a number of machined castings lying on the stand at the left of the machine. Fig. 3 shows a lay-out of the equipment with which this machine is provided. The sequence of the various steps in this chucking is as follows: (1) The bowl is placed in a three-jaw chuck that grips the work along surface *A*. (2) Surface *B* is faced and surface *C* is formed by the forming cutter *T* which is mounted on the rear of the cross-slide. (3) Surface *E* is formed by the circular forming cutter *U* which is held in the slide-tool mounted in Face 1 of the turret. After this cut has been taken the tool-holder and tools on this slide-tool are moved radially toward the center of the machine by means of the sliding arrangement and a rough cut is taken in hole *D* by the boring cutter *V* which is also mounted on the slide-tool. (4) Hole *D* is rough-bored by the four-fluted or "core" drill mounted in the box-tool in Face 2 of the turret, and a portion of surface *F* is faced by two cutters which are also held in this box-tool. (5) The remainder of surface *F* is finished and the circular groove *G* is formed by several cutters held in the box-tool mounted in Face 3 of the turret. (6) Groove *G* is dovetailed by the cutter mounted in Face 4 of the turret. (7) Surface *H* is bored by the boring cutter mounted in Face 5 of the turret. When this step is performed, the turret lock-bolt is withdrawn so that the boring cutter can be guided by a guiding block in contact

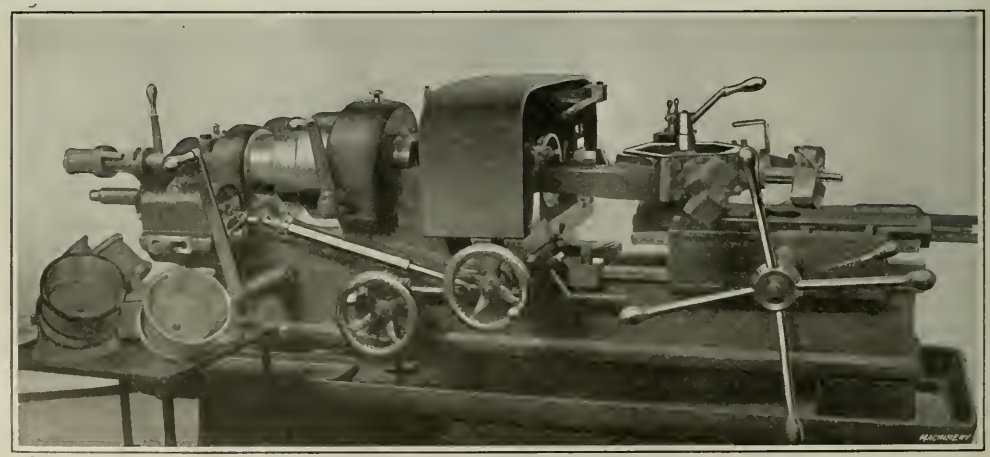


Fig. 1. Machine equipped for First Chucking on Aluminum Casting

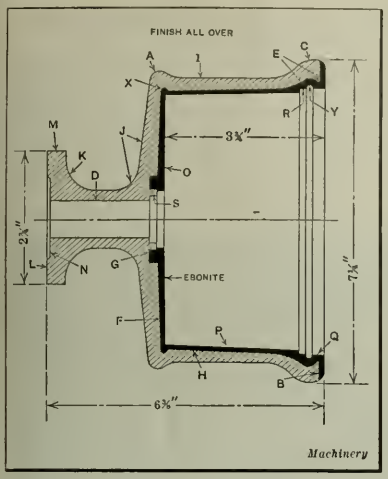


Fig. 2. Ebonite-lined Aluminum Bowl

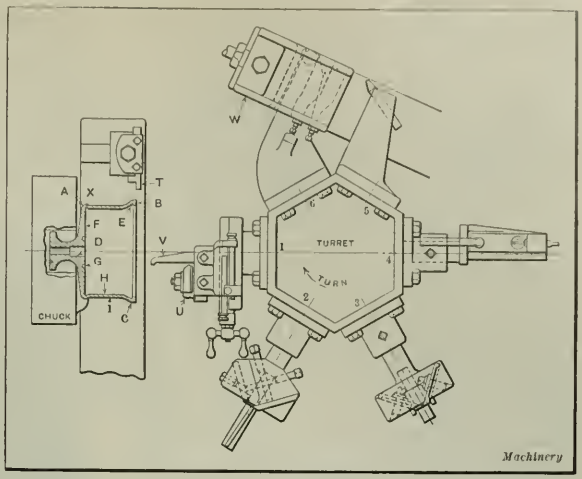


Fig. 3. Lay-out of Tooling Equipment used on Machine shown in Fig. 1

with a surface on bracket *W* that corresponds with the contour of the surface being machined by this tool. When the cutter has entirely machined surface *H*, groove *X* is produced by means of the same cutter being fed into the metal through the use of the cross-slide. Bracket *W* is really mounted on the front of the cross-slide, but is shown in the position indicated to illustrate its relative position with reference to the tool mounted in Face 6 of the turret, the bracket also being used in connection with this tool. (8) Surface *I* is turned by the cutter mounted in Face 6 of the turret. In this step the turret lock-bolt is also withdrawn and the cutter is guided along surface *I* by means of bracket *W* in the manner previously mentioned. (9) The work is removed from the chuck.

The tooling equipment used in the second chucking is illustrated in Fig. 4. This operation consists of finishing the remaining surfaces of the aluminum casting, the various steps of the series being taken in the following succession: (1) The work is mounted on a special draw-back type of chuck. (2) Surface *J* is faced and formed by cutter *a* which is mounted on a slide-tool on the rear of the cross-slide. The tool is guided by a block in contact with the slanting surface of guide *b* which is bolted to the side of the cross-slide saddle. (3) Surface *K* is formed by cutter *C;* surface *L* is faced by cutter *d;* and surface *A* is formed by the circular forming cutter *e;* all of these cutters are mounted on a tool-block on the front of the cross-slide. (4) Hole *D* is finish-bored by the boring cutter held in the adjustable boring-tool holder mounted in Face 1 of the turret. (5) Hole *D* is reamed by the reamer mounted in the holder in Face 2 of the turret. (6) Surface *M* is turned by cutter *f*, and surface *N* is counterbored by counterbore *g*, these tools being held in the box-tool mounted in Face 3 of the turret. (7) The work is removed from the chuck.

After the work is removed from the machine at the end of the second chucking, it is ready to be lined with ebonite as shown in Fig. 2. At the completion of this process, the work is subjected to a final operation, which consists of machining the several ebonite surfaces and counterboring surface *S*. A lay-out of the tooling equipment used in this chucking is illustrated in Fig. 5. The various steps in this chucking are taken in the following procedure: (1) The work is placed in a three-jaw chuck that secures the bowl on the machine by gripping it along the previously finished surface *A*. (2) Surface *P* is bored and surface *O* is faced by the cutter held in the holder in Face 1 of the turret. The turret lock-bolt is withdrawn for the performance of this step, the cutter being guided along surface *P* by means of a guide block in contact with a guiding surface on bracket *W* which is mounted on the front of the cross-slide. After surface *P* has been entirely machined, the same cutter is faced across surface *O* by means of the cross-slide. (3) Surfaces *Q* and *R* are bored by cutters *h* and *i*, respectively, and surface *S* is counterbored by counterbore *j*, these tools being held in the box-tool in Face 2 of the turret. (4) Groove *Y* is formed by the circular forming cutter *k* which is mounted in the slide-tool held in Face 3 of the turret. (5) The bowl, which is now completely finished, is removed from the machine.

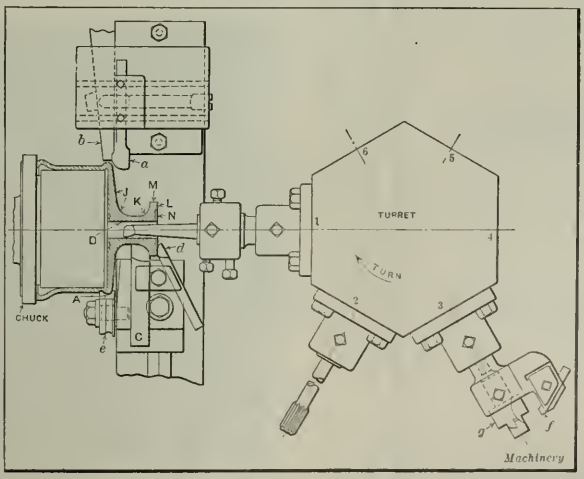


Fig. 4. Tooling Equipment required in the Second Chucking on Aluminum Bowl

Equipment Employed in Finishing a Clutch Cone

The cast-iron clutch cone illustrated in Fig. 6 is machined as indicated by the heavy lines in one chucking on a No. 4 universal turret screw machine. This operation requires 10 minutes. A lay-out of the tooling equipment provided on the machine used for this job is shown in Fig. 7. The successive steps in this operation are: (1)

The work is placed on a three-jaw chuck on which it is held by means of the jaws being expanded and exerting pressure on the inside of the cored opening. (2) Surface *A* is rough-turned by cutter *J*, and surfaces *E*, *F*, *G*, and *C* are rough-faced by cutter *K*, these cutters being mounted in the square turret. At the same time as these cuts are being taken surface *B* is rough-turned by cutter *N* which is held in an angle cutter-holder; surface *C* is finish-faced by cutter *O* mounted in a straight cutter-holder; hole *D* is rough-bored by the cutter mounted in boring-bar *P*; and surface *E* is finish-faced by cutter *Q* which is held in a facing head. The boring-bar and various tool-holders used for mounting these cutters are held in the adjustable turning head mounted in Face 1 of the turret. (3) Surface *B* is finish-turned by cutter O_1, and hole *D* is finish-bored by the cutter mounted in boring-bar P_1, the boring-bar and cutter being held in the single turning head mounted in Face 3 of the turret. At the same time, surface *A* is finish-turned by cutter *R* which is mounted on the taper attachment, and surface *G* is finish-turned by cutter *L* which is held in the square turret. (4) Hole *D* is reamed by the reamer mounted in Face 5 of the turret. (5) The threads on surface *B* are cut by cutter *M* which is mounted in the square turret and which is used in conjunction with a thread chasing attachment. (6) The finished casting is removed from the chuck. A machine equipped with the tools used in this chucking is shown in Fig. 8. This illustration shows the work ready to be removed from the machine. A close-up view of the same machine is illustrated in Fig. 9 and clearly shows the appearance of the work at the completion of the operation.

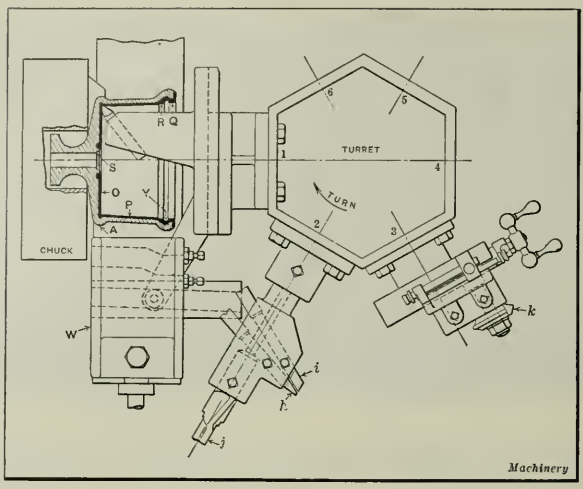


Fig. 5. Equipment employed in machining Ebonite Surfaces of Bowl

Producing Special Studs from Bar Stock

Fig. 10 shows a special stud which is produced from 1⅛-inch round bar steel. This part is machined in 7 minutes on a No. 4 universal turret screw machine. This includes the time required to feed the stock to the stop and to cut the finished stud from the bar. A lay-out of the tooling equipment required in manufacturing this part is shown in Fig. 11. The various steps in this operation are taken as follows: (1) The stock is fed to the combination stop and starting drill which is held in Face 1 of the turret, after which a spot is drilled in end *G* by means of this drill. (2) Surfaces *A* and *B* are turned by the tools mounted in the multiple-cutter turner in Face 2 of the turret, while surface *C* is turned by cutter *J* which is held in the square turret. (3) Hole *E* is drilled by the drill held in the holder mounted in Face 3 of the turret, and surface *D* is turned by cutter *J*. (4) Chamfer *F* is produced by the center drilling tool mounted in Face 4 of the turret. (5) Grooves *H* and *I*, Fig. 10, are turned by the cutter mounted in fixture *K* which is held in the square turret, Fig. 11. (6) End *G* is rounded by the pointing tool mounted in Face 5 of the turret. (7) Surface *A* is threaded by the die-head held in Face 6 of the turret. (8) Finally the finished stud is cut from the stock by cutter *L* which is mounted in the square turret.

The examples of hand screw machine practice described in the foregoing indicate clearly the importance of selecting the proper sequence of operations in order to obtain the most economical methods of manufacture.

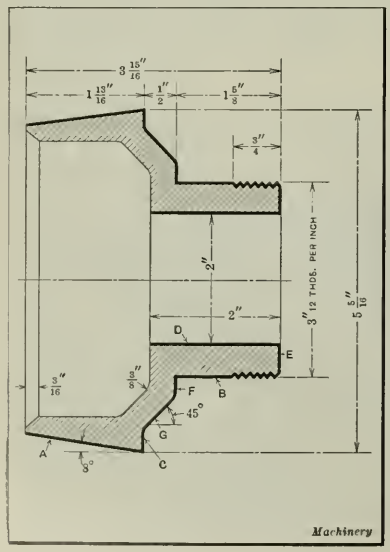


Fig. 6. Drawing of Cast-iron Clutch Cone

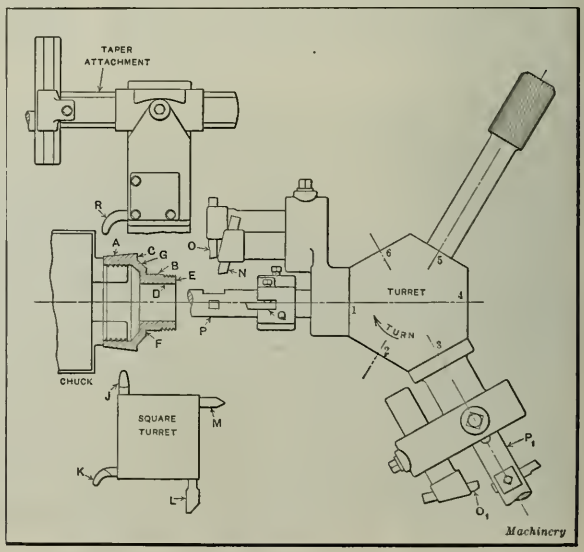


Fig. 7. Tool Lay-out used in finishing Clutch Cone shown in Fig. 6

THE DISPOSAL OF OLD COMPRESSED-GAS CYLINDERS

Some time ago a rather unusual incident occurred in a manufacturing plant says *The Traveler's Standard*, showing the necessity of handling with great care cylinders or tanks used as containers for compressed gases. In the plant referred to, large quantities of steel and iron scrap of the most miscellaneous character are melted in an open-hearth furnace and the metal thus obtained forms the basis for the manufactured products of the plant. At one time a com-

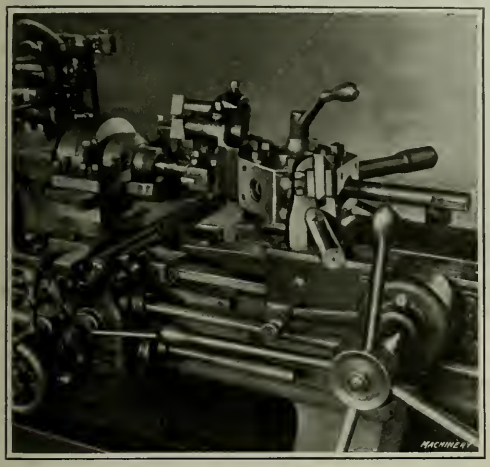


Fig. 8. Machine provided with Equipment required in machining Clutch Cone

pressed-gas cylinder was received with other scrap, and upon being thrown into the furnace it exploded and blew the entire top off the furnace. This experience was remembered, and when a similar gas cylinder was received on another occasion, it was taken off the charging buggy and thrown on the charging floor. Several hours later one of the employes, observing that the valve on the cylinder was still in place, secured a wrench and opened the valve. The cylinder had been filled with chlorine, and enough of the gas was released to cause serious discomfort to three men, and to make them unfit for work for several days. Not long after this occurrence still another gas cylinder was found in the scrap, and exam-

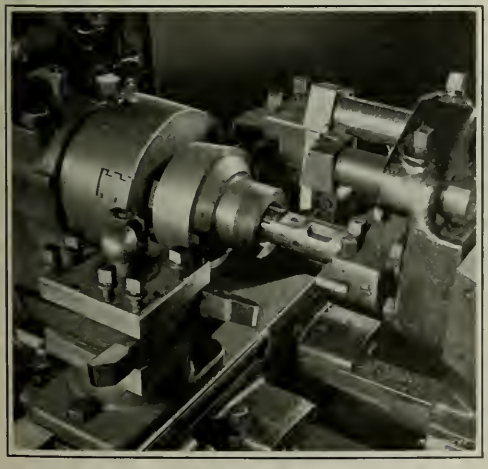


Fig. 9. Close-up View of Machine showing Work at the Completion of the Operation

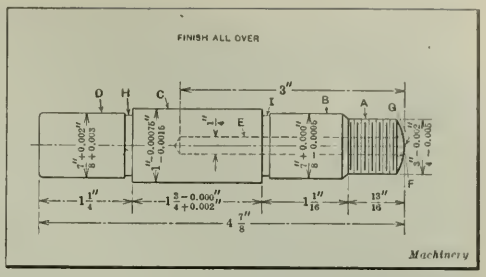


Fig. 10. Stud produced from Bar Stock on Hand Screw Machine

ination revealed the fact that it contained something like 25 pounds of anhydrous ammonia. This also might have caused trouble if it had been put into the furnace or left lying about the plant. As a result of these experiences, an order was issued to the effect that all cylinders thereafter received should be taken to the "skull-cracker" and broken up, before charging them into the furnace. There are at least two lessons to be learned from these experiences: (1) Compressed-gas cylinders should not be exposed to high temperatures unless it is known, positively, that they are *entirely* empty (and if the valve is still in place and closed, and there are no easily seen openings in a tank, it is safer to assume that it is *not* entirely empty); (2) all possible precautions should be used when opening gas cylinders, even if they are supposed to be empty—do it out-of-doors, be sure there are no fires or open flames anywhere in the vicinity, and have the work done by some person who understands

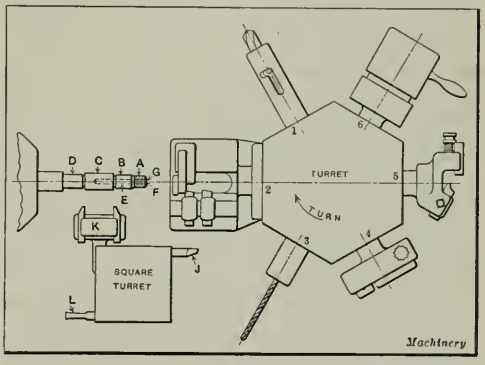


Fig. 11. Lay-out of Tools used in manufacturing Stud illustrated in Fig. 10

the dangerous properties of gases. A warning of particular importance to the users of compressed gases is this: Be sure each cylinder is empty before discarding it, and if any gas remains in the cylinder, see that the cylinder is put in a safe place and marked in some way so that it cannot possibly be thrown on the scrap pile through error. Instead of scrapping a gas cylinder, return it to the gas manufacturer. If it is in good repair it has a money value and can be re-filled and sent out again; and if it is no longer serviceable, the manufacturer will know how to dispose of it safely. If a cylinder is received in a leaky condition, leave it out in the open air and protect it so that inquisitive persons cannot be harmed by the escaping gas; and if the gas remaining in the cylinder cannot be used safely, notify the gas manufacturer and ask for instructions regarding it.

* * *

The Association of Chinese and American Engineers was recently formed in Peking, China. Forty engineers joined the association at its first meeting. More than one-half of the important engineering positions in China to-day are held by Chinese educated in America.



View in Willys-Overland Forge Shop

Successful Substitute for Apprenticeship

ONE of the troublesome problems which confronts the management of present-day metal-working plants is how to obtain the necessary number of capable all-around mechanics. Frequent reference is made in the technical press to the demand for such thoroughly trained men; and one hears the subject discussed in most gatherings of manufacturers of metal products. Years ago, this question was of little importance, because in order to earn an adequate wage in the machine shop, a boy had to serve a term of apprenticeship, during the course of which he received a thorough grounding in the basic principles of mechanics. But the departmental method of factory administration now in vogue has changed this situation. A boy is able to enter the employ of a manufacturing firm and receive sufficient training in about two weeks to enable him to operate a given type of machine engaged on a single operation; and in the performance of this repetition task, he will soon acquire sufficient dexterity to earn a fair wage, without serving four years' apprenticeship at a nominal rate of pay.

This tendency for boys to avoid apprenticeship has been found unsatisfactory for two reasons: From the employe's viewpoint it is undesirable, because while he is able to quickly reach a point where he can earn a fairly good wage as a machine operator, there is little possibility of making much further progress, owing to a lack of training in the fundamental principles of mechanics. And from the employer's point of view, the result is equally unsatisfactory because it fails to develop men possessing sufficient mechanical knowledge to be able to enter upon more responsible work; also, men trained as machine operators never can be expected to take the same interest in their work as those having a knowledge of the reasons why certain standards of workmanship must be maintained. A further disadvantage of the ordinary machine operator is that he has not the same ambition for promotion as a trained mechanic.

A Successful System of Labor Training

With a view of overcoming these undesirable characteristics of employes who are merely trained for the performance of repetition work, and also to provide a source of semi-skilled labor, the Willys-Overland Co., Toledo, Ohio, has recently established a training shop which is operated according to a carefully developed system of labor training. In common with the practice followed in the vestibule shops of wartime, this system keeps the "improvers," as the men taking a course of training are called, engaged upon regular lines of production work. This not only gives them a knowledge of the exact class of machine on which they will be employed upon entering the regular manufacturing department of the plant, but it also avoids the wasting of material on exercise work, and enables the training shop to be self-supporting, through the value of the product which it turns out. In this connection, it is important to note that the average amount of work spoiled in this training shop does not exceed 1.4 per cent, which includes all pieces that failed to pass the usual process of inspection. This is substantially lower than the average rate of spoilage in regular manufacturing departments. The training shop is equipped with all standard types of machine tools which are used in the manufacture of parts of the Willys-Overland car, and the "improvers" are able to obtain instruction in operating any of the machines in which they are interested.

How the System is Applied

Having made a brief general statement as to the manner of conducting this training shop, a more detailed description of its functions can now be presented. It has already been explained that the purpose is not only to afford a means of training new employes in the performance of the work on which they will be engaged in the plant, but also to afford a means of "up-grading" the men who are already employed in the factory. Regardless of whether the improver who enters the training shop is just entering the employ of the Willys-Overland Co. or has been on its payroll for a considerable period of time, he will be paid during his period of instruction in the performance of a new class of work at a rate 10 per cent lower than the regular price paid for the same job in a manufacturing department of the factory. By reducing the rate paid to men in course of training to 90 per cent of the regular rate for the same job, sufficient compensation is made for the lower productive capacity of such men so that the value of the product which they turn out will be sufficient to pay the expense of maintaining the training shop, exclusive of overhead charges.

Another highly important function of the training shop is to afford a means of definitely estimating the amount of skill possessed by men who represent themselves as capable operators of a given type of machine, at the time when they first come to the employment office for an interview. Every experienced shop man knows of the serious delays and spoil-

age of material which are frequently caused by men entering a production department on their own representation that they have received training in a given line of work, when they are utterly incapable of handling such work in an efficient manner. By sending all employes through the training shop, regardless of the claims which they make concerning their experience and ability, a reliable opinion may be obtained from the training shop foreman as to the degree of efficiency with which each man can handle the work on which he is to be employed in the plant. The most important consideration in this connection is that the work of all men can be carefully watched in the training shop to prevent the possibility of a lot of pieces being spoiled before the inefficiency of the operator is discovered. Naturally, experienced men who can demonstrate their ability are soon transferred from the training shop to a manufacturing department of the factory.



Fig. 1. Partial View of the Training Shop where Advanced Instruction is given in Automotive Machine Shop Work

Creating Incentive for Promotion

One of the great features of this system of labor training is that it serves the double purpose of affording a means for ambitious employes to obtain a thorough knowledge of their trade, while earning a rate of pay that enables them to keep up with American standards of living; and by so doing, solves the manufacturers' problem of securing an adequate supply of fully trained, or so-called "all-around" mechanics. For ordinary classes of machine work, it takes from a few hours to as much as two weeks to train an operator to a point where he is able to attain the rate of production that is required in a manufacturing department of the plant. But after he is sent out from the training shop, it does not necessarily mean that his experience with that institution has come to an end. The future is optional with him, and if he so desires he can come back for repeated courses of training in a number of different classes of machine work until he has finally gained a thorough knowledge of his trade.

It is this feature of this system of training which was largely responsible for instituting the 10 per cent reduction in wages paid to "improvers" employed in the training shop. The amount of work done by such men during their short period of training is naturally less than that of experienced operators, so that it is eminently fair for them to be paid a lower wage; but the main object in making the reduction is to deter all employes from seeking an opportunity for additional training in the shop, except those who are possessed of an earnest desire to succeed and are willing to pay for the gratification of this desire by accepting a slightly lower wage during the time they are securing the desired training. Those who are considering the merits of this system with a view of introducing it in their own plants, are likely to ask the question, "How is one to prevent an operator of one of the simplest types of machine tools, who has had no other mechanical experience, from attempting to secure training as an operator of one of the more complicated types of machines, where he will earn something approaching the maximum machinists' rate of pay?"

How the Development of All-around Mechanics is Attained

In other words, this question resolves itself into, "How is the management of a plant in which this system of training is employed, going to arrange matters so that the men will obtain training in all departments of a machinist's trade?" The answer to both questions is, "Where applicants are being considered for training in any class of work, the successful candidates will be those who are at present employed on a class of work most nearly allied to the one in which they desire to be trained." This makes it necessary for the man at the bottom of the ladder to approach his goal rung by rung, in order to gratify his ambition to reach the top, both as regards pay and responsibility.

According to the usual system of apprenticeship, a boy is required to sign an indenture contract for a period of four years, at a purely nominal rate of pay; and an actual analysis of his four years' work will show that in many cases a large percentage of the time has been spent in the performance of classes of work that were profitable to the employer, but where the employe obtained very little experience of value to him. If this contention is accurate, it is fair to assume that a man gaining his experience by this system can take a number of rapid courses in the training shop and alternate this with practical work in manufacturing departments of the factory, with the result that he will not only secure as comprehensive a training as that given to the apprentice boy, but that he will also earn a very satisfactory average rate of wages during the entire period.



Fig. 2. Instruction is given in painting Motor Car Bodies, an Operation which requires Skill and Judgment

A Constantly Increased Earning Capacity for Ambitious Men

It will be evident to one who gives this plan a brief consideration, that the rate of pay earned by a man who repeatedly returns to the training shop for knowledge of more advanced lines of work, is constantly being raised. For instance, a man who is receiving initial training in a job

paying 40 cents an hour, earns 36 cents an hour during his training. After he has worked on this job in the manufacturing department for a sufficient period to gain an adequate knowledge of the work, he may return to the training shop to qualify for a job paying 45 cents an hour. During the period of training, he will earn 40½ cents an hour, which is in excess of the rate he was earning in a manufacturing department; and after being trained, he goes back to the factory at the 45 cent rate. By constantly repeating this practice, he not only gains a wide mechanical experience, but is also able to constantly increase his earning power. This financial incentive is sufficient to act as a spur for those men who would not be tempted to make these repeated changes in order to qualify for advancement into a responsible position.

At specified intervals, lectures are delivered to groups of foremen and other factory executives. The purpose of these lectures is to impress upon foremen the value of improving the quality of labor employed in their respective departments.

Incidentally, the quality of service obtained from the foremen is also improved because these lectures impress upon them the fact that their departments are going to be filled with trained men who will be qualified to assume the duties of a foreman. Last, but far from least, the point is emphasized that with a training shop for the development of thoroughly experienced mechanics, any important factory executive positions which become vacant can be filled with men taken from the company's payroll, instead of resorting to the practice of seeking them elsewhere. In any plant, there will always be a lot of men who are content to work from day to day and spend their wages as received; but there will also be a certain percentage of the exceptional men who are anxious to succeed; and by emphasizing the possibility of promotion, which is afforded by this system of training, the ambition of such desirable employes will be stimulated instead of allowing them to become discouraged by the numerous obstacles which the regular departmental method of factory management throws in the way of advancement for the rank and file of machine operators.

* * *

CORRECT STATEMENT OF AVERAGES

In an article appearing in a recent number of *Mechanical Engineering*, the author, Henry Hess, points out the difference between the usual method of expressing averages and the correct method. The dictionary definition of average is as follows: "Average: A sum or quantity intermediate to a number of different sums or quantities, obtained by adding them together and dividing the result by the number of quantities added; an arithmetical mean. Thus, if four persons lose, respectively, $10, $20, $30 and $40, the average loss of the four is $25."

The dictionary definition is correct, but incomplete; consequently the majority of people and engineers who deal with averages fail to realize how absolutely misleading the definition is. For example:

(1) The average of $2 + 3 + 4 = 3$
(2) The average of $1 + 3 + 5 = 3$
(3) The average of $3 + 3 + 3 = 3$
(4) The average of $2 + 2 + 5 = 3$

In these four instances, the average does not express the amount that the *stated* average differs from the original value. This difference should be expressed when stating averages, thus:

(1) 3, plus or minus 1;
(2) 3, plus or minus 2;
(3) 3, plus or minus 0;
(4) 3, plus 2 or minus 1.

When the averages are expressed as shown above, it is at once clear that in the first case the terminal values of the series are 2 and 4; that in the second case they are 1 and 5; in the third case 3 and 3; and in the fourth case 2 and 5. It is a matter of decided importance to know whether the maximum and the minimum values of a series differ much or little from each other. The importance of this statement is further emphasized by Mr. Hess when he cites an incident from his own personal experience: Occasion arose casting doubt on the uniformity of the strength of balls of a well-known and highly regarded make. On voicing that doubt to the manufacturer the assurance was given that carefully conducted tests on a considerable quantity of balls showed marked uniformity within a relatively few points. A request for the tabulated results of these tests brought forth the complete data, which showed that the claim was made in perfectly good faith but was nevertheless in error, because the averages took into account the *ordinary* average only, the plus and minus variations not having been considered. The tabulation, including the breaking loads of the three series of balls of equal diameter, is shown below.

	62,500	76,000	93,500
	68,000	84,500	63,000
	72,000	86,000	74,000
	94,000	91,000	69,000
	83,000	75,500	71,500
	379,500	413,000	371,000
Average	75,900	82,600	74,200

Considering only the ordinary average, these values do not show a very serious difference. If these averages had been expressed correctly, a clue would have been furnished from which the seriousness of the amount of divergency from the stated average would have been apparent. Following is the correct method of expressing the true average for the breaking loads of the three series of balls:

$$75{,}900 \begin{matrix} -\ 13{,}400 \\ +\ 18{,}100 \end{matrix} \qquad 82{,}600 \begin{matrix} -\ 7400 \\ +\ 8400 \end{matrix} \qquad 74{,}200 \begin{matrix} -\ 11{,}200 \\ +\ 19{,}300 \end{matrix}$$

The ordinary average, 75,900, gave no indication as to whether this was an average of 75,901 and 75,899, with a difference of only one point plus or minus, or whether the difference was great, as the plus and minus values clearly showed to be the actual case.

The misleading use of the term average is so general that it is even found in such standard works as engineering handbooks. For instance, one authority gives the compression in pounds per square inch of granite as averaging 15,000 pounds, and for four different varieties gives 12,000, 15,000, 16,000, and 15,000 pounds. The true average of these four varieties is $14{,}500, -2500 + 1500$. If the strength of all granites lies between the limits of these four varieties, the complete average stated gives safe data. In another case the average for slate is given at 10,000 pounds, but no varieties are quoted; yet it is certain that all slates are not of the same strength. The completion of the average by the use of a minus and a plus limitation would give the necessary information.

It is certain that some steel castings have higher elastic limits than 40,000 pounds per square inch; this value is quoted by one authority as an average, but the range is not given. A complete statement of the average would substitute definite information for guesswork.

On the basis of the above comparison of the statement of averages, a more complete definition than that found in the dictionary would be: "Average is that quantity intermediate to a number of different quantities obtained by adding together these quantities, dividing the result by the number of quantities that were added, supplemented by a statement of the quantities by which the result differs from the largest and the smallest of the quantities. Thus, of four sums, 10, 20, 30 and 60, the average sum is $30 \begin{matrix} -\ 20 \\ +\ 30 \end{matrix}$."

* * *

In a paper read before the American Society of Mechanical Engineers, N. C. Harrison defines pulverized coal as coal that has been reduced to such fine particles that at least 95 per cent will pass through a 100-mesh sieve, such a sieve having 10,000 openings to the square inch. The finer the coal is pulverized, the more efficiently it can be burned.



Furnaces Used in Heat-treating Steel

Comparison of Types of Furnaces Used in Carburizing, Hardening and Tempering

By S. P. ROCKWELL, Metallurgist, Weekes-Hoffman Co., Syracuse, N. Y.

IF the fuel is disregarded, there are really only three types of furnaces used in the heat-treating of steel—the under-fired, over-fired, and hearth- or heating-chamber-fired. The under-fired furnace is one in which the initial heat of combustion is generated below the hearth and then carried to the heating chamber through the hearth. (See *A*, Fig. 1). This type of furnace is, as a rule, best adapted for reheating, in which it is not desirable to have the products of combustion or the flames strike directly against the work. As the heated gases flow against the sides of the hearth, thus heating the edge up more than the remainder, it is better to have walls at the edges of the hearth as shown at *B*, especially if the hearth is of considerable width. The value of this construction lies in its simplicity and lightness, and most portable furnaces are built in this manner. Some modifications may be made in the flue arrangement of the combustion chamber, but these modifications in all cases tend to break up the products of the combustible gases and to distribute them evenly. In this way the gases entering into the heating chamber are of the right chemical proportion to give the best results to the work. Further, this distribution tends to keep the heating chamber at an even temperature, which depends on the distribution of the work and the method of handling it, including the door operation.

The temperature of the combustion chamber is usually in excess of the temperature of the heating chamber, especially when the furnace is being "rushed." For this reason the hearth breaks up, due to its supports warping and cracking, and allows the combustion gases to pass through and strike the work. As repairs are then necessary, furnaces of this type should be designed so that the hearth may be easily removed and the combustion flues will be readily accessible, without ripping open the outside walls or the entire front of the furnace. The best quality of heat-resisting brick should always be used in building the hearth and the combustion flues, and in portable furnaces of this type the flues are usually made of slabs from 2 to 4 inches thick. In non-portable types, where lightness is not a consideration, the combustion flues may be arched over and the floor slabs set on the arches as illustrated at *C*. This construction will require fewer repairs, but they will be more expensive. When the work undergoing treatment is heavy, such as heavy carburizing pots, a furnace of this construction is required. If the hearth plates are broken in this type of furnace, they can be easily replaced.

An over-fired furnace is one in which the combustion chamber is above the heating chamber arch, the combustion gases being carried to the heating chamber through perforations in this arch, and leaving the furnace at the bottom of the hearth, as shown at *D* in Fig. 1. This type of furnace is not commonly used, as the arch construction is expensive and delicate. The ill effects produced by high temperatures in the combustion chamber of the under-fired furnace are the same as those referred to in connection with the over-fired furnace. The principle of the over-fired furnace is wrong, because heated gas has a tendency to rise, and in this type of furnace, extra draft must be used to draw the heat down. For extremely high furnaces, this type can be used in conjunction with the under-fired type. Its construction is also suitable for furnaces requiring removable hearths which are mounted on wheels, where there is no possibility of using the under-fired type. Such a furnace is shown at *A* in Fig. 2.

In a hearth- or heating-chamber-fired furnace, the initial heat of combustion enters directly into the heating chamber, as indicated at *B*. This type of furnace is usually constructed to allow the gases to come into direct contact with the work, and on account of fuel impurities it is not desirable for the heat-treatment of finished products. In carburizing, however, the work is protected and excellent and economical results can be obtained if there are proper flue outlets. This type of furnace can also be used for annealing if the product later undergoes machining. The removable

type of hearth can also be installed in this furnace.

Methods of Handling Waste Gases

Furnaces may be designed for various classes of work, but they generally embody features of the standard types or a combination of them. The main difference in the design of furnaces is the method of handling the waste gases. When designing the flues, it is important to make sure that they do not let gases pass out that contain available heat which could be used for the work, and that they are smaller in area than the flues entering the heating chamber from the combustion chamber. This is so that a slight pressure may be kept on the gases in the heating chamber which will prevent cold air from entering the furnace when the doors are opened. It is often advisable to place a damper in these flues to check off the escaping gases and allow the pressure to be regulated at will.

It can be readily seen that the flue arrangements of the furnaces shown at *A*, *B*, and *C*, in Fig. 1, are poor from the standpoint of heat-saving, as the waste gases leave the furnace at the top, thus losing a great deal of available heat. The flues, however, may be closed by placing a brick over them, and if there is more than one flue in a furnace, the heat can be thrown toward the back or front of the furnace at will. The flue arrangements of the furnaces shown at *D*, Fig. 1 and at *B*, Fig. 2, are better, as the hot gases are brought back under the hearth and are thus partially utilized. If this arrangement is used in constructing such furnaces as shown at *A*, *B*, and *C* in Fig. 1, and the majority of the waste gases are removed from the heating chamber near the door or at the ends of the furnace and then led under and lengthwise across the hearth, the maximum benefits will be obtained. An ingenious method of handling these waste gases was developed in designing a furnace for annealing coiled wire. It was required that the furnace be large enough in diameter for the coils and at least 12 feet long. The wire had to be annealed bright, as no pickling was allowed. Fig. 3 shows the under-fired type of furnace built for the purpose.

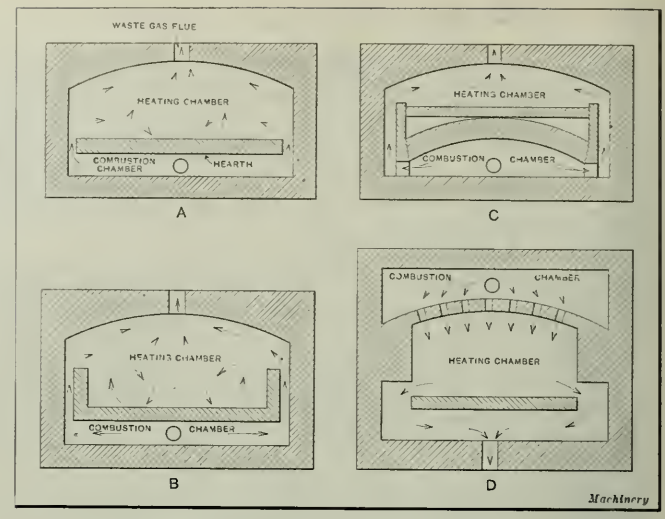


Fig. 1. Diagrammatical Sections showing Principles of Under- and Over-fired Furnaces

The wire is first placed in the cylindrical boiler plate tanks *A* and *B* which have a hole through the center of the bottoms and covers. Small hollow cylinders *C* and *D* are then placed in the center of the coils over the holes in the tanks, and charcoal is packed between the cylinders and the coils and around the outside of the coils. The tanks are next placed in the furnace, one on top of the other. Oil is used for fuel, and it enters the furnace at an angle so as to give a rotary effect to the gases. The small cylinders in the center of the wire pots act as return flues for the gases.

In the Smallwood type of furnace, the gases from the heating chamber pass out at the rear of the hearth and then up over the heating chamber arch and out at the front end of the furnace, at the top, as shown at *C* in Fig. 4. Although carefully planned, a furnace may not show an even temperature when loaded with work. To guard against this, it is always desirable to so design the furnace that the area of the flues entering into the heating chamber may be cut down by sliding bricks over them, as previously mentioned. This will allow any part of the furnace to be brought to a higher or lower temperature.

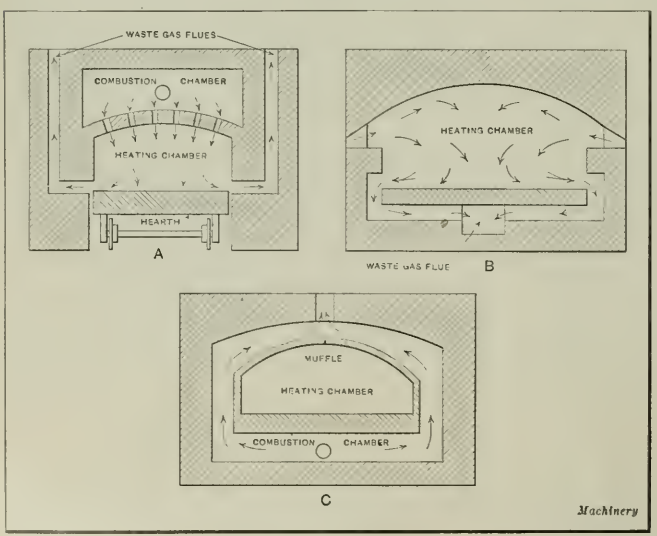


Fig. 2. Diagrammatical Sections showing Principles of Over-fired and Muffle Furnaces

Design of Combustion Chambers

The openings from the combustion chamber to the heating chamber should be so designed that a slight pressure can be applied to the gases in the combustion chamber. In this manner the temperature of the combustion chamber can be kept more even. This can be done by making the total area of these openings slightly less than the cross-section area of the combustion chamber. The usual combustion chamber lay-out for furnaces of the type shown at *A* and *B* in Fig. 1, is illustrated at *A* in Fig. 4. The walls of this type of chamber support the floor tiling. In furnaces using oil for fuel, each successive opening in the wall, from the front to the back of the chamber, is $\frac{1}{2}$ inch smaller than its predecessor. This produces a friction on the hot gases entering the heating chamber furthest from the burner, and allows their free passage at the front, which evens up the effect of the flame-throwing force of the burner. If the furnace is particularly wide and

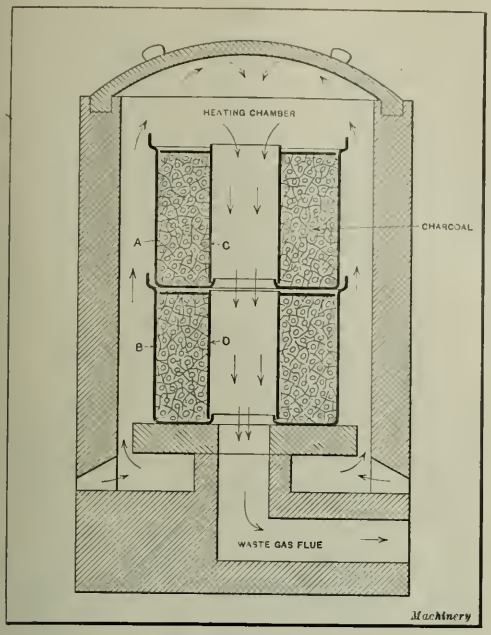


Fig. 3. Special Under-fired Furnace used for annealing Coiled Wire

oil or gas is used as fuel, another supporting wall is placed in the center, and combustion from the burners takes place on both sides of this wall and between the outside walls.

For small furnaces, 36 by 48 inches or less, some such arrangement as shown at *B* in Fig. 4 can be used. This method is particularly suitable for oil-burning tempering tank furnaces in which red heats are not used, but where incandescence of the brick in front of the burner is necessary to prevent the burner from going out. The height of the walls is governed by the size of the furnace and the maximum temperature. Large hearths, of course, require more fuel than small hearths and there should be space enough for the combustion of the gases. No combustion chamber should be less than 5 inches in height, and this height should be increased roughly 1½ inches for every additional 5 square feet of hearth space that is in excess of 5 square feet.

In the Smallwood type of furnace, a slightly different form of combustion chamber is used which is in reality, a modification of the construction shown at *A*, Fig. 4. It is claimed that this construction causes double combustion of the heating gases, that is, a primary or partial combustion at the place of heat generation—as partial burning of coal or firing of oil or gas—and a final combustion of the gases generated from the first combustion. The method of arranging the combustion flues is illustrated at *C*. This principle can be carried out on a small scale several times under the same hearth, but this depends on certain conditions obtaining, such as long narrow furnaces or many sources of heat. When the hearth is extra wide, there should be openings from the central flue through the hearth, as shown at *T* and *U*, which tend to carry to the extreme ends of the furnace, the heat needed.

Designing and Building Furnaces

The materials for building the furnaces should be selected according to the requirements. For combustion chambers which will receive high temperatures, the best heat-resisting brick should be used. Heating chamber slabs should not be made of too soft brick, as they will wear when work is dragged or rolled over them. Conservation of radiated heat is of great importance from the standpoints of economy and comfort and is best maintained with insulating materials, such as magnesia, asbestos, and various insulating bricks. The heading illustration shows a row of carburizing furnaces built double to reduce radiation losses. Cast-iron sides are valueless except for portable furnaces, bought ready built, and for large furnaces having large door-openings. In stationary types, a red brick exterior braced by channel irons held vertically by tie-rods is sufficient. Angle-irons set horizontally in the red brick at the "skew backs" for the arches will hold the arches in place. Fig. 5 shows a furnace constructed in this manner.

The size of the furnace should be governed entirely by the size and amount of the work. A great mistake is often made in using a furnace having a capacity for large and heavy work, for heat-treating a few pieces of small work. For this reason a number of small furnaces are more satisfactory than one large furnace because fuel costs may be cut down when the amount of work decreases; and furthermore, production is not entirely stopped when it is necessary to make repairs. On the other hand, too small furnaces should not be used, as they are apt to heat the work unevenly, which happens when gases strike the work directly. When determining the size of a furnace to be used for carburizing, the daily production necessary and the time required for performing it should be considered. For example, assume that it is desired to build a furnace having sufficient capacity for carburizing, at one time, 300 ring gears, 8 inches in diameter and 1 inch thick, each one of which requires eight hours to be carburized all over, only day work being desired. A pot about 12 inches outside diameter and 14 inches high is a good size to use. Six gears can be placed in a pot of this size if the pot thickness is ¾ inch, the legs 2 inches high, and ½ inch of carburizer is placed between each piece of work, and from 1¾ to 2 inches is placed on top of the work. If six gears are placed in one pot, the number of pots required would be $300 \div 6 = 50$. Each pot takes up one square foot of hearth space. If 500 pieces of work is the maximum production

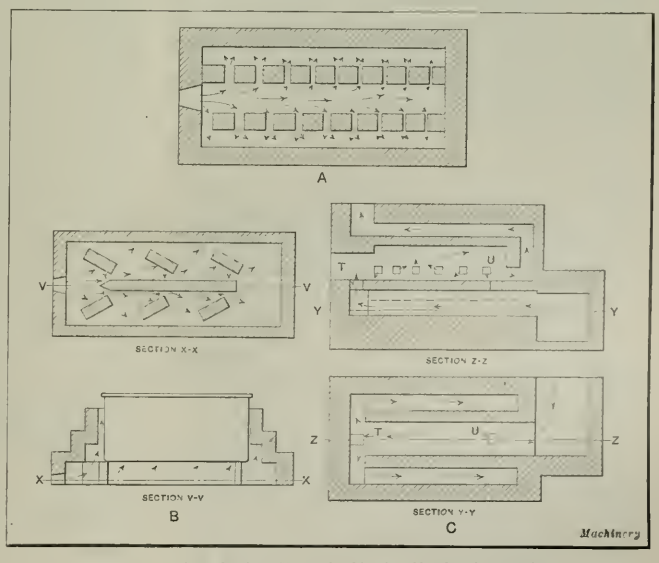


Fig. 4. Sections showing Various Combination Chamber Constructions

expected and the production may drop 33 1/3 per cent at certain times, three units are advisable. This means three 18-pot furnaces of about 18 square feet available hearth space or, say, 3 feet wide by 6 feet long. The combustion gases in furnaces of the types shown at *B* and *C*, Fig. 1 and *B*, Fig. 2, should enter the heating chamber at least 4 inches above the top of the pots, and the top of the arch should be at least five inches higher. The type of furnace shown at *A* in Fig. 1 should not be used. In furnaces of the type shown at *D*, Fig. 1 and *A*, Fig. 2, the distance from the top of the pots to the high point of the arch should be at least 5 inches.

Assuming that it is desired to harden the work once, it will be found that the time required for heating one gear will be about fifteen minutes. If they are quenched singly they should not be held more than ten minutes at the hardening temperature. Supposing that two pieces of work are quenched per minute in a Gleason hardening machine, ten pieces in a furnace at one time will be sufficient. Assume that the furnace is to be of sufficient length and width to take four rows of work, each containing five pieces, then in two rows, the gears can first be preheated, after which they can be moved to the other side of the furnace and their former place filled with ten new pieces of work. After the first ten have come to the proper temperature and are quenched, the routine is continued. There should be a space equal to the width of a gear between the two rows, or 8 inches; therefore the furnace should be about 4 feet wide by 5 feet long. A furnace of this size will have a capacity for heating forty gears per hour, so that if there are nine actual hardening hours in a ten-hour day, this means an output of 360 pieces per day, and thus one furnace will be sufficient. The height of the heating chamber can be equal to 1 1/3 times the height of the combustion chamber, but for convenient operation this height should not be less than 12 inches. The flue opening from the combustion chamber should be at least 4 inches above the work. The door openings may be made as small as convenient handling of the work will permit or about 4 feet by 8 inches.

As a general thing, it is more economical for a firm to build its own furnaces, as from 20 to 50 per cent can be saved, provided the furnace design is adapted to the work and is of a type which is known to give good results for that or similar work. Slight changes in these standard designs are permissible to meet individual shop conditions. The cost of having furnaces installed by outsiders is often excessive, as the builders must figure on selling costs, patents, superintendence, overhead expenses, and profit. Furnaces are often erected in banks to conserve floor space, heat and furnace walls. Large oil-fired carburizing furnaces are erected with two or four chambers as shown at *A* in Fig. 6, while hardening furnaces are erected in double or single banks as shown at *B*.

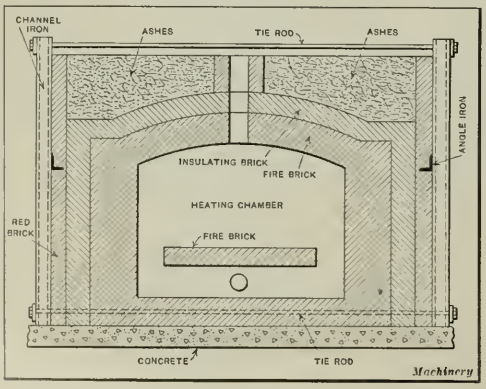


Fig. 5. Typical Construction of Stationary Under-fired Furnace

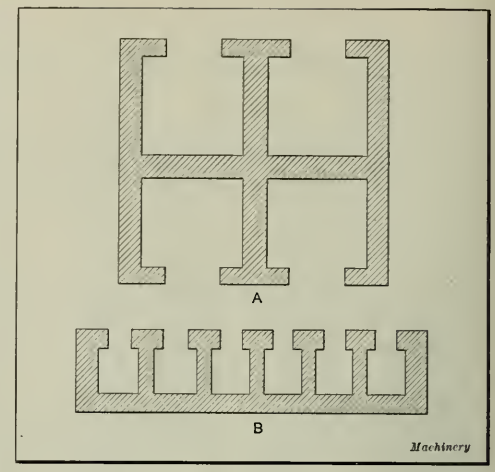


Fig. 6. (A) Method of erecting Large Oil-fired Carburizing Furnaces. (B) Bank of Small Hardening Furnaces

Automatic and Rotary Hardening Furnaces

Automatic furnaces or furnaces which are equipped with machinery for carrying the work through them, should be carefully considered before their installation, as they are often unsatisfactory. This is because proper heating is frequently overlooked in order to obtain a good mechanism, and as a result the metal is exposed to extreme temperatures resulting in warpage and burns. Complicated designs are apt to get out of order due to the number of parts, resulting in expensive repairs and long idleness.

The rotary hardening furnace has proved successful on certain classes of work such as set-screws, washers, nuts, pins, etc., but a number of large concerns who tried to use it on high-class ball bearings experienced trouble because every ball passing through the machine did not travel at the same rate of speed. The consequence was that some balls were not heated through while others were heated too long.

Muffle Furnaces

The principle of muffle furnaces is to improve the steel by separating the heated work from the combustion gases. There is no doubt that this is advantageous under the usual conditions of firing a furnace. However, with a properly designed furnace and proper burning of fuel, the combustion gases may be made practically harmless to the steel. The muffle type of furnace is apt to have more oxygen in contact with the metal than the open heating-chamber type as the result of sealing the work. To prevent oxidation, charcoal is often placed in the muffle to generate a protective gas that will burn up the oxygen and thus prevent the steel from scaling. The construction of a muffle furnace is similar to the three types mentioned, and if the furnace illustrated at *A* in Fig. 1 had a muffle placed on the hearth, as shown at *C* in Fig. 2, it would be considered a muffle furnace. Each pot in a carburizing furnace becomes an individual muffle furnace.

Surface Combustion and Lead Pot Furnaces

Surface combustion furnaces are only different from the types mentioned in that the gaseous fuel is broken into many little flames by impinging it on irregular surfaces or crushed material, such as firebrick. This causes the material to become incandescent and produces a more even throwing off of heat into the heating chamber. The principle is the same as having a multitude of small burners instead of one or a few large burners. As this method extracts the maximum heating value from the gas, its economy is great but the cost of hearth installation is high.

The lead pot furnace is often used in hardening carburized work, especially when the piece has been carburized all over and it is desired to have only part of the piece hardened. In this case only the part which is desired to be hardened is immersed in the lead and the part remaining outside of the lead, of course, does not reach the hardening temperature. Another advantage of the lead pot furnace is its ability to hold even temperatures. This is because the temperature of the mass of molten metal does not fluctuate readily. The lead pot furnace does not differ greatly from any of the three main types of furnaces, and can be likened to an inverted under-fired muffle furnace, the part containing the lead really being the muffle.

* * *

MILLING INTERMITTENT GEARS ON AN AUTOMATIC SCREW MACHINE

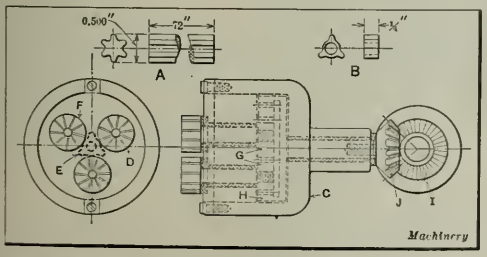
By JOHN J. McNIFF

The "skip" or intermittent gear shown at *B* in the accompanying illustration is made from brass pinion rod stock such as shown at *A*. This stock has six teeth, an outside diameter of 0.500 inch, and is furnished in bars 6 feet long. To produce gear *B* it is necessary to mill away every alternate tooth, drill and ream the central hole, and cut off the work. These operations are performed on a Brown & Sharpe automatic screw machine equipped with the special milling tool shown in the lower part of the illustration.

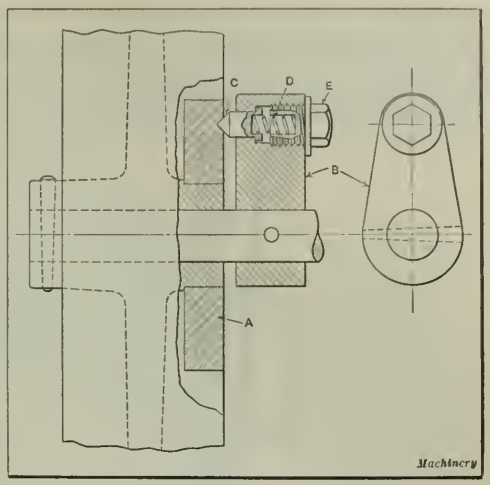
The most interesting features in connection with the production of these gears is the method of milling away the alternate teeth and the construction of the tool employed for the purpose. As shown, this tool consists of a body *C* carrying three end milling cutters *D*, *E*, and *F*. These cutters are mounted on arbors fitted with spur gears *G* which are driven by internal gear *H*. Gear *H* is driven through bevel gears *I* and *J*, gear I being keyed to a belt-driven spindle mounted in the post of the turret.

The cutters are fed forward by means of a lobe on the turret cam. The spindle of the machine is stopped and held stationary during the milling operation by a spindle brake provided for this purpose. The order or sequence of operations in machining the work is as follows: Center, drill, ream, stop spindle, mill, start spindle, cut off, feed stock forward, and repeat operations. When operating the machine at a spindle speed of 1800 revolutions per minute the actual cutting time and time spent indexing the tools into position may be determined from the following table:

Order of Operations	Number of Revolutions	Travel (Inch)	Feed per Rev. (Inch)
Revolve turret	22	....	....
Center	12	0.040	0.004
Revolve turret	22	....	....
Drill	32	0.320	0.010
Revolve turret	22	....	....
Ream	27	0.270	0.010
Revolve turret and stop spindle	24	....	....
Mill away teeth	56	0.280	0.005
Start spindle	22	....	....
Cut off	100	0.180	0.0018
Feed stock to stop	21	....	....
Total revolutions	360	....	....



Special Milling Tool employed on Automatic Screw Machine to produce Intermittent Gears



Slip Drive with Simple Spring-actuated Locking Detent

SLIP DRIVE FOR DRIVING PULLEY

By S. A. McDONALD

An arrangement which causes the driving pulley to be disengaged from the driving shaft when the machine becomes choked or when some part interferes with the proper functioning of the mechanism is illustrated herewith. The arrangement is called a slip drive, and has been used to good advantage on machines of various types. The application of this type of drive will do away with the breakage caused by the machine becoming blocked and will permit the pulley to continue to revolve without the belt slipping off. The drive, as will be seen by inspecting the illustration, is from the driving shaft through a fixed arm and then through the loose pulley.

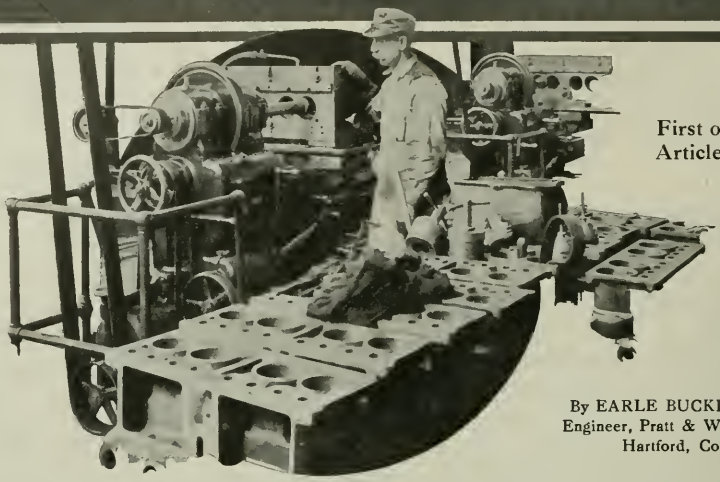
The construction of the arrangement is as follows: A machine steel disk *A* is bored out to fit the turned end of the driving pulley hub, to which it is either keyed or held by means of a drive fit. The driving arm *B* is secured to the driving shaft by a tapered pin, and carries a hardened tool-steel plunger, or detent *C*, backed by the pressure spring *D*, both of which are housed in a recess in the arm by means of the retaining screw *E*. A single spot is countersunk in the disk *A* for the purpose of receiving the point of the plunger, which should be a good fit in it. The pressure spring should be stiff enough to hold the plunger in the recess of the disk while the machine is being driven under a normal load. It will be apparent from the illustration that when the machine becomes blocked the plunger will slip out of its conical seat in the disk as the driving shaft continues to revolve, thus disconnecting the drive. The plunger will snap in and out of this recess at each revolution, and this clicking noise will attract the attention of the operator if his attention happens to be directed to some other machine at that particular moment.

* * *

The Navy Department has made comparative trials between one of the surrendered German U-boats which was built at Kiel in 1918, and the S-3, which was designed by the Navy Department and built at the Portsmouth Navy Yard. The two boats are practically the same in size, and the trials show the following results: The speed of the German boat was 13.8 knots on the surface and 7.8 knots submerged; the speed of the S-3 was 14.7 knots on the surface and 12.4 knots submerged. The German boat can cruise 8500 miles at 8 knots, and the S-3 can cruise 10,000 miles at 11 knots.

Equipment for Interchangeable Manufacturing

A Discussion of the Principles to be Considered in the Selection of Machine Tools and in Designing Jigs, Fixtures and Cutting Tools for Interchangeable Manufacture



First of Three Articles

By EARLE BUCKINGHAM
Engineer, Pratt & Whitney Co.
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IN the articles relating to interchangeable manufacturing published in preceding numbers of MACHINERY, an idea was given of the information required for interchangeable manufacturing, desirable lines to be followed in obtaining these data were indicated and proper methods of recording this information were described and illustrated. Even with the exercise of the greatest care in this preliminary work, many petty details will be overlooked; but the design and construction of the manufacturing equipment can be carried through with expedition and confidence as soon as this preliminary information is obtained. If time is important, the work of designing and constructing this equipment can be turned over to a large number of persons or to several different plants to develop independently. It is, of course, essential that a uniform method of interpreting drawings and tolerances be used, and that complete operation lists be furnished.

These operation lists should map out the plan of action for the selection or design of the equipment. Fig. 1 shows a form which has proved very satisfactory in service. The preliminary lists should give such descriptions of the special tools and gages to be made that their design can be readily developed. The final lists may refer to these tools and gages by number only. If these lists are kept up to date, they become a valuable key to all production.

Selection of Machine Tools

In order to insure ultimate economy, the proper choice must be made between standard or special machine tools. The amount and type of available equipment affects this decision. In general, standard equipment is advisable, although occasionally the reverse is true. For example, in the case of an extremely high rate of production, special automatic machines built to serve one specific purpose prove more economical. In other cases, a small special, single-purpose machine can be built as cheaply as a special fixture to be used on a standard machine tool.

The following factors must be taken into account if ultimate economy and high quality of product are to be secured. In purchasing new equipment its first cost must be considered. This, in itself, should never be the determining factor, neither should it be entirely ignored. The operation and maintenance costs are of far more importance than the first cost. These are important whether the equipment is old or new. If general data are compiled, in the manner described in the March number of MACHINERY, a convenient and reliable source of information will be at hand to assist in establishing the economical balance between the first cost and operating expenses.

In the course of time new demands are made of different classes of commodities. The typewriter, for example, was originally built to handle ordinary correspondence. Now it is also used in making up invoices and loose-leaf ledger sheets. In some cases, special machines are used for this purpose, but there are firms that cannot afford a double equipment of typewriters and to meet this demand, new features have been introduced on the machines, such as tabular stops, etc. The possibility of such modifications must never be overlooked. Therefore, another characteristic of the machine tool equipment is its adaptability. All other factors being equal, that machine which is the most adaptable to other operations should be chosen. In this connection, it is of interest to note that single-purpose machines are usually the more adaptable, and furthermore, that they often prove more economical in other ways. For instance, the writer knows of a watch factory which was engaged in making fuse bodies during the war. Some were made on semi-automatic turret lathes and others were machined on small bench lathes. The turret lathes practically completed the parts in two operations, while more than a dozen operations were required on the bench lathes. The parts produced on the bench lathes were not only more nearly identical than those produced on the turret lathes, but also cost less to manufacture. The turret lathes were purchased particularly for this job while the bench lathes had been formerly used in turning watch cases.

The machines selected must be sufficiently rigid to perform their task. The introduction of high-speed steels for cutters has created more severe conditions than formerly existed, and the improvement of the cutters in this respect has caused a great increase in the rigidity of many machine tools. It is interesting to compare the general construction of an earlier type of manufacturing milling machine which is shown in Fig. 2, with that of a more recent type shown in Fig. 5.

From the production standpoint, the most important factor of the machine tool equipment is the ease and facility with which it can be set up, adjusted, and operated. Several successive operations on simple single-purpose machines are often more economical than a single operation on a more

NAME OF PART _____ PART NO. _____
MATERIAL _____ POUNDS PER _____ PIECES
DATE _____ SHEET NO. _____ OF _____ SHEETS

OPER. NO.	NAME OF OPERATION, HOLDING POINTS, ETC.	MACHINE	JIGS AND FIXTURES	CUTTERS	MAN HOURS PER 100 PIECES	MACH. HOURS PER 100 PIECES	PIECE PRICE PER 100 PIECES	GAGES		
								WORKING	INSPECTION	MASTER

Machinery

Fig. 1. Operation Sheets on which should be given Essential Information required in designing Special Tools and Gages

complicated machine. The actual production time of the latter may be much less than that of the former, but when it is stopped for adjusment and setting-up, the loss of production is correspondingly greater. Furthermore, the multiplicity of adjustable parts makes it necessary to stop for readjustments more frequently. It should not be assumed from this that single-operation machines are always the most economical, because on parts having liberal tolerances the reverse is true.

Design of Jigs and Fixtures

Jigs and fixtures are provided to assist in machining specific surfaces on specific parts, and their design depends to a large extent upon the design of the parts to be machined. There are, however, a number of general principles which apply equally to all types of fixtures. The holding or register points of tools and fixtures for all finishing cuts should be identical with those surfaces from which the dimensions are given on the component drawings. On roughing cuts, these holding points are of lesser importance, yet it is good practice to maintain, as far as possible, the same register points on both roughing and finishing cuts. The stud shown in Fig. 3 is presented as a simple example to illustrate this principle. It will be noted that the dimensions of length, except the depth of the counterbore, are all given from one end, that the depth of the counterbore is given from the opposite end, and that the part is to be machined all over. This part can be machined in a single operation on a screw machine by means of the tools illustrated in Fig. 4.

Surface Y of the cutting-off tool A establishes the register point for forming tool B and facing tool C. Surface X of the forming tool is adjusted in relation to surface Y of the cutting-off tool so that the length of the stem on the work will be as given on the component drawing. Surface Z of the facing tool is also adjusted in relation to surface Y of the cutting-off tool in order to maintain the proper over-all length of the piece. Counterbore D is provided with an adjustable stop E which registers against the forward end of the stud. The contact surface of this stop is adjusted in relation to surface W of the counterbore so as to maintain the prescribed depth.

If the bottom of this counterbore were located on the component drawing from the end of the stem, the stop on the turret would be adjusted so that surface W of the counterbore would keep its proper position in relation to surface Y of the cutting-off tool. Stops on the cross-slide carrying the forming tool control the outside diameters.

The next question that arises is the proper limit at which to set the tools. There are four main sources of variation to consider: First, the errors resulting from imperfections in the machine; second, those caused by wear on the cutting edges of the tool; third, those due to errors in the tools; and fourth, those caused by improper setting of the raw material in their holding devices. In the following, only those variations which affect the lengths of the stud will be dealt with.

Results of End Play in the Machine Spindle

Referring to Fig. 4, any end play in the spindle of the machine will reduce the distance between the surfaces machined by tools A and C. If the forming and cutting-off tools are held rigidly together, this end play will not affect the distance between the surfaces machined by tool A and surface X on tool B. If, however, these two tools are independent of each other, as shown in the illustration, this end play may cause a variation in either direction. In the first case mentioned, a male dimension is dealt with and inaccuracies in the action of machine tools cause a minus variation in such a length whether the cutting tools are independent of each other, or combined in a single tool. Similarly in the case of a female dimension, it is evident that the variation will be plus. End play in the machine will not affect the depth of counterbore when the tool is self-registering as shown; thus a self-registering tool often produces more accurate results than one controlled by stops on the machine itself.

Wear on the cutting edges of tools A and C will increase the distance between surfaces Y and Z, but if the wear on surfaces Y and X is uniform, no variation will develop from this source. If it is not uniform, the variation may be in either direction. As surface W becomes worn, the distance, between this surface and the contact surface of stop E decreases, that is, of course, assuming that there is no appreciable wear on the contact surface of the stop.

Considering only the first two factors, that is, imperfections in the machines and wear on the cutting edges of the tools, the original setting of facing tool C should be as near to the minimum limit as the accuracy of the machine permits; the setting of forming tool B should be at the mean dimension until actual practice demonstrates a tendency to vary more in one direction than the other; while the setting of stop E on counterbore D should be as near to the maximum limit as possible. This will give the maximum time between readjustments. The conditions created by errors in the tools themselves will be dealt with later in the article.

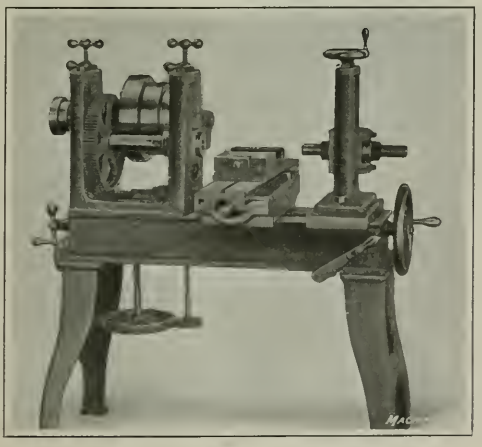


Fig. 2. Early Type of Manufacturing Milling Machine

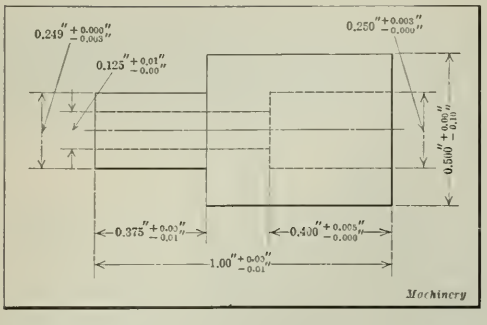


Fig. 3. Drawing of Stud machined in One Operation on a Screw Machine

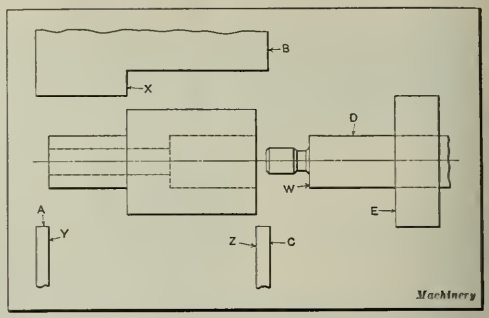


Fig. 4. Diagrammatic Illustration of Tools used in machining Stud

Results of Wear on the Cutting Edges of Tools

It is thus evident that the effect of imperfections in the operation of machine tools, when the cutting tools are located by stops on the machine, is to cause a plus variation on female dimensions, a minus variation on male dimensions, and a plus and minus variation on neuter dimensions, such as the horizontal distance between surfaces Y and X, which cannot be strictly classified as either male or female. In other words, imperfections in machine tools, such as end play, etc., cause additional metal to be removed. In a similar manner, the wear on the cutting edges of the tools causes a minus variation on female dimensions, a plus variation on male dimensions, and a plus or minus variation on neuter dimensions. In the last case, if the cutting edge of one tool consistently wears faster than that of the other, the variation will run in only one direction. Assuming that surface Y wears faster than surface X, the variation will be plus. If the wear is equal, no variations develop from this cause. In other words, the wear on the cutting edges of the tools usually causes a variation in the reverse direction from that caused through the presence of imperfections in the machine tools.

The same principles apply equally to all types of operations such as turning, milling, planing, grinding, profiling, shaping, boring, etc. In order to establish the proper dimensions for the holding and registering points on tools and fixtures, it is necessary to analyze each particular surface carefully and proceed accordingly.

In the above example, errors due to the improper setting of the stock in the holding device are not present. In the case of milling, drilling and other similar operations, where the parts are handled singly instead of being machined from bar stock, this is one of the most serious problems. Chips are apt to remain on the locating points or the operator may fail at times to seat the piece properly before clamping. In the case of drilling, this results in the improper location of the holes. In the case of other operations, it will result in removing additional stock. Proper training of the operator is the only cure for this fault. Correctly designed fixtures greatly reduce the chances of these errors, yet, as in other matters, it is not possible to make everything so that it will be entirely fool-proof.

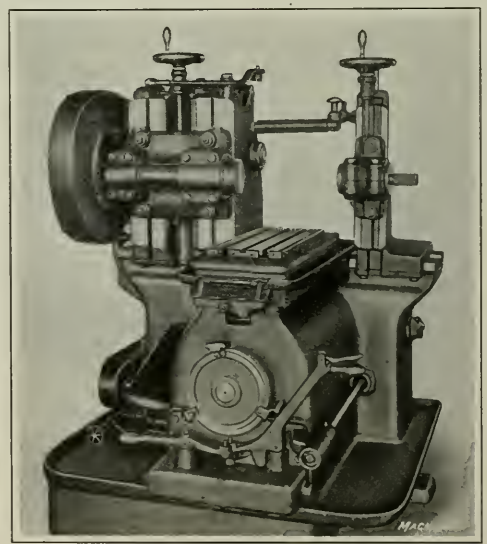


Fig. 5. Modern Type of Manufacturing Milling Machine

Factors to be Considered when Designing Fixtures

The second important factor of the design of fixtures is their operation in service. The selection of the proper locating points controls in a large measure the uniformity of the product. The facility with which these fixtures may be operated determines to a great extent the rate of production. The direct labor cost of production is also greatly reduced with quick-acting jigs and fixtures. On the other hand, such equipment is often very expensive, and therefore the total output involved determines the amount of money which may be economically expended on the equipment. In the case of a very small total output, little or no special equipment need be provided.

When continuous production is involved, every effort should be made in designing the equipment to have it operate rapidly. It should operate easily and with a single motion of the operator's hand if possible. Secondly, the fixture should open so that the part to be removed is accessible. Third, the position of such openings in relation to the cutting tools should be such that there is no danger to the operator. Whenever the operator is required to place his hand close to the cutting tool, he normally moves slowly and cautiously, thus reducing the rate of production. Fourth, all exposed sharp corners and edges on the fixtures should be eliminated to prevent injury to the operator. Fifth, the locating points should be accessible, to facilitate cleaning and the proper insertion of the work. Sixth, liberal chip clearances should be provided to facilitate cleaning the fixture and also to prevent marring the machined surfaces of the parts under the process of manufacture.

Examples of Efficient Fixture Design

Except for relatively large parts, careful study will make apparent a simple and effective means of clamping the work with a single motion of the operating handle. Loose nuts and screws should be avoided for clamping purposes whenever possible, as these are very slow to operate. A milling fixture which requires only a single motion to clamp is shown in Fig. 6. An assembly view of this fixture is shown in Fig. 8, and the details of its construction will be understood by reference to this illustration.

This fixture is used when milling the bottom, right- and left-hand sides of a small

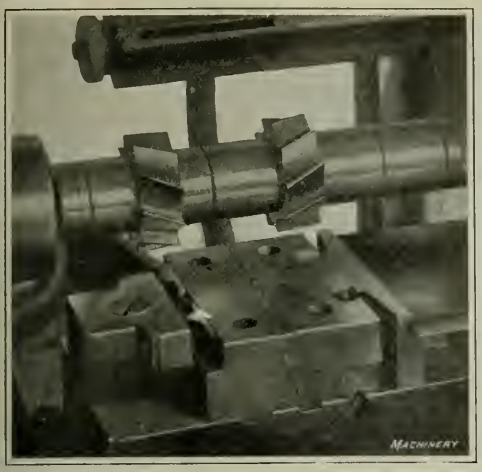


Fig. 6. Design of Milling Fixture in which Three Pieces of Work are clamped by a Single Motion

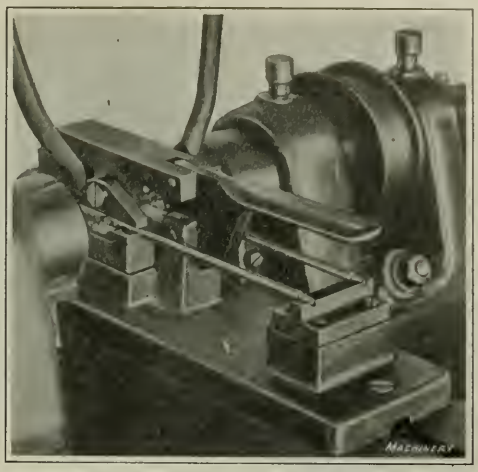


Fig. 7. Machine provided with Fixture used in Spline Milling in which the Work is Readily Accessible

forging in a single operation. The forging is first placed in the position indicated at *A* by dot-and-dash lines, where one side is milled. This piece is then advanced to position *B*, where the opposite side is milled. It is then inserted at *C* in which position the bottom is milled. In actual operation, when the original piece is placed in position *B*, a second piece is placed at *A*, and when the original piece is moved to *C*, the second piece is moved to *B* and a third piece is placed at *A*. Thus three pieces are being machined at the same time. All three parts are clamped by one motion of the lever, *D* and *E* being fixed jaws and *F* and *G* clamping jaws. The cam which is attached to the operating lever draws back the jaw *F* and pushes forward the jaw *G*. The jaw *F* is designed so that it can rock, thus securing the parts at *A* and *B* with equal pressure regardless of the variations in size between the two pieces. This particular construction permits clamping in three places simultaneously with a single motion of the operating lever. Modifications may be made in this design which will permit clamping in three or more different directions when this is desirable or necessary.

Inaccessibility is one of the most common faults found with jigs and fixtures. Sufficient clearance should always be allowed to enable the operator to remove the completed work readily and also to insert a new part and hold it in position while clamping. Careful attention to this point will greatly promote rapid production. Fig. 7 shows a spline milling fixture which affords a simple example of this point. The construction of this fixture is shown in Fig. 9. Two pieces are held at one time, the pieces being clamped in position by a leaf. It will be noted that each piece is clamped in two places by a single operating lever. The leaf is hinged so that it may be thrown back out of the way when the work is being removed or inserted. The rapidity with which this can be accomplished is a means of increasing the production.

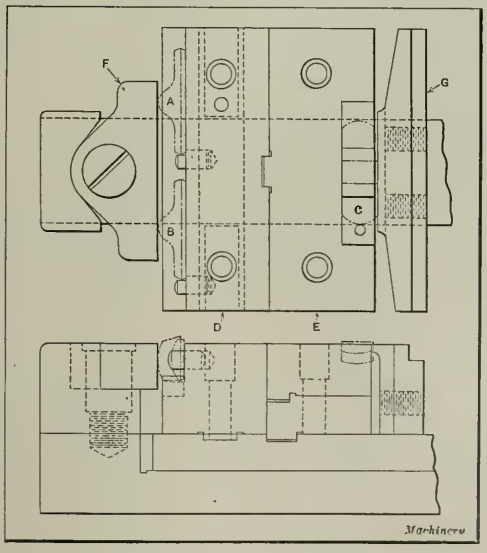


Fig. 8. Assembly Drawing of the Milling Fixture illustrated in Fig. 6

Providing Protection from Cutting Tools and Sharp Corners, and Accessibility of Locating Points

In many cases, standard machine tools are so designed that the table is well away from the cutting tool in its loading position. In the case of drill jigs, the operator withdraws them from beneath the spindle of the machine before he unloads them. Sometimes, however, the design of the machine tool or fixture is such that the fixture cannot be removed from under the cutting tools. In such cases, if the fixture cannot be designed to open on the side away from the cutting tool, provision should be made for rolling or rocking the fixture away from the tool. If this cannot be done, some safety device should be designed which will stop the cutting tool and prevent it from starting while the operator's hand is in any position of danger. Safety guards and automatic stopping devices on punch presses are good examples.

It is evident that the operator will handle a jig or fixture without sharp edges much more quickly and surely than one on which he is continually tearing his hands. It is the standard practice of most tool-rooms to remove all such corners carefully, whether the drawing of the fixtures specifies it or not. The locating points in the jigs and fixtures should be so placed that they can be readily reached. This not only facilitates the cleaning of the fixture but enables it to be more accurately made. It also allows any necessary corrections due to wear or change in dimensions to be quickly and economically made. These locating points should stand clear and be as nearly self-cleaning, as regards chips and dirt, as it is possible to make them.

Necessity of Providing Proper Chip Clearances

Careful consideration should always be given to the provision of suitable chip clearances. If this point is neglected, the operator will often spend more time in

removing the chips from the fixture than he does on any other operation. On the other hand, if he does not remove them, inaccurate work will result. Many ingenious devices have been developed for cleaning. A jet of compressed air or a stream of oil or soda water properly directed often accomplishes this task quickly and well, and this demands that the design of the fixture be such that the chips are readily carried away. A little attention to this point by the tool designer will often save hours of time later during production— time of both operator and machine. In Fig. 10 is shown a simple jig which illustrates, among other features, simple methods of obtaining chip clearances. The construction drawing of this fixture is shown in Fig. 11. The part to be drilled is located in one place by the tapered tongue *B* shown in section *A–A*, and is clamped by a leaf. The body of the jig is a skeleton frame which contains no pockets to catch the chips. The leaf swings open, thus allowing all chips to be easily brushed or blown out.

The following example shows the results actually obtained in production by attention to these details. A certain firm contracted to make 200,000 small pinions as shown in Fig. 12. It will be noted that three of the six teeth are partly removed. The pinions were made from brass pinion stock being extruded to form, after which they were drilled and cut off in an automatic screw machine, and counterbored in a drilling machine to remove the stock from three of the teeth. The drill jig first employed in the last operation was one with a leaf in which several pinions were held. It was designed and built without much thought, as the job seemed simple and unimportant. The parts were so small and difficult to handle rapidly and the chips were so troublesome that the best rate of production possible with this jig was about 160 an hour. This was so far under the estimated production that a serious loss on the contract seemed inevitable. After a little study, a new jig—incidentally a cheaper one than the original—was designed and built. This jig is shown in Fig. 13. A pair of parallel jaw pliers *A* was used as a basis. These had special jaws *B* inserted to hold the pinions, one of them carrying plate *C* which had three holes that served as drill bushings. Spring *D* which was attached to one jaw, opened the pliers, while the grip of the operator closed them and held the pinion in position. A cast-iron parallel *E* about two inches high was clamped to the table of the drilling machine, and two rods *F* which served as feet to level the device, were riveted to the handles of the pliers. The bottom of the pinion rested on the cast-iron parallel, while the top rested against the drill plate *C*. The operator handled this jig as follows: About half a dozen pinions were placed on the cast-iron parallel approximately an inch apart. The open pliers were placed over the first piece and then closed. The shape of the jaws insured that the piece when clamped would be in the proper position for the operation. The pliers were then slid under the spindle of the drilling machine and the pinion was counterbored. To unload, the operator moved the jaws away from the cast-iron parallel as he released his grip. The completed parts and all chips then dropped out, and he proceeded to pick up the next pinion. The rate of production with this jig was over 500 an hour, and nearly double the estimated output.

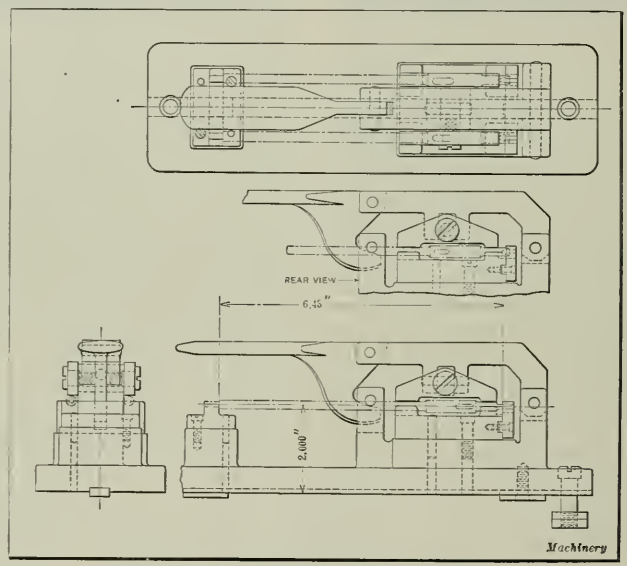


Fig. 9. Construction of Spline Milling Fixture

Needless to say, the greater the rigidity of the tools, the greater the accuracy of the product. Whenever possible, the pressure of the cutting tools should be withstood by a solid part of the fixture and not by a clamp. Fixtures which are permanently fastened to the machine should be sufficiently rugged to withstand all use and abuse. Independent jigs which must be lifted or turned over in operation should be as light as they can safely be made. The design in all cases should be as simple as possible because simplicity is a primary source of economy. This simplicity, however, is seldom attained spontaneously. It is the result of constant study and careful and painstaking development. It may be safely asserted that designs which are not simple are incompletely developed.

Economy in the construction of jigs and fixtures offers a field for standardization. Not only the various drill bushings, operation levers, drill jig feet, vise jaws, etc., but also the baseplates for jigs and fixtures, various clamping devices, leaves, etc., can be standardized to advantage. This is now common practice in many up-to-date tool-rooms.

Methods Employed in Manufacturing Fixtures

The information required on fixture drawings depends to a large extent upon the methods to be employed in the construction of these fixtures. One of two general methods is usually employed. First, the complete fixture may be made by one man or a small group of men working in close cooperation. Second, the work on all fixtures may be resolved into its elements and one man or one group of men may do only the work of a certain type, such as planing, milling, boring, etc.

Each method has certain advantages and certain disadvantages. Among the disadvantages of the first method are the following: When one man performs all types of operations, either the tool-room must be over-equipped with machinery or a considerable amount of time will be lost by the various men in waiting their turn to use certain machines. Again, few men are equally expert in operating all types of machinery. The use of this method prevents the specialization of the men on those operations in which they are most expert. In order to overcome the foregoing disadvantages, the second method has been used. This often results in reducing the amount of tool-room equipment and increasing the total output. On the other hand, the elimination of the disadvantages of the first method has resulted in the loss of many of its advantages. With the first method, the toolmaker takes a personal interest in the development and completion of a certain fixture. It is a complete mechanism in which he can take personal pride, and this advantage is lost by the adoption of the second method. Furthermore, a careful dis-

tinction must be made between working time and elapsed time. The adoption of the second method, while it often reduces the total working time required to complete tools, inevitably increases the elapsed time between the receipt of the order and the delivery of the completed fixture.

To operate successfully under the second method, a certain amount of work must be kept ahead of each operation. This means that although the machines and men may be kept busy, each piece of work must wait its turn at each operation. Thus, in many cases, the elapsed time required to complete the fixtures under the second method is more than double the elapsed time required under the first. For replacement work, which can be anticipated and started well in advance, and for new work when time is not essential, the second method is often the better. In other cases, if ultimate economy is desired, the first method must be employed. Take for example an emergency repair. If we balance the decreased cost in the tool-room under the second method against the increased cost of the idle time of productive machinery and labor, we shall find that we have lost more than we have gained. This holds true for the construction of equipment for a new product when time is essential.

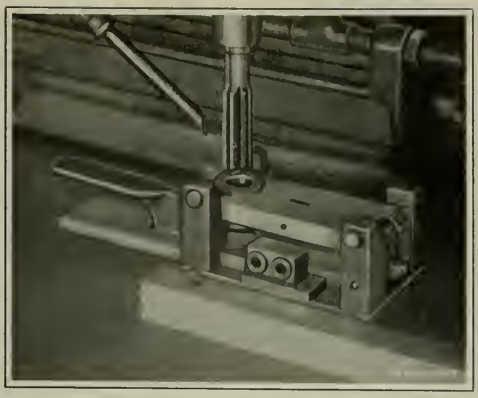


Fig. 10. Jig designed to permit Easy Removal of Chips during Various Operations on the Same Piece

When Tolerances should be Supplied on Fixture Drawings

The drawings required in the tool-room under the first method of production need be functional ones only. Except on important dimensions of functional locations, etc., tolerances will be of doubtful value. Detailed drawings of the individual parts of fixtures must be supplied, yet tolerances and clearances on these details can be safely omitted. On the other hand, drawings to be used with the second method should include tolerances on all but atmospheric fits. The direction of the tolerances on those surfaces which are fitted at assembly should leave surplus metal. Those parts which assemble without fitting should have their dimensions and tolerances expressed in the same manner as on the component drawings of the interchangeable product itself.

The establishment of the tolerances on the functional locations is identical in all cases. Variations in these dimensions will be reproduced in the product itself. The effect of these will be to reduce the manufacturing tolerance. It is obvious that these variations must be in that direction which will hold the product within the established tolerances. Naturally, then, these tolerances should be kept as small as possible. The fixtures are usually made but once, while the product must be reproduced many times over. The amount of this tolerance on the jigs and fixtures should be a fair percentage of the component tolerance and 20 per cent should be sufficient in most cases. It is clear that the location of drill bushings for holes which may vary 0.020 inch is not so important as for holes which can vary but 0.002 inch.

It should be kept in mind that in many cases adjustment is provided on the machine tools to align the work-holding fixture correctly in relation to the cutting tool. Such is the case on milling, planing, and other similar machine tools. In the case of jigs for drilling and boring, however, no such adjustment is possible. Such equipment must therefore be constructed with greater accuracy than milling fixtures. It is thus apparent that the original tolerances and clearances for those surfaces machined on this type of equipment must be designated on the component drawings with great care. It is obvious that if needlessly severe tolerances are required by the component drawings, the cost of the equipment will be greatly increased and no commensurate benefit will be derived from it.

Checking and Testing Jigs and Fixtures

The most effective method of checking jigs and fixtures is to set them up and make the required cuts on sample pieces. This, however, is not always possible and so model parts are a good substitute. Such parts are invaluable for checking purposes during the construction of any of the special manufacturing equipment. The final inspection of the completed fixtures should be a functional inspection only. The

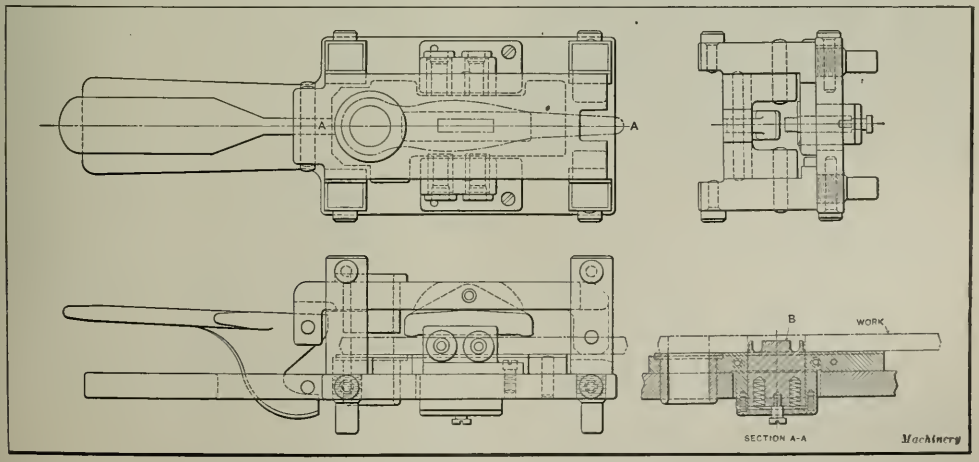


Fig. 11. Assembly Drawing of the Jig illustrated in Fig. 10

operating parts must function properly and the functional locations must bear the proper relation to one another. The component drawings, as well as the fixture drawing, should be consulted. Any fixture which will insure the proper machining of the component part is satisfactory as regards its accuracy. If the fixture drawing has been carefully completed, the information given there will indicate reasonable limits. If the fixture, however, exceeds those limits, but does insure the completion of the component part within the established tolerances, and without imposing over-severe conditions in the production, the fixture should not be rejected because of this technicality. It is well to keep a record of such deviations for reference. The purpose of this inspection is not to see how much fault can be found with the work accomplished, but to determine as surely as possible whether or not it will fulfill the purpose for which it is intended. This is never definitely determined until the fixture has actually produced satisfactory work.

Tolerances to be Allowed on Cutting Tools

In the early portion of this article, in connection with Figs. 3 and 4, several sources of variations in the product were mentioned. Some of these errors are fixed quantities, other are variable. In discussing the cutting tools, we will consider two sources of variations—the first variable, the second practically fixed. The first source of error, which has been previously mentioned, is that due to the wear on the cutting edges of the tool. This, as we have seen, results in leaving more metal on the piece. Disregarding all other factors of error, and assuming that the wear is equal on all surfaces, we should make the tools to the minimum metal sizes of the component drawings, in order to insure their longest life. When faces are neither male or female, the initial size of the tool should be the mean dimension. But if a tolerance of, say, 20 per cent of the component tolerance has been permitted on the jigs and fixtures, the cutting tools should be made approximately the same percentage inside the minimum metal sizes of the component, except those made to the mean dimensions. Tools made to such dimensions should produce work within the established limits. If, however, sample parts made by such tools are beyond the established limits, they will vary outside of the minimum metal sizes. In such cases the tools can be salvaged, as metal must be removed from the tools to correct this fault.

The second source of variation in the product is initial error in the size or form of the tool itself. Tolerances for tools should be established from experience gained in actual practice as carefully as the tolerances are established for the components themselves. Cutting tools must be replaced over and over again in the course of production. On one hand, in order to reduce the first cost of these tools, their tolerances should be as liberal as possible. On the other hand, to lengthen their life and thus reduce the number of replacements, they should be held as close to the minimum metal limits as other conditions will permit. The economical balance between these two factors establishes the proper tolerances. In practice, the fixed error due to inaccuracies

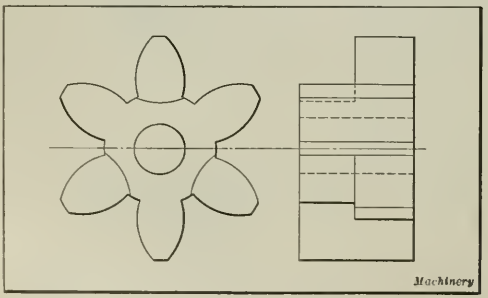


Fig. 12. Pinion having Three Teeth partially removed

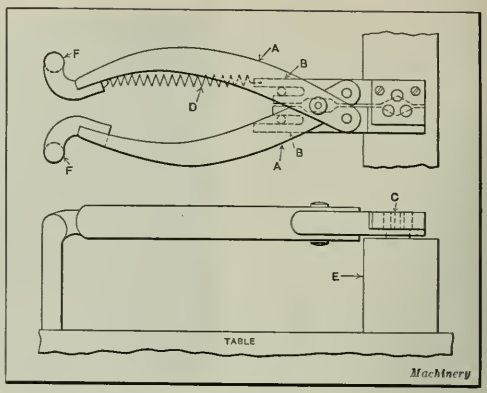


Fig. 13. Jig developed for handling Pinions in Counterboring Operation

in machine tools and fixtures can readily be determined after production is under way. This error, properly added to or subtracted from the minimum metal limit of the component, establishes the maximum metal limit of the cutting tool. This maximum metal limit should be the basic dimension of the cutting tool. The application of the tolerance then establishes the minimum limit of new cutting tools. Whenever the established tolerance on the component is exacting, the tool should be made adjustable if possible, thus enabling wider limits to be established on the tools, reducing their initial cost and prolonging their life. Such, for example, is the purpose of interlocking milling cutters.

Difficulty of Maintaining Tolerances on Tools Machining Several Surfaces

It is well to note that the more surfaces machined by a single tool, the more difficult it is to maintain close tolerances, either on the tool itself or on the product. Take, for instance, the cutting of a thread. If a die is used, the three main elements are carried on one tool; namely, the form, the lead, and the diameter. Adjustment for the diameter is possible, but the form and lead are fixed. Under present conditions, variations develop in the lead and shape when the tool is hardened and these are difficult and expensive to correct. As one die is replaced with another, these variations are different. If the tolerances on the component are sufficiently liberal, the use of dies is satisfactory. If they are severe, satisfactory dies are very expensive, although the direct production costs are low. In these cases, if the threads are milled or chased, the form alone is carried by the tool. Such a tool is readily and accurately made and maintained. The diameter is controlled by the setting of the tool, and is readily adjusted and readjusted. The lead is controlled by the lead-screw of the machine and is practically constant. Lead-screws can be obtained within any reasonable degree of accuracy.

Sufficient chip clearances must be provided on all cutting tools if a free cutting tool is to be obtained. The proper rake of the cutting edge should be determined as early as possible and carefully maintained. The design should be as simple and rugged as conditions will permit. The individual design and requirements of the cutting tools, of course, depend on the nature of the material to be machined and the methods of machining employed. The drawings of the cutting tools should be made with as much care and in conformity with the same basic principles as the component drawings themselves. When continuous production is involved, a constant supply of cutting tools must be provided, a supply which must be available for instant use with little adjusting or correction.

The next article on this subject will give examples of jig and fixture design, illustrating the application of the principles stated in the foregoing.

Chart for Determining Safe Loads of Round Steel Columns

By JOHN S. WATTS

THE accompanying chart, based on the American Bridge Co.'s practice may be used to determine the safe loads of steel columns up to 3 inches in diameter. The unit stress specified by this concern depends upon the slenderness ratio l/r of the column, l being the length of the column in inches and r the radius of gyration in inches. The allowable compressive unit stress S, in pounds per square inch, of columns where the ratio is between 60 and 120 is:

$$S = 19{,}000 - \frac{100 \times l}{r}$$

For the above ratios, the allowable unit stress varies 1000 pounds per square inch for each difference of 10 in the slenderness ratio, the allowable stress for a ratio of 60 or less being 13,000 pounds per square inch. When the slenderness ratio is between 120 and 200, the following formula applies:

$$S = 13{,}000 - \frac{50 \times l}{r}$$

By this formula the allowable unit stress varies 500 pounds per square inch for each difference of 10 in the ratio. The allowable unit stress for various ratios of from 60 to 200 are given in the table shown in connection with the chart, and proportional stresses should be allowed for intermediate ratios. The slenderness ratio should not exceed 120 for permanent work, but for work of a temporary nature the ratio may be larger, although it should not exceed 200.

Assume that the safe load for a column 2 inches in diameter and 56 inches long is to be found. Starting at the upper left-hand part of the chart, follow the perpendicular line marked 2, which represents the diameter of the column, to its point of intersection with the horizontal line marked 56, which represents the length of the column. Next draw a line from the upper left-hand corner of the chart through this point of intersection and extend it to the vertical line A. From this point draw a line to the lower right-hand corner of the chart and from the point where this line intersects the vertical line marked 2 draw a horizontal line to the right-hand edge of the chart, which will show the safe load to be approximately 24,500 pounds. It will be noted that the numbers along the line A which represent column lengths, refer only to the horizontal lines of the left-hand triangle, while the safe loads marked along the hypotenuse of the right-hand triangle refer to the horizontal lines marked on that triangle.

The slenderness ratio can be quickly determined by multiplying the value marked along line A nearest to the point where the line drawn on the left-hand triangle reaches this line by 1.33. In the example given this occurred near the horizontal line marked 84 so that the slenderness ratio equals $84 \times 1.33 = 112$. It is obvious that all values obtained on line A by the use of the chart vary as the slenderness ratios of the columns under consideration, and consequently are proportional to both the unit stress and the safe load. An idea of the unit stress can be obtained by noting the relative position of the intersection of the line drawn on the right-hand triangle and the vertical line representing the diameter of the column, with respect to the three stress lines on this triangle. In the given example, this intersection is a little above the line marked 7000 pounds per square inch, so that the unit stress is approximately 8000 pounds per square inch. If the size of the chart will allow, stress lines may be drawn to represent each variation of 1000 pounds, although this is not absolutely essential.

When the length and load of a column are specified, the necessary diameter can be readily determined by trial. It may also be found by stretching a thread from the upper left-hand corner of the chart to the lower right-hand corner, and then by means of a pencil, pushing the thread up or down, keeping the pencil on line A until the vertical line in the left-hand triangle nearest the intersection of the thread and the specified length line, indicates the same diameter as the vertical line on the right-hand triangle nearest the intersection of the thread and the specified load line. When the intersection of the length and the diameter lines occurs above the line marked $l/r = 60$, the safe load is found by following down the line indicating a unit stress of 13,000 pounds per square inch, to its intersection with the line giving the diameter of the column. This is because the allowable unit stress for columns having a slenderness ratio of 60 or less is 13,000 pounds per square inch. From this, it is obvious that in each case the load given by the intersection of any vertical line in the right-hand triangle and the hypotenuse marked 13,000 pounds per square inch is the maximum safe load for a column of that diameter, regardless of the length of the column, although for slenderness ratios under 60, this provides a lower factor of safety than is allowed for larger ratios.

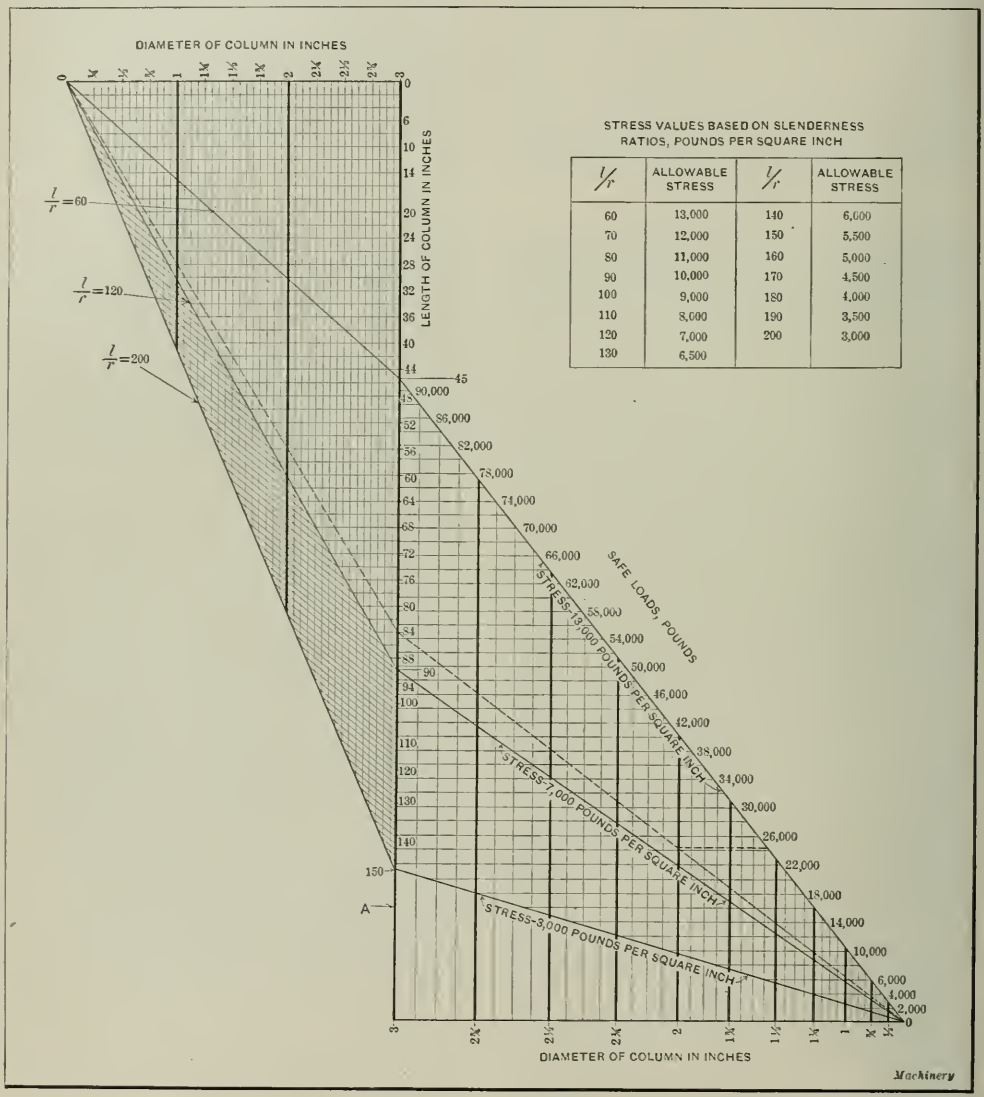
The chart is constructed as follows: The lower horizontal line of the right-hand triangle was first drawn, and as the safe load of circular bars varies as the square of the diameter, it was necessary for the length of this line to be proportional to the square of the largest diameter considered. In this case 3^2, or 9 inches, is the length of the line, which was drawn half size. Vertical lines representing the various column diameters, were then erected on this line at distances from its right-hand end, equal to the square of the diameter that each line represented. Since the greatest allowable unit-stress value used on this chart is 13,000 pounds per square inch, the safe load for a column 3 inches in diameter for slenderness ratios of 60 or less, is $0.7854d^2 \times 13{,}000$, or 91.892 pounds, d being the diameter of the column.

The vertical line A was next drawn to a length equivalent to this safe load, when laid out to some convenient scale; in this case, a scale of 1 inch = 16,000 pounds was used. At this scale the vertical line is 5.74 inches long. From the upper end of this line, the hypotenuse was drawn to the right-hand end of the horizontal base line, thus completing the triangle. The safe loads of a 3-inch diameter column for two other allowable unit stresses were then found. In this case, 3000 and 7000 pounds per square inch were the stresses selected, the corresponding loads being found to be 21,206 and 49,480 pounds, respectively. These values were also laid out on line A to the scale adopted for this line, and lines were then projected from these points to the right-hand corner of the triangle. Horizontal lines for each 2000 pounds of safe load were then equally spaced between the 3000- and 13,000-pound stress lines.

From the table shown in connection with the chart, it will be noted that the corresponding slenderness ratio for a unit stress of 3000 pounds per square inch is 200; for a unit stress of 7000 pounds, 120; and for a unit stress of 13,000 pounds, 60. Thus the points on line A from which the lines representing these stresses are drawn, also represent lengths of 3-inch diameter columns. The lengths of columns corresponding to each of the above ratios were accordingly calculated in order to lay out the length scale. For a circular

section $r = d/4$ in which d = the section diameter and r, the radius of gyration, so that for a 3-inch diameter bar, $r = 3/4$ inch. Therefore, when the slenderness ratio is 200, $l = 200 \times 3/4 = 150$ inches; when the ratio is 120, $l = 120 \times 3/4 = 90$ inches; and when the ratio is 60, $l = 60 \times 3/4 = 45$ inches. The points where the stress lines join line A were then marked to indicate these lengths, this line being then subdivided to represent each difference of 2 inches in length. Thus the distance between the lines marked 45 and 90 was divided into 22½ equal spaces, and the distance between 90 values varies directly as the diameter. The divisions between 0 and 90 are twice as great as those between 90 and 150, because the decrease in unit stress for each increase of 10 in the slenderness ratio between ratios 60 and 120, is twice as great as the decrease between the ratios 120 and 200.

As the distance between 90 and 150 was made proportional to the difference between the stresses 7000 and 3000 pounds per square inch, or 4000 pounds, and the distance between 45 and 90 was made proportional to the difference between 13,000 and 7000 pounds per square inch, or 6000



STRESS VALUES BASED ON SLENDERNESS RATIOS, POUNDS PER SQUARE INCH

l/r	ALLOWABLE STRESS	l/r	ALLOWABLE STRESS
60	13,000	140	6,000
70	12,000	150	5,500
80	11,000	160	5,000
90	10,000	170	4,500
100	9,000	180	4,000
110	8,000	190	3,500
120	7,000	200	3,000
130	6,500		

Safe Load Chart for Round Columns, based on the Specifications of the American Bridge Co.

and 150 was divided into 30 equal spaces. From point 45 upward, 22½ spaces were laid out to the same scale as the spaces between 45 and 90. At 0, the upper extremity of line A, a horizontal line 3 inches long, full scale, was drawn to the left and graduated into sixteenths of an inch. The length of either this line or the spaces into which it is divided does not affect the values obtained in the right-hand triangle, since the radius of gyration which controls these pounds, the distance between 45 and 90 is therefore 1.5 times the distance between 90 and 150. The latter represents 60 inches in length, and as the distance between 45 and 90 is 1.5 times as long, or $1.5 \times 60 = 90$ inches, the point 45 may be considered as the zero point, when laying out the portion of the chart, for slenderness ratios between 120 and 150. For this reason, the length lines between 90 and 150 were drawn parallel to the diagonal line $l/r = 60$.

LETTERS ON PRACTICAL SUBJECTS

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FORMULA FOR TAPER MEASUREMENTS

Recently, while using the rule given on page 899 of MACHINERY'S HANDBOOK for finding the diameter of a disk to be placed in contact with a smaller disk of known diameter when measuring tapers, it occurred to the writer that a formula which did not involve a division of quantities would be easier to apply. Accordingly the following formula was evolved:

$$D = d \times \cot^2 \frac{180 \text{ deg.} - a}{4}$$

in which D = diameter of the large disk;
d = diameter of the small disk;
a = the angle to be measured.

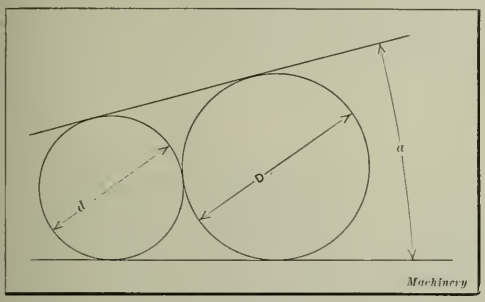


Diagram for Use in finding Diameter of Large Disk when measuring Tapers

The following example will illustrate the application of the formula: If the required angle a, as shown in the accompanying illustration, is 15 degrees and the diameter of the smaller disk is 1 inch, find the diameter D of the larger disk.

Substituting the given values in the above formula, we have:

$$D = 1 \times \cot^2 \frac{180 \text{ deg.} - 15 \text{ deg.}}{4}$$

$$= 1 \times (1.1403)^2 = 1.3002$$

From this example it will be seen that D may be obtained by comparatively simple arithmetical operations. This formula may be given in the form of a rule as follows: Subtract the required angle from 180 degrees, divide by 4, find the cotangent corresponding to this angle in a table of trigonometrical functions and multiply the square of this cotangent by the diameter of the small disk.

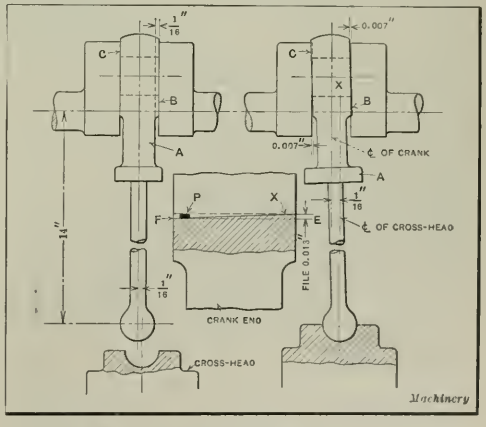
Ecorse, Mich. HERBERT BOLD

FITTING CONNECTING-RODS

It frequently happens that the fitting of connecting-rods to crankpins results in side play due to inexperience or poor judgment in aligning the connecting-rods with the cross-head center. In the case of punch presses and other similar crank-operated machines, the writer has frequently noticed a space permitting a play of as much as 5/64 inch on a crankpin $1\frac{3}{4}$ inches in diameter.

A method commonly employed when fitting ball-end connecting-rods is to first fit the crankshaft in its bearings and then fit the connecting-rod end A, with its cap, to the crankpin. The cross-head is next scraped to fit its slide and then connected with the connecting-rod end. It is during the latter procedure that the trouble occurs, for it will usually be found that the cap bears heavily on the side C and the body part of the rod end on side B, and in order to correct this, the two points are filed, but the trouble is not immediately eliminated; it will be found that side B continues to bear, and by the time the filing has produced the desired results, a full 1/16 inch will be filed away, and the result will be excessive side play in the bearing.

The following method for making the connection may be criticized as theoretically wrong; nevertheless, it has been found to work correctly. First, fit the cross-head into its position in the slide and then screw the rod into the bearing end A. After bluing the crankpin and the sides, place the ball in its socket with its cap removed, and slide the cross-head, bringing bearing end A against the crank. Assuming that the center of the cross-head is offset 1/16 inch from the center of the crankpin, it will be necessary to file off the sides at C and B as shown to allow the crank-end to strike the crankpin, which will occur at a point X. At a corresponding point near the opposite edge of the bearing (see enlarged view) place a piece of putty, as at P. Then slide the cross-head forward again until the crank-end strikes the pin and flattens the putty to a thickness which will indicate the amount of metal that must be filed from the bearing. With a 14-inch connecting-rod and a bearing 3 inches wide, this thickness will be about 0.013 inch, as is graphically shown by the broken line EF. In removing this metal, bevel the corner at X as shown, so as to assist in determining the depth of metal to be removed, then by using a 14-inch coarse half-round or bastard file, the metal can be readily removed to within the scraping limit. The cap must be treated in the same way. In fitting up the rod ends, there



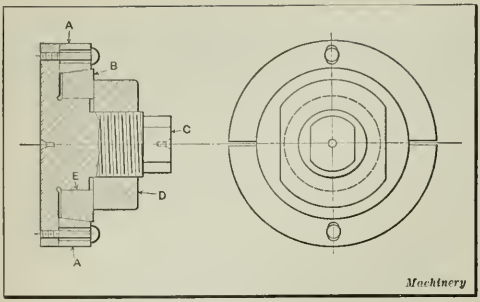
Illustrating Method of fitting Connecting-rods so as not to cause Side Play

should not be any side play, although the diagonally opposite sides will show a space about 0.007 inch wide, corresponding to the amount that was removed in order to get the ball end to swing over 1/16 inch.

San Francisco, Cal. M. JACKER

EXPANDING CENTER PLUG

The expanding center plug shown in the accompanying illustration is used when grinding the outside of a long-stem gear which is counterbored at the large end. Since this counterbore is used as a running surface for a set of ball bearings, which hold the gear in position when assembled, it was



Expanding Center Plug used in grinding Long-stem Gears

deemed advisable to use this as a working point for the head end when finish-grinding the stem. The main body of the fixture consists of a large flange *C* whose diameter equals the low limit dimension of the counterbore, and a stem which is threaded for a nut *D*. The threaded end is flattened as shown to suit a standard wrench. The flange is ground at *E* to fit the solid ring *B*, which is tapered to match the expanding members *A*. Two screws, which pass through loose slots, hold parts *A* in position and yet allow for expansion. All parts are hardened and ground.

The large end of the plug is inserted into the counterbore of the gear and the nut tightened. This forces ring *B* down, which, in turn, causes the parts *A* to expand outward and grip the gear firmly. The drilled center in part *C* and the one in the end of the stem are used as supporting points while grinding. Variation in the size of the counterbore is thus taken care of, and at the same time the gear is accurately centered.

Cleveland, Ohio. HARDIN D. THWEATT

DIES FOR DRAWING A UNIVERSAL JOINT COVER

Some of the more interesting dies used in forming the universal joint cover shown at *D* in Fig. 2 are described in this article. The shell is drawn from metal 0.166 inch thick, the blank being 8 inches in diameter. The die employed in the blanking operation is of simple construction and does not require special description. The second operation on the shell is performed by the push-through die shown at the left in Fig. 1. The blank is located on the die by means of the gage ring *A* which is attached to the die-block *B* and holds the drawing ring or die *C* in place. The drawing ring has a 30-degree angle and a liberally rounded corner over which the shell is drawn. There are three radial holes *D* in the die-block, which hold spring-actuated strippers so that when the punch ascends after having formed the shell as shown, the strippers will operate and prevent the shell from adhering to the punch. The punch is also provided with a knock-out which operates in hole *E*, but in this particular die the knock-out is not necessary, as the shell is stripped from the punch by means of the spring-actuated device previously mentioned. The dies used in the third and fourth operations are not illustrated, since their general construction is similar to that of the die employed in performing the fifth operation. Reference to Fig. 2 will show at *B* and *C* the shape of the shell after each of these operations.

The fifth operation, besides further reducing the body of the shell, also starts a small reduction on the end, as shown at *D*, Fig. 2. The die shown in Fig. 1 which is employed for this operation is of the same construction as the other dies used in the forming operations, except that on account of the tapered end of the shell a gage ring is not required to locate it in the die. A knock-out is provided in the punch at *E* and also one in the die at *K*. The sixth operation consists of further reducing the small end of the shell, and the dies employed are of similar design to those previously described. The shape of the shell after this operation is shown at *E*, Fig. 2. It will be noticed in all of these reducing operations that the 5¾-inch diameter at the flared end of the cover has been maintained throughout.

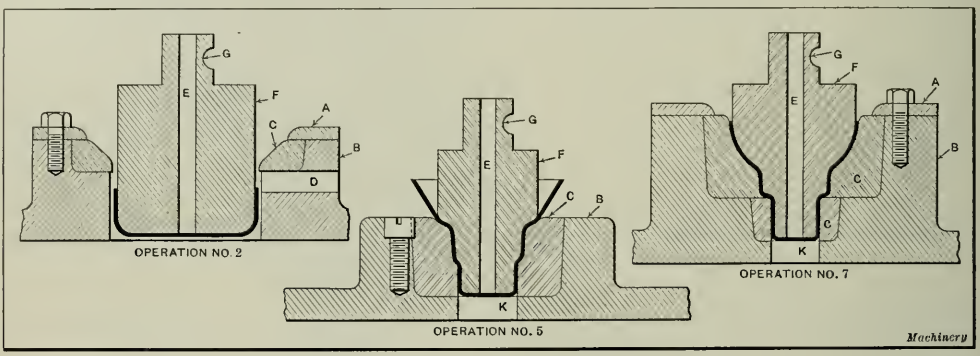


Fig. 1. Three Dies used in the Course of forming the Universal Joint Cover

The finish-forming die is shown at the right in Fig. 1 and is used in the seventh operation to expand the small end of the shell slightly and at the same time to form the bell-shaped flange to the dimensions shown at *F*, Fig. 2. This

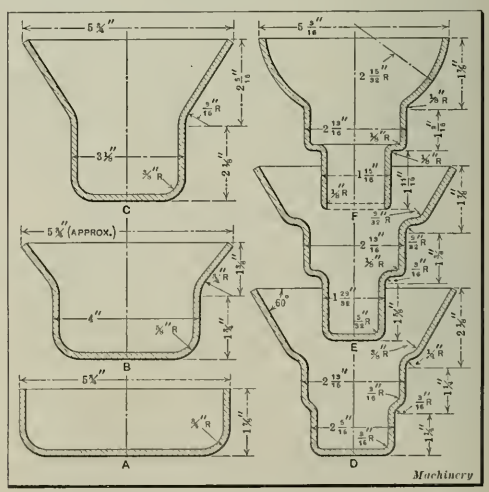


Fig. 2. Appearance of the Cover at Various Stages in the Forming Process

die consists of two separate die rings *C*, Fig. 1, the lower one of which is used for forming the straight part and the other for making the bell shape. The latter ring holds the lower ring in place and, in turn, is secured by means of gage ring *A* and machine screws, as shown. Both dies are carefully fitted in the cast-iron holder *B*, which should be of rather heavy construction on account of the considerable amount of force exerted on these tools. This will permit the die rings to be made comparatively light. The final operation on this shell consists of cutting out the bottom as indicated by the dotted lines at *F*, Fig. 2. This completes the forming of the shell, which must now be machined out in the small diameter before being ready for assembling.

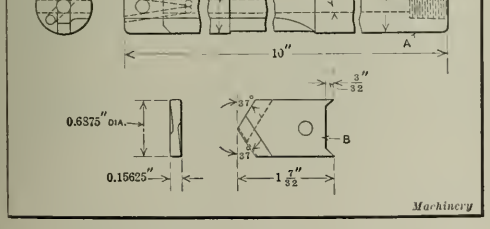
It should be stated generally that in drawing shells of this kind, it is good practice to keep the radii of the corners over which the metal is drawn quite large on both die and punch as this will prevent drawing thin places in the shell. In the dies illustrated and described in this article, a 1½-degree taper has been allowed for fitting the die rings into the die-block. All the dies should be hardened and ground at these angles and then carefully fitted in place. The punches are secured in the holder by means of a pin passing through the holder as indicated at *G* in Fig. 1. This provides a simple way of replacing punches without removing the holder from the press. In those dies where a knock-out is provided, as at *K*, it is, of course, understood that the familiar type of rubber buffer attachment is employed in drawing the shape.

Toledo, Ohio J. BINGHAM

DRILL FOR DEEP-HOLE WORK

Drills of the oil-tube type such as are used for drilling the through holes in lathe spindles or other similar deep-hole work are very expensive; consequently, if they cannot be used on work other than that for which they were originally purchased after they have become shortened as a result of the necessary frequent grindings, their use is exceedingly uneconomical, when the actual drilling service rendered is considered.

The tool shown in the accompanying illustration, which was designed to take the place of the regular type of oil-tube drill in order to reduce tool expense, has proved very satisfactory, having been found to maintain as high rates of production as the commercial type of high-speed oil-tube drill. This tool, which is intended for drilling a hole 11/16 inch in diameter, consists of a machine steel shank *A* and a high-speed steel cutter *B*. The cutter is inserted in the slot at the left-hand end of the shank and fastened securely in place by a taper pin. The chips are cleared from the



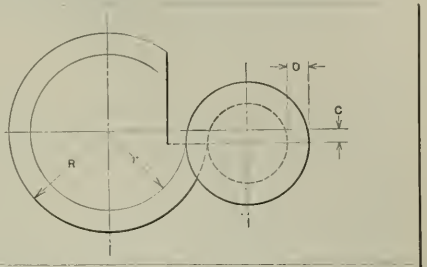
Details of Tool designed for Deep-hole Drilling in Steel

tool effectively by being forced back through the flutes on the shank by a cutting lubricant conducted to the cutter through the 3/16-inch longitudinal hole in the shank which connects with the two ⅛-inch holes at the cutter end. As the inserted cutter of high-speed steel is small and can be readily replaced when worn, it is evident that this type of tool is economical to use as well as inexpensive to make. B. R.

DIMENSIONS OF CIRCULAR FORMING TOOLS FOR AUTOMATIC SCREW MACHINES

The accompanying table gives two dimensions *R* and *C* of circular forming tools which are constant for various sizes of Brown & Sharpe, Acme, and Cleveland automatic screw machines, and formulas for determining radius *r*. This radius varies according to radius *R* of the forming tool, the offset *C* and the difference *D* between the two radii on the

DIMENSIONS OF CIRCULAR FORMING TOOLS FOR VARIOUS TYPES OF AUTOMATIC SCREW MACHINES



Make of Mach.	Size of Machine	R Inches	C Inches	r Inches
Brown & Sharpe	No. 00	0.875	0.125	$\sqrt{(0.8660-D)^2+0.0156}$
	No. 0	1.125	0.15625	$\sqrt{(1.1141-D)^2+0.0244}$
	No. 2	1.50	0.250	$\sqrt{(1.4790-D)^2+0.0625}$
Acme	No. 51	0.75	0.09375	$\sqrt{(0.7441-D)^2+0.0088}$
	No. 515	0.75	0.09375	$\sqrt{(0.7441-D)^2+0.0088}$
	No. 52	1.0	0.09375	$\sqrt{(0.9956-D)^2+0.0088}$
	No. 53	1.1875	0.125	$\sqrt{(1.1809-D)^2+0.0156}$
	No. 54	1.250	0.15625	$\sqrt{(1.2402-D)^2+0.0244}$
	No. 55	1.250	0.15625	$\sqrt{(1.2402-D)^2+0.0244}$
	No. 56	1.50	0.1875	$\sqrt{(1.4882-D)^2+0.0352}$
Cleveland	¼"	0.625	0.03125	$\sqrt{(0.6242-D)^2+0.0010}$
	⅜"	0.84375	0.0625	$\sqrt{(0.8414-D)^2+0.0039}$
	⅝"	1.15625	0.0625	$\sqrt{(1.1546-D)^2+0.0039}$
	⅞"	1.1875	0.0625	$\sqrt{(1.1859-D)^2+0.0039}$
	1¼"	1.375	0.0625	$\sqrt{(1.3736-D)^2+0.0039}$
	2"	1.375	0.0625	$\sqrt{(1.3736-D)^2+0.0039}$
	2¼"	1.625	0.125	$\sqrt{(1.6202-D)^2+0.0156}$
	2¾"	1.875	0.15625	$\sqrt{(1.8685-D)^2+0.0244}$
	3¼"	1.875	0.15625	$\sqrt{(1.8685-D)^2+0.0244}$
	4¼"	2.50	0.250	$\sqrt{(2.4875-D)^2+0.0625}$
	6"	2.625	0.250	$\sqrt{(2.6131-D)^2+0.0625}$

Machinery

work. The formulas were obtained by substituting the values for radius *R* and offset *C* in the formula

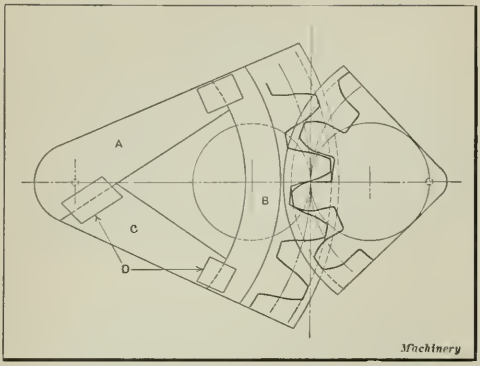
$$r=\sqrt{(\sqrt{R^2-C^2}-D)^2+C^2}$$

and simplifying. This formula is given in MACHINERY'S HANDBOOK on page 826.

Kenmore, N. Y. FELIX E. AVERILL

TESTING TOOTH OUTLINE OF SPECIAL GEARS

On page 327 of the December number of MACHINERY, a method of testing the tooth outlines of special gears by means of cardboard templets was described. The writer here presents another good method of doing this which does not require the making of templets. First make a pencil drawing showing a portion of each gear with the teeth engaged. The teeth of the gears should, of course, be developed with the special generating circle or curve employed in designing them. Care should be taken to make this drawing to a sufficiently large scale to permit accurate laying out of the profiles. Next ink in the center lines, pitch circles, and indicate the arcs of approach and recess. After this has been



Tracings employed as Templets in testing Gear-tooth Profiles

done, an ink tracing should be made of each gear segment on separate sheets, showing the centers, pitch circles and teeth.

If the tracing is a large one, strips of cardboard should be pasted on as shown at *A*, *B*, and *C*, in the accompanying illustration, and if necessary a short piece should also be pasted over each joint as at *D*. The illustration shows the traced segments pinned to their respective centers on the drawing and overlapping each other at their tooth ends. Now by turning the segments with their teeth engaged, any interference can be readily detected. This method also enables one to compare the tooth contact point with the arcs of approach and recess, which show through the tracing from the paper drawing.

San Francisco, Cal. M. JACKER

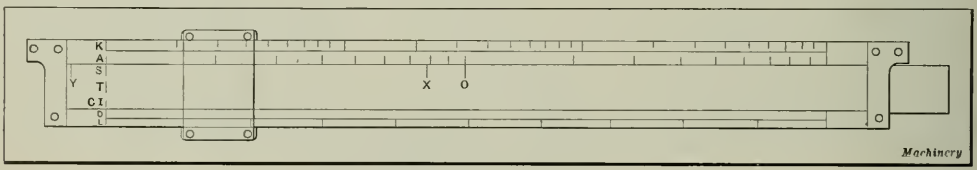
SIMPLIFIED METHOD OF FINDING AREAS OF CIRCLES WITH POLYPHASE DUPLEX SLIDE-RULE

Since the polyphase duplex slide-rule has come into such general use among engineers and designers, an arrangement whereby a mathematical computation commonly performed with this rule may be considerably simplified may be of some interest. In finding the area of a circle using a duplex rule of the type shown in the accompanying illustration, it becomes necessary to mentally carry the square of the diameter or radius of the circle while turning the rule over to refer to the scales on the other side. If a provision were made whereby a constant were marked on the scale it would obviate this inconvenience and greatly simplify the process. On the common type of duplex rule, the scales are arranged on one side as follows: *K* or cube scale at the top of the rule; next *A*, or square scale; *S*, or sine scale; *T*, or tangent scale; *CI* scale (*C* scale inverted), for reciprocal work; *D*, the full-length regular *D* scale; and *L*, a scale of equal parts, or logarithm scale. The opposite side of the rule has the following scales: *CF* and *DF* (*C* and *D* scales folded); *CIF*, or *C* scale inverted and folded; and regular full-length scales *C* and *D*. Folded scales are those in which the graduations begin and end approximately at the center of the rule, the scales being so placed as to bring the division π in line with the index marks on the lower *D* scale.

The operation of finding the area of a circle with this rule is to set the runner so that the hair line is on the diameter of the circle on the *D* scale, using the side first mentioned and reading the square of the diameter on the *A* scale. It is then necessary to turn the rule over and set figure 4 on the *C* scale directly over the π mark on the *D* scale. This brings the right-hand index over graduation 0.7854; the answer is read on scale *D* directly under the square of the diameter of the circle on scale *C*.

In laying out a constant such as previously suggested, set the dividers to the distance from 4 to π on either scale *C* or *D*, and after marking this distance on some plane surface, bisect carefully. With the aid of the dividers lay off this distance to the left of the left-hand index mark on the *S*, or sine scale, and scribe as at *Y*. Since the square scale *A* contains two complete scales, an index must be scribed on the *S* scale under the central 1 of the scale *A*, and to its left another constant scribed as shown at *X*. In scribing these marks on the central part of scale *S*, the end index marks should align with the corresponding marks on the square scale, using, of course, the same setting of the dividers as before. When computing the area of a circle on a slide-rule, which has been scribed as just mentioned, the process is as follows: Set the runner with the hair line superimposed on the diameter mark of scale *D* as before; then operate the slide until the proper index on scale *S* lies under the hair line of the runner and read the answer on scale *A* directly over the constant. The distance of the constant from the index marks on the *S* scale is obviously one-half the distance from 1 to 0.7854 on the *C* or *D* scales, since the square scale is but one-half as long as the *C* or *D* scales.

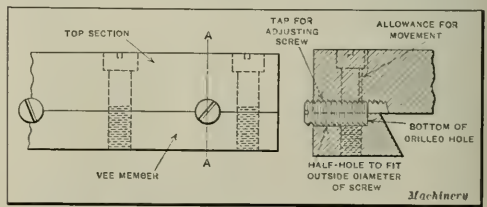
Decatur, Ill. WARREN ICHLER



Polyphase Slide-rule with Constants for obtaining Areas of Circles

ADJUSTABLE V-SLIDE

The built-up type of V-slide here illustrated presents a type of gibbing arrangement which, on account of its simplicity and strength of construction, should be of considerable interest. A valuable feature of this adjustable slide is that the clamping screws employed to hold the vee member to the top section, afford a means of maintaining the adjustment after it has once been made. In building up a slide of this type, clamp the vee member to the top part and lay out and drill the clamping screw holes; also lay out and prick-punch the location of the adjusting screw holes. These prick-punch marks should come on the dividing line between the two members so that when the pieces are unclamped, the location may be determined from either piece. After unclamping the pieces, clamp a piece of scrap stock to the upper member, and repunch the location of the holes so



Machine Slide with Adjustable Vee Member

as to form a center from which to drill the tapped hole. After drilling this hole, use a bottoming tap and run it in to about the depth shown in the sectional view. Repeat this sequence of operations for each adjusting screw employed. The half-holes in the vee member of the slide are next machined, using a scrap piece of stock as before and drilling to suit the outside diameter of the screws to be used. As shown in the illustration, these holes extend about two-thirds through the vee member and are bottomed to form a seat for the adjusting screws. Adjustment of this type of slide is accomplished by loosening the upper clamping screws and operating the adjusting screws until they bottom against the half-hole in the vee member. Continued adjustment of these screws will, of course, permit the slide to be tightened as required, to compensate for wear. It will be noted that the holes in which the clamping screws are tightened are elongated to allow this adjustment to be made. After the adjustment has been secured, the clamping screws are tightened and the entire arrangement firmly and positively locked.

The writer has used this type of slide on small grinding machine vises and lathes, and on jig work in which adjustable slides are required, and in every case it has proved highly satisfactory.

Allentown, Pa. JOE V. ROMIG

DANGER OF SNAP JUDGMENT IN ADOPTING EFFICIENCY METHODS

Many efficiency engineers assume to know more about a man's own production problems than he does himself. However, such assumptions are often dangerous, unless a thorough investigation is first made. The following example will illustrate this statement: Some time ago the writer had occasion to be in a shop where guns and rifles are made. This shop has been in successful operation for a great many years and is old enough to have a Brown & Sharpe universal milling machine without an overhanging arm—a machine that sold for $650 in 1879; hence, experience in good shop practice was not lacking. The gun barrels were turned in special barrel turning lathes. The writer was engaged in appraising the machinery, and found upon entering the gun barrel turning department that the gun barrel lathes were run with only one tool. As such lathes are used with four tools elsewhere, it was reasonable to assume that these machines were not strictly up-to-date and that a considerable amount should be allowed for depreciation. However, as it was apparent that the labor cost was lower per machine than it would have been with a machine using four tools, it was considered best to talk to the superintendent about this matter before making a decision. This is what the superintendent had to say when the subject of the gun barrel turning lathes was broached:

"Yes," he said, "we think that one man and four single-tool lathes is a better proposition for us than the same man with one or even two four-tool machines. Our turning costs are probably as low as any of our competitors', but even if they were not, the saving in the polishing department would make up for the difference. It is impossible to get four cuts on a piece to match up perfectly, and when they do not, it makes extra work in the polishing room. Another thing that probably hadn't occurred to you is that four tools are apt to make a lot of short kinks in the barrel that are very hard to get out. Gun barrel straighteners are the highest paid men we have. They get as much as $75 a week. You can see that our straightening expense is very low, but I have heard that companies using four-tool lathes have costs as high as 75 cents per barrel, so you can see that we are satisfied that our method is the best one, for us, at least."

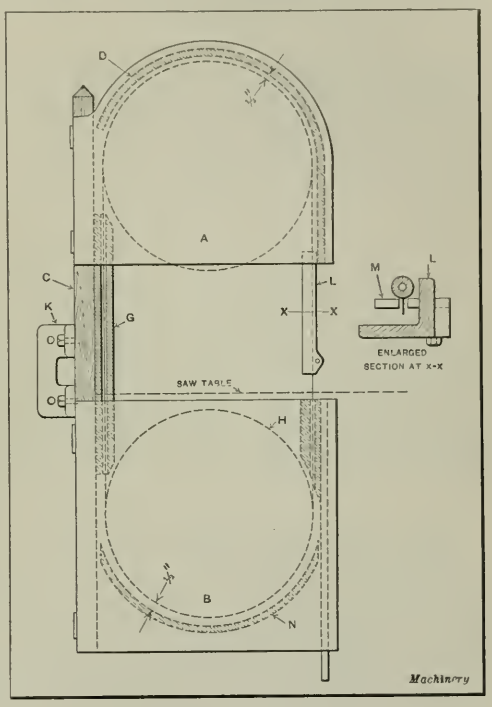
As I went out of the shop, I reflected that there are many things that even the well-informed efficiency engineer has never thought of.

Boston, Mass. L. L. THWING

BAND-SAW GUARD

It is said that a man who was once being examined for the position of state factory inspector, when asked the question, "What is the purpose of a guard on a band saw," replied as follows: "The purpose of a guard is a protection from injury," and continuing, added, "but more often kinked, bent, and broken saws, lower production, and a source of annoyance to the operator are the results."

Past experiences have caused the writer to form the same opinion of band-saw guards in general, especially those types in which little consideration has been given to the design from the standpoint of convenience to the operator. The design shown in the accompanying illustration is an all-wood guard, which has proved very satisfactory. No metal is



Improved Type of Band-saw Guard

used in the construction of this guard in places where it could possibly come in contact with the saw, either while in operation or in case the saw should break or slip off the wheels. It will be noticed that the saw is covered wherever possible, not only to protect the operator, but also to prevent it from becoming kinked, bent, or broken.

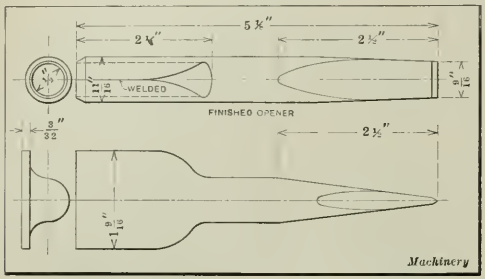
The guards *D*, *G*, *H*, and *N*, are of wood, guard *H* being so attached that it forms a chute for the sawdust when no dust collector is used. The wooden doors *A* and *B* are made from ¾-inch material and are hinged to post *C*. The complete guard is fastened in place on the machine by means of the bracket *K* to which the post *C* is attached by lag screws. The wooden piece *L*, a cross-section of which is shown in the enlarged sectional view, is fastened to the metal guide *M* in such a way that it is free to move vertically against the inside of door *A*. This permits guard *L* to be readily adjusted for work of various thicknesses. From the illustration it will be seen that when the doors *A* and *B* are opened there is nothing to obstruct the view or interfere with putting on, taking off, or adjusting the saw. To remove the guard it is only necessary to take out the two bolts in bracket *K*.

Kenosha, Wis. M. E. DUGGAN

SHOP AND DRAFTING-ROOM KINKS

COTTER-PIN OPENER

Workmen often cut or bruise their hands when trying to open or spread the ends of a cotter-pin after the pin has been driven into place. The accompanying illustration shows a device which has been designed to eliminate such discomforts, which are often experienced, especially when the cotter-pins are located in inaccessible places. In using this



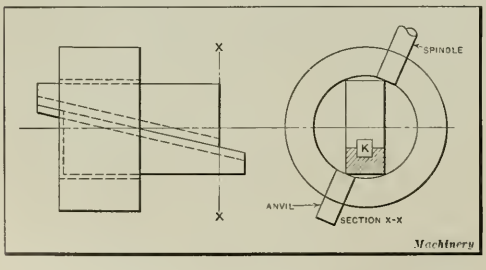
Tool for opening or spreading the Ends of Cotter-pins

tool the ends of the cotter-pin or key are separated by the chisel end of the tool and then bent over to the required angle by slipping the hollow cylindrical end of the tool over the projecting ends of the key. The tool is made from spring steel, the tubular end being produced by first flattening the end shown in the lower view and then forming and welding it to the shape shown in the upper view.

NORMAN MCCLEOD

MEASURING DIAMETERS OF HOLES

The measurement of straight holes or bores is usually attended by much variation in results and no little uncertainty as to the degree of accuracy. The use of an inside micrometer or the ordinary caliper and outside micrometer will not give results, as a rule, closer than 0.0005 inch. The method to be described in connection with the accompanying illustration will permit the measurement of internal diameters with a high degree of accuracy. The measurements are taken by means of an adjustable parallel and the use of an ordinary outside micrometer. The angle of the mating parts of the parallel is of no importance. The angular surfaces of both members as well as the key *K* should be ground and lapped, and the key slot in both members should be ground after hardening. In one half of the parallel this key should be a snug push fit, and in the other half it should be an easy running fit.



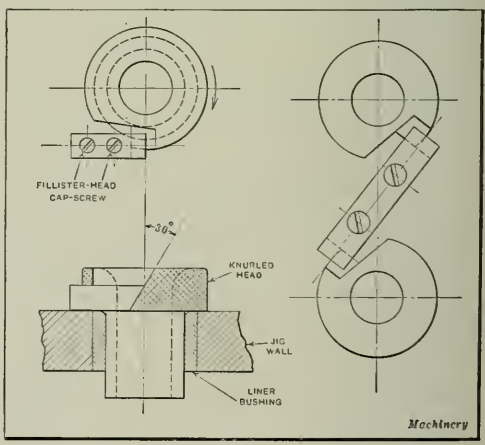
Method of using Adjustable Parallel when measuring Diameters of Bores

The assembled parallel must be ground all over, using a magnetic chuck or some other suitable holding device, and the four edges should be lapped to a slight radius, taking care that these edges are perfectly parallel throughout their entire length. The parallel is inserted into the hole to be measured and adjusted so that the edges touch the bore of the piece as illustrated, the measurement being taken over either pair of diagonally opposite edges. The degree of accuracy obtainable depends upon the skill of the mechanic using the micrometer, but should not produce a variation of over 0.0001 inch when measured by two different mechanics using the same micrometer. In lapping the edges to the slight radius it is understood, of course, that each pair of diagonally opposite edges should be lapped to exactly the same measurement. The use of this adjustable parallel will enable any slight taper in the hole to be easily detected, as such a condition will cause the parallel to rock or pivot when it contacts with that part of the bore which is tapered.

New Britain, Conn. WILLIAM C. BETZ

IMPROVED TYPE OF SLIP BUSHING

An improved type of slip bushing for drill jigs, which will stand the most severe usage, is shown in the illustration. The head of this bushing is milled off on one side to an angle of 30 degrees from the vertical. A hardened steel wedge made of square key stock, and having an angle of 30 degrees on one end, is screwed to the top of the jig by means of two



Arrangement for preventing Slip Bushings from working out of Place

fillister-head cap-screws, and in a position so that the two 30-degree surfaces will be parallel. When in use, the bushing will tend to rotate with the tool in the direction of the arrow, which will cause the bushing to wedge against the block and prevent it from revolving and consequently from working itself out of the jig. The right-hand side of this illustration shows the method of applying the slabbed slip bushing where the holes are close enough together to permit a single wedge block to be employed. F. W. S.

* * *

It is estimated that fifty of the leading automobile manufacturers employ altogether about 160,000 men in their factories.

HOW AND WHY

QUESTIONS ON PRACTICAL SUBJECTS OF GENERAL INTEREST

DIRECTION OF FEEDING MOVEMENT FOR THREAD-CUTTING TOOLS

G. E. J.—Should the inward feeding movement of a thread tool be at right angles to the axis of the work?

A.—It is preferable to set the compound rest at an angle of 30 degrees and feed the tool inward at this angle for each successive cut instead of at right angles to the axis of the work. When the tool is fed in at an angle of 30 degrees, one edge does practically all the cutting and the other edge moves parallel or opposite to the side of the thread; consequently the tool tends to tear the thread less and produces a smoother cut than when fed at right angles to the axis of the work. The tool may be moved straight in to take a light finishing cut after most of the metal has been removed by the angular feeding method.

HEAT-TREATMENT PROBLEM

ANSWERED BY S. P. ROCKWELL, SYRACUSE, N. Y.

The following information relative to the carburizing and casehardening of chain blocks is given in reply to the question submitted in the March number of MACHINERY, page 668. Although the question does not state just what trouble was experienced in carburizing the chain blocks, it is surmised that two troubles may exist: First, cracking of the work when hardening; second, breaking of the work after it has been assembled and placed under working strain. Nearly all trouble experienced in cracking while in the quenching bath is due to improper saturation. By this is meant not only the lack of uniform heating throughout the work, but also the degree of heat. Such an intricate part as a chain block demands that these factors be given special consideration. The casting should first be pack-annealed in charcoal or in a used carburizer, for a period of two or three hours at 1350 degrees F. This annealing process is required to remove the casting strains and to bring the grain structure to its normal condition.

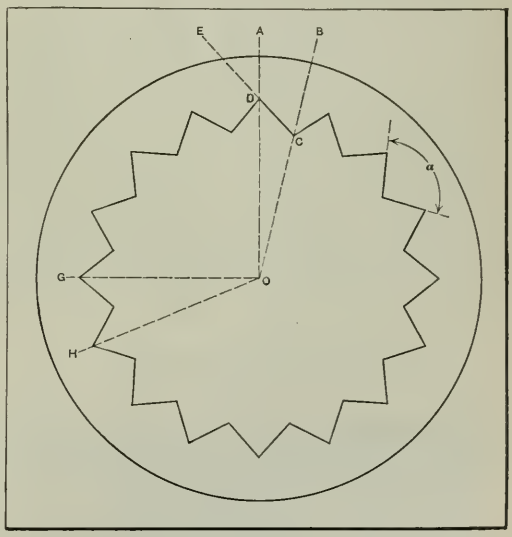
In carburizing, it is recommended that the cored surfaces be left soft and free from carburization, if this is possible. This may be accomplished by plugging the cored portions with clay or asbestos, or by painting with a viscous mixture of clay, water-glass, and white lead. It is advisable when carburizing to use a granular carburizing material of the air-regenerative type and to employ, as nearly as possible, a temperature of 1600 degrees F. The length of time required for carburizing cannot be intelligently stated, as the size of the carburizing pots etc., is not known. In order to determine when the required depth of carburization has been obtained, tell-tale rods thrust through the cover should be used, one of which should be occasionally removed, quenched, and broken so that the progress may be observed. The work should be allowed to cool while in the pot and then be reheated to a temperature of 1000 to 1625 degrees F., after which it should be quenched in oil.

The grain of the core in broken specimens should be as refined as possible, as any increase in the coarseness of grain indicates that the heat has been either too high or too low. The work should now be reheated to a temperature of 1475 degrees F. and quenched in oil. If, however, the surface hardness requirements are not obtained by quenching in oil, the work may be quenched in water when at a temperature of 1425 degrees F. The best condition will be indicated in the fracture by the finest case structure. The work should be drawn in oil using as high a degree of temperature as possible without danger of destroying the required degree of hardness. This temperature will be about 375 to 400 degrees F. By following this process, the highest physical qualities should be produced, and if proper saturation is obtained, no breakage when quenching should occur.

ANGLE OF TOOL FOR NOTCHING A RING

H. D.—The ring shown in the accompanying illustration is to have V-shaped teeth of a given angle a. What is the relation between this angle and the included angle of the tool used for cutting the notches, and how is the angle of the tool determined?

A.—Since the tool is to be shaped to cut out the notches between the teeth, the angle of the tool must be equal to the angle between the sides of any one of the notches. Draw the radial line OA, bisecting one of the notches, and the



radial line OB bisecting one of the teeth. Then, ECB equals one-half the angle of tooth, ODC equals one-half the angle of tool, and AOB equals one-half the center angle. By center angle is meant the angle between radial lines drawn from the center of the ring to corresponding points of two adjacent teeth, as, for example, angle GOH. By a principle of geometry, the exterior angle ECB of the triangle ODC equals the two opposite interior angles of the triangle. Hence,

$$\text{Angle } ECB = ODC + DOC, \text{ or}$$

$$\text{Angle } ODC = ECB - DOC$$

Multiplying by 2,

$$2 \times ODC = 2 \times (ECB - DOC), \text{ or}$$

$$\text{Angle of tool} = \text{angle of tooth} - \text{center angle} = \text{angle of tooth} - \frac{360}{\text{number of teeth}}$$

Example—What is the angle of the tool when the angle of the tooth equals 90 degrees and the ring is to have 60 teeth?

$$\text{Angle of tool} = 90 - \frac{360}{60} = 90 - 6 = 84 \text{ degrees}$$

NUMBERING DRAWINGS

J. W.—What is the best method of numbering drawings of jigs, tools, etc., and to what extent are symbols used to indicate classification?

A.—There is more or less difference of opinion regarding this matter and the exact method depends to some extent upon the conditions existing in various plants. In a plant building different types of machines, it is common practice to give each type a distinctive letter. For instance, "L" might represent lathe; "M," milling machine, etc. Following the letter, there is a number indicating the size of the machine. For instance, "L18" represents an 18-inch engine lathe. In order to identify the different parts of a machine, these parts are given serial numbers; thus, "L18-22" may represent the cone pulley of the lathe. This symbol would also be placed on the pattern in order to identify it.

Whether the part is made of steel or is a casting might be indicated by the size of the serial number. For instance, all castings might have numbers below 500, and all steel parts, numbers above 500. This idea has been carried a step further in some plants, especially where a single product is manufactured. For instance, one concern which manufactures an adding typewriter uses letters to indicate general sections of the typewriter or adding mechanism, and the number shows whether the part is a shaft, screw, collar, drop-forging, casting, punched part, spring, or a miscellaneous piece not belonging to the more common classes referred to. If "A" represents the accumulator mechanism, and if all parts between 10 and 29 represent some kind of stud, pin, or screw, the symbol for a screw of the accumulator mechanism would be composed of the letter "A" followed by some number between 10 and 29. This symbol is marked on the drawing and on any special tool that might be required.

A method commonly employed in numbering tool drawings, is to give each tool a serial number and combine this number with symbols representing the part the tool is used for and the machine to which the part belongs. For instance, if "L18-22" represents the cone pulley of an 18-inch engine lathe, the symbol "L18-22-55" might represent a special reamer used for this cone pulley.

CASEHARDENING STEEL

J. M. E.—What general equipment is required in casehardening machine steel with cyanide to obtain the bright colors usually found on firearms? What grade of machine steel is generally used? From whom can cyanide be obtained, and what is its present cost? Is cyanide explosive and, if so, under what conditions?

ANSWERED BY S. P. ROCKWELL, SYRACUSE, N. Y.

The use of cyanide to produce variegated colors on hardened steel is a simple process. The work is immersed in the bath, brought up to its hardening temperature, and then transferred to a water bath for quenching. While in the cyanide bath the steel is protected from the oxidizing effect of the air and it is also protected during its transfer to the quenching bath by a liquid film of cyanide which adheres to the steel and thus prevents the air from coming in contact with the work.

At the moment of quenching, the cyanide causes the quenching bath to become violently agitated as a result of the rapid transformation of small quantities of water to steam; this steam and the air drawn into the water by this agitation, partially oxidizes the steel in spots, giving the variegated colors, which are simply intensified tempering colors. The use of a cyanide pot for complete immersion of the work is more satisfactory than the method of sprinkling powdered cyanide on the work while it is being heated. Fair results can often be secured by the latter method, but more often the cyanide burns off and the steel is oxidized beyond the temper colors of, say, 650 degrees F. To increase the mosaic effect and obtain brighter colors, hardeners effectively employ either or both of the following methods: (1) Pass the hot steel through a water spray when transferring from the cyanide to the quenching bath. (2) Have a stream of air bubbling through the water in the quenching tank.

If the quenched work is removed from the quenching bath while warm and rubbed with oil, the colors will be brought out more perfectly. In order to obtain the best color results the steel should have a good initial polish. Blemishes such as rust, oxidation, finger prints, greases, etc., are liable to destroy perfect results. Cyanide furnaces are produced by a large number of furnace-makers and may be obtained at prices ranging from $100 to $500, depending upon the size of the furnace. However, furnaces which are suitable for this work can be constructed by the user for about one-half the cost of the commercial types. Cast-steel pots are, as a rule, most satisfactory and can be secured in standard patterns for twelve cents per pound.

Firearm manufacturers do not depend on cyanide alone for their color effects. They often desire a deeper hardening effect than can possibly be obtained with cyanide, and to meet such requirements they pack the cleaned steel in bone, charcoal, leather, or a combination of these materials. A small percentage of cyanide salts is added in some cases. Regular carburizing boxes are used as containers. These boxes are charged into a furnace maintained at 1400 to 1550 degrees F., and held there until the work has been carburized to the required depth. The boxes and contents are then brought close to the surface of the water in the quenching tank which usually has air bubbling up through it. From this position the pot is turned upside down, the steel falls into a screen basket in the tank and the packing material falls to the bottom from where it is later removed. Any steel will color if properly treated. The following gives the analysis of the steels commonly employed by gun-makers:

	Carbon, Per Cent	Manganese, Per Cent	Silicon, Per Cent	Sulphur, Per Cent	Phosphorus, Per Cent
Screw Stock ..	0.10-0.30	0.30-0.70	0.02-0.15	0.08	0.12
Gun Steel	0.15-0.25	0.50-0.90	0.02-0.15	0.06	0.06
C Steel	0.30-0.40	0.70-1.00	0.06-0.10	0.04	0.04
A Steel	0.45-0.55	0.45-0.75	0.15-0.25	0.04	0.035
Lock Steel	0.70-0.90	0.30-0.80	0.05-0.20	0.035	0.035
B Steel	0.95-1.10	0.25-0.40	0.15-0.20	0.019	0.022

The second, third, and fourth steels are forging steels; the fifth is used for parts which must be very hard and which must be subjected to shock; and the sixth is used for springs. The grade of steel used, of course, depends on the amount of strain, torsion, or shock which the finished article must withstand.

Cyanogen gas for commercial use is compounded with salts, the most common salts being those of sodium or potassium. Sodium cyanide has been used extensively during and since the war, as potassium cyanide could be secured only with difficulty. Sodium cyanide, however, can be procured from the Solvay Process Co., the Grasselli Chemical Co., or almost any chemical supply house. There are on the market a number of patent preparations supposed to be non-poisonous. These are, as a rule, simply diluted cyanide compounds. The diluted salts may be sodium chloride, potassium chloride, or barium chloride. These compounds give off less harmful gases but, on the other hand, do not ordinarily produce as good results in hardening or give the bright colors obtained by the use of commercial sodium or potassium cyanide. The former may be purchased in 100-pound lots for about 27 cents per pound at the present time.

Cyanide is not explosive. The contents of a cyanide pot will often be thrown out suddenly, due to water being forced beneath the surface by wet tongs or work. The steam which is suddenly evolved expands so rapidly that it throws out the cyanide. This will happen with any salt and with molten lead. Oil, however, will not have this effect, and for this reason it is usually best to dip the tongs or work into oil after having had them in water, or before immersing them in the cyanide.

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW AMERICAN METAL-WORKING MACHINERY

National Acme Three- and Four-inch Multiple Automatics. National Acme Co., Cleveland, Ohio..... 771
Ryerson-Conradson Radial Drilling Machine. Joseph T. Ryerson & Son, 16th and Rockwell Sts., Chicago, Ill..... 774
Betts-Bridgeford Geared-head Lathe. Betts Machine Co., Rochester, N. Y..... 775
Machine Products Co.'s Gear Quenching Machine. Machine Products Co., E. 179th St. and St. Clair Ave., Cleveland, Ohio..... 775
Hunter Improved Tooth Adjustment for Inserted-tooth Saw Blades. Hunter Saw & Machine Co., Pittsburg, Pa..... 776
Detroit Hexagon Drills. Detroit Hexagon Drill Co., 27-29 Woodward Ave., Detroit, Mich..... 776
Genesee Facing Tool. Genesee Mfg. Co., Rochester, N. Y.... 777
"Sterling" Saw for Motor Truck Tires and Rims. Diamond Saw & Stamping Works, 357-361 Seventh St., Buffalo, N. Y..... 777
Mummert-Dixon Radial Grinder. Mummert-Dixon Co., Hanover, Pa..... 777
Grand Rapids Tap Grinding Machine. Grand Rapids Grinding Machine Co., 29 Ottawa Ave. N. W., Grand Rapids, Mich..... 778
Atlas Arbor Presses. Atlas Press Co., 323 N. Park St., Kalamazoo, Mich..... 778
Peerless "Duplex" Hacksaw Blades. Peerless Machine Co., 1611 Racine St., Racine, Wis..... 779
O. R. Adams "Short Cut" Lathe. O. R. Adams Mfg. Co., Inc., Norton St., Rochester, N. Y..... 779
Lapointe Machine Tool Co.'s Duplex Broaching Machine. Lapointe Machine Tool Co., Hudson, Mass..... 780
Quick-action Drill Chuck. Superior Collet Chuck Co., Grand Rapids, Mich..... 780
Ryerson-Glader Wire Nail Machine. Joseph T. Ryerson & Son, 16th and Rockwell Sts., Chicago, Ill..... 781
Efficiency Pipe Wrench. Efficiency Device Corporation, 203 8th St., Long Island City, N. Y..... 781
Sebastian Engine Lathe. Sebastian Lathe Co., 154 Culvert St., Cincinnati, Ohio..... 782
Badger Grinding Machine. Badger Tool Co., Beloit, Wis.... 782
United Power Hammer for Pulverizing Pig Iron. United Hammer Co., Oliver Bldg., Boston, Mass..... 782
Greenfield Universal Grinding Machine. Greenfield Machine Co., Greenfield, Mass..... 782
Streine Forming and Roofing Press. Streine Tool & Mfg. Co., New Bremen, Ohio..... 783
Bicknell-Thomas Tapping Machine. Bicknell-Thomas Co., Greenfield, Mass..... 783
GTD Limit Screw Pitch Gage. Greenfield Tap & Die Corporation, Greenfield, Mass..... 784
Gammons-Holman Taper Pin Hole Reamer. Gammons-Holman Co., Manchester, Conn..... 784
Victor Collapsible Tap. Victor Tool Co., Inc., Waynesboro, Pa..... 784

National Acme Multiple Automatics

These 3- and 4-inch automatic screw machines have been designed along lines which provide for applying to the production of large sized work, the principle of completing all operations in the time of the longest cut. Although the general features of this company's previous machines have been retained in the design, many details were modified to provide for contingencies incident to the construction of larger machines; and to incorporate in an equipment of this size such features as convenience of operation, reduction of the consumption of power to a minimum, the application of safety devices, the simplification of design, and standardization of auxiliary apparatus.

TO meet the requirements of metal-working plants which manufacture parts that could be advantageously produced from bar stock on automatic screw machines, the National Acme Co., Cleveland, Ohio, has recently added to its line an "automatic" which is built in 3- and 4-inch sizes. This machine utilizes the multiple-spindle principle of construction which is familiar to the trade in machines of smaller capacity, and makes it possible to save time through completing all operations in the time of the longest cut. Aside from the necessity of providing increased strength incident to the construction of a larger sized machine, it was necessary for the designers to make a number of departures from the previous lines of construction followed by this company. Among these features of design attention is called to the standardization of auxiliary equipment for use on the machine, care which has been taken to assure convenience of operation, precautions taken to reduce the consumption

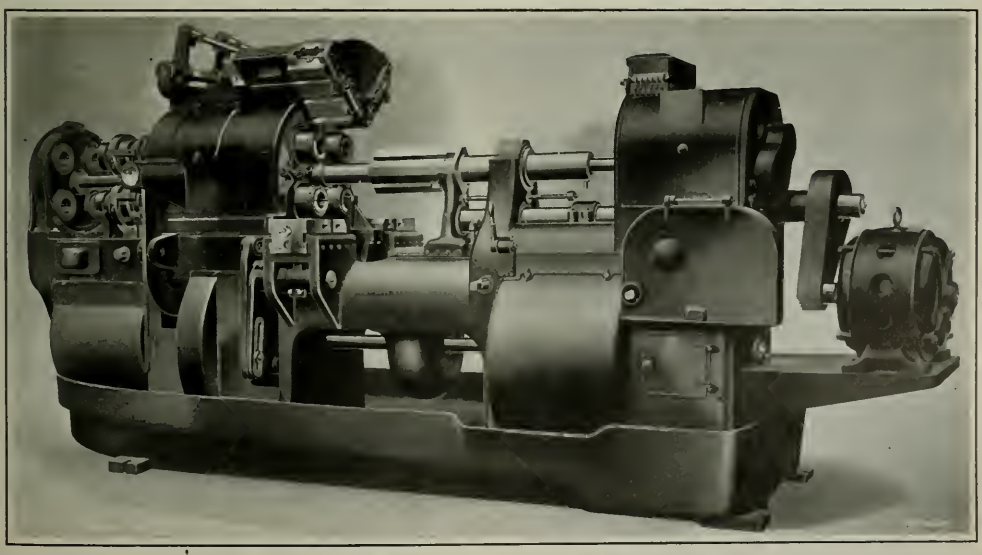


Fig. 1. General View of the National Acme Multiple-spindle Automatic Screw Machine which is built in 3- and 4-inch Capacities

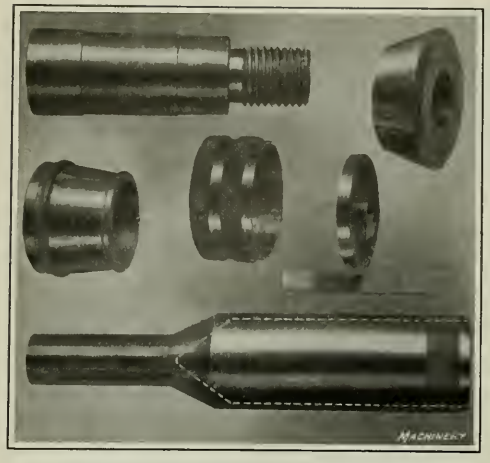


Fig. 2. Examples of Typical Work produced on National Acme Screw Machines of the Type shown in Fig. 1

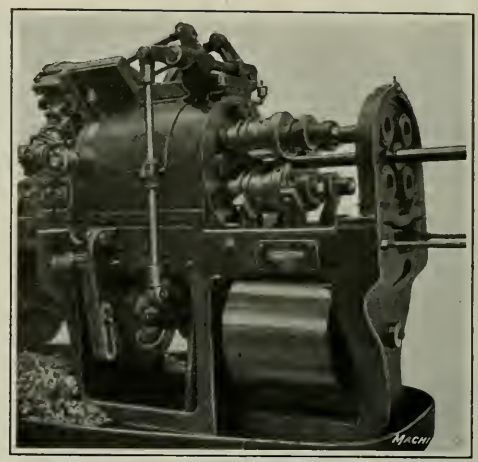


Fig. 3. Stock may be fed in either the First or Fourth Spindle Position by making a Simple Adjustment

of power as far as possible, the application of safety devices, and the simplification of design.

Noteworthy Features of Design

Attention is called to the following noteworthy details of design and construction: The pan is of unusual size and made with three strong ribs in the floor portion. Ample chip space is afforded by the open construction below the main tool turret; and the oval form of the center bed allows the chips to be quickly washed off into the pan. By placing the side operating mechanisms, forming tools, and cut-off under the cylinder, the chips are kept away from the working parts. All tools on the main tool-carrier are placed inside the circumference of the spindles, thereby providing for the use of tools of various sizes and shapes without interfering with each other or with the center turret extension. The tooling is placed at a convenient height for the operator, which greatly facilitates setting up or making adjustments. Lubricant is delivered to the tools through feed-pumps and tubing of ample size to provide a copious flow to each tool.

All gears, cams, drums, etc., are completely covered, and a safety device is applied directly to the worm-gear on the camshaft. It consists of shear pins connecting a disk keyed to the shaft with the worm-wheel, and these pins can be easily replaced when broken. Such a device prevents accidents resulting from improper timing due to errors in setting up the tools, or carelessness in operation. The starting clutch lever for the automatic feed is controlled from either side, and when thrown into the automatic feed, the hand crank is mechanically disengaged, thus avoiding any possibility of accidents. The main tool-carrier cams are supplied in accordance with the requirements of the work. The top slides are controlled by one cam on the main shaft and straight interchangeable cams placed directly behind the top slides. Both the 3- and 4-inch machines may be equipped for either belt or individual motor drive.

Main Tool-slide

Provision is made in the design of the end tool turret for rigidly supporting the tools as well as making them readily accessible while setting up. One end of the steel casting from which this part is made extends beyond the four-faced turret and enters a bearing at the center of the cylinder. The rear end is supported in a heavy bearing through an upright extension of the frame, which is cast integral with the bed. It is supported just back of the tools by an extension of the pusher-rod which controls the feed of the tool-carrier. This pusher is independent of the tool-carrier, being connected to the carrier by a pin at the top, and at the bottom it travels on a wide bearing plate on the frame. From the pusher-rod there is an extension with a roller for

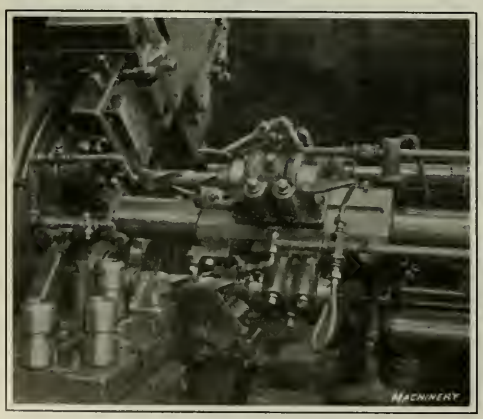


Fig. 4. Heavy-duty Drilling Operation with Oil-tube Drills, showing how the Tools are held on a Wide Bearing Surface of the Carrier

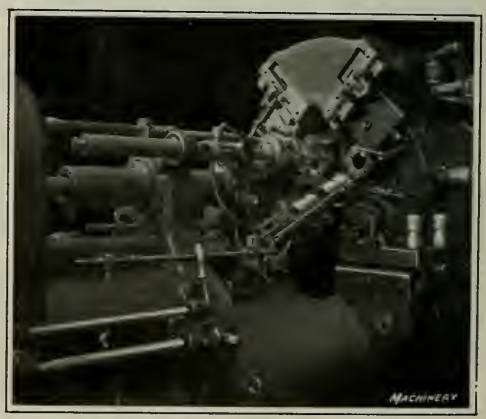


Fig. 5. Application of the Accelerated Reamer Attachment and Carriers for Heavy Work. This View also shows Top Slides

the lead cam, this extension being fastened to the pusher-rod which is supported at a 45-degree angle with respect to the lead cam, and its movement is against a hardened steel plate secured to the bed. The bearings receive no side thrust from the lead and take-back cams. This system of supporting the tool-carrier equalizes side thrust, so that heavy cuts and coarse feeds may be employed without affecting the accuracy of the product. The stop-rod between the pusher and the carrier is the main stop for accurately regulating the length of turret travel. This is controlled by nuts adjusted for different lead cams. Tool-holders with wide bearings are fastened against the four flat faces of the turret, and are supported directly beneath their cutting points with no overhang.

Arrangement of the Forming and Cut-off Slides

Both the forming and cut-off slide bearings are cast integral with the bed and designed to support the forming tool over its entire length and directly beneath the cutting pressure. Connection between the forming and cut-off levers and their slides is through a 2½-inch hexagonal shaft, which assures a positive feed to the slides without any tendency to spring. The slides are adjusted vertically by tapered gibs, and horizontally by straight gibs. Levers which control the feed of the cross-slides are furnished with slots, making them easily adjustable and requiring only a minimum change of cams for different feeds. Three cams are



Fig. 6. A Typical Set-up of Turning Tools; in this Illustration are also shown the Top Slides and Provision for forming

sufficient to cover all requirements. A forming stop, which consists of a bracket mounted on the slide in connection with adjustable studs located between each of the four spindles, provides a separate adjustment for each and constitutes an additional safeguard for the uniformity of the product. To facilitate quick, accurate adjustment for the depth of cut for the forming and cut-off tools, the screws are operated through the center of the slides independently of the tool-holders.

Construction of the Cylinder

In working out the cylinder design, features have been developed which are claimed to minimize wear and facilitate the making of adjustments. The cylinder casing has been made unusually strong, and in addition to being secured to the bed by heavy bolts, it is dovetailed to the bed. Two brass shoes are located independently on top of the cylinder casing, for both front and rear bushings, and they are adjusted by screws without any interference with the top slide. It should be borne in mind that this adjustment is made toward the center of the machine where the greatest strain is experienced. Compensation for end wear is accomplished by a take-up located on the rear of the cylinder and secured by adjustable brass shoes on the reel cross support and tightened to the cylinder. However, the cylinder does not depend wholly upon its bearing against the adjustable shoes to resist the end thrust, because the front of the cylinder is counterbored thus giving the bearing its entire periphery in the cylinder casing.

Design of the Spindles and Bearings

Both the front and rear spindle bearings are of the straight type, the material used being a special bronze composition, with end thrust bearings. Attention is called to the fact that the spindles are not affected by wear, because main bronze bearings are secured to the spindles and run in hardened steel bushings fitted to the cylinder. Moreover, the spindle gears are located centrally between the bearings instead of at the ends of the spindles, so that the pressure of the gears tends to equalize the action against the bearings on the spindles, at the same time affording rigid support by reason of the bearings being located further apart. The result of this construction is an easy rotative action, lower power consumption, higher speed, and easy replacement of both the spindle and cylinder bearings when they become worn.

Threading Spindle Mechanism

These Acme 3- and 4-inch automatics are not ordinarily equipped with a threading spindle, but provision is made for including it as part of the equipment. The die spindle is operated independently of the travel of the main tool-carrier, and is rotated at a speed slightly less than that of the stock spindles while the thread is being cut, but after-

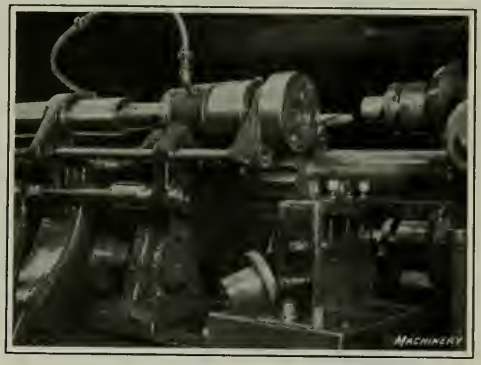


Fig. 7. Application of a "Namco" Self-opening Die on the National Acme Screw Machine for performing a Threading Operation

ward at a higher speed to run the die off the work. There are two cutting and two return speeds. A double gear is used to afford these two changes. Spindle speeds are varied by changing the double gears; and changes from left-hand to right-hand threads are accomplished merely by reversing the cams operating the friction. When button dies or taps are used, an extra holder is employed; but for opening dies or collapsing taps, only the regular equipment is required. No arrangement is made for stopping the die spindle to permit using special operation fixtures, as on smaller machines of this company's manufacture.

The Quick Turn-over

The turn-over of the stock-carrying cylinder is accomplished by a Geneva movement, which is quick and positive in operation and exerts a minimum strain on the parts. Locking of the cylinder in its four successive positions is done by a latch bolt on the forming side of the cylinder and a locking bolt on the cut-off side. This arrangement has been found most practicable, because the locking bolt naturally pulls the cylinder down, and with this system there is less competing pressure. Positive operation of the locking bolt is controlled by a spring directly in connection with the bolt, and by a cam and roller from the main camshaft, which affords a rigid locking action when heavy or exceptionally long bars are being machined.

Arrangement of the Top Slides

Operation of the top slides is accomplished by two straight and interchangeable cams, from which movement is transmitted through rods and levers arranged so that both slides can be adjusted by manipulating one interchangeable cam on the main camshaft. The top slides accommodate the same holders and tools that are used on the forming and cut-off slides, and the method of adjusting these slides by gibs is the same.

Stock Feed

Stock may be fed in either the first or fourth spindle position, according to the class of work in hand. The wedge levers for opening and closing the first and fourth position tubes are readapted merely by reversing the brass shoes. Movement of the stock stop is changed simply by shifting the cam-lever 30 degrees on the square end of the hexagonal shaft, and moving the cam backward to give the proper throw. The slide controlling the stock feed is independent, having its bearing on two rods between the casing and the

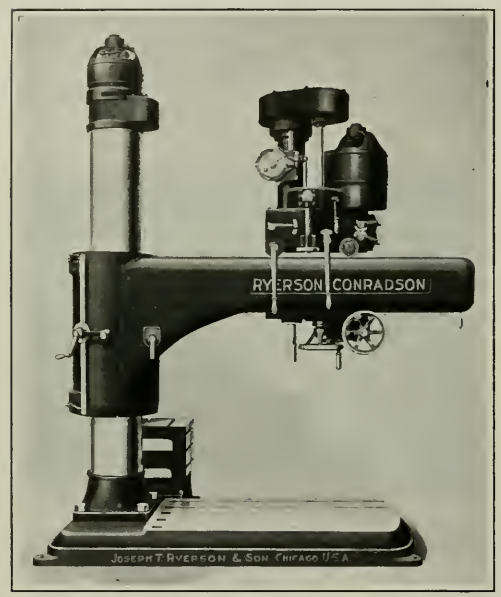


Fig. 1. Radial Drilling Machine built by the Conradson Machine Tool Co., for which Joseph T. Ryerson & Son have the Exclusive Sales Agency

end of the machine. It is equipped with double levers connected by rollers, and one of these rollers is changed in two positions for the 6-inch and 12-inch feeds. Intermediate rates of feed are secured simply by adjusting the collar on the stock pusher-rod.

RYERSON-CONRADSON RADIAL DRILLING MACHINE

Reference to the accompanying illustrations will make it apparent that in working out the design of a radial drilling machine which has recently been placed on the market by the Conradson Machine Tool Co., Green Bay, Wis., a marked departure has been made from established lines followed in the construction of this type of machine tool. This is a twin motor-driven, high-power machine, and it is stated that drilling, tapping, boring, and reaming operations can be performed on it with an equal degree of efficiency. Attention is called to the simplicity of the mechanism, there being only four shafts and sixteen gears.

Arrangement of the Head

The head is mounted on S K F ball bearings and travels on the top surface of the arm, where it is held in place by a plate guided by parallel vees on the under side of the arm. This plate serves various purposes, chief of which is to keep the head in perfect alignment with the arm. Cross traverse of the head is facilitated by having it carried on ball bearing rollers provided with eccentric shafts which furnish means of adjusting to compensate for wear. A reversible motor is mounted on the head and directly connected to the driving shaft by means of a self-aligning internally splined coupling. This driving shaft carries a pinion and gear, the pinion being cut integral with the shaft, and both run in mesh at all times with clutch gears of the conical friction type. The friction cones are mounted on a spacing rod and a movement up or down from the neutral position engages the high- or low-speed clutch gear. Four other gears are keyed to this clutch shaft and drive the spindle sleeve over change-gears on an auxiliary shaft.

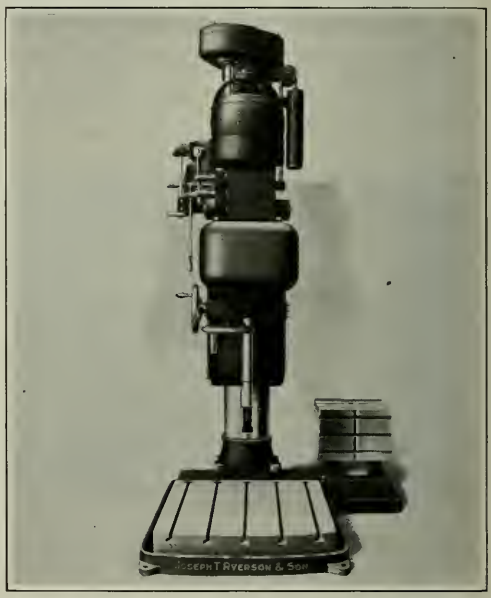


Fig. 2. End View of Ryerson-Conradson Radial Drilling Machine, illustrated in Fig. 1, showing Extension of Base and Box Table

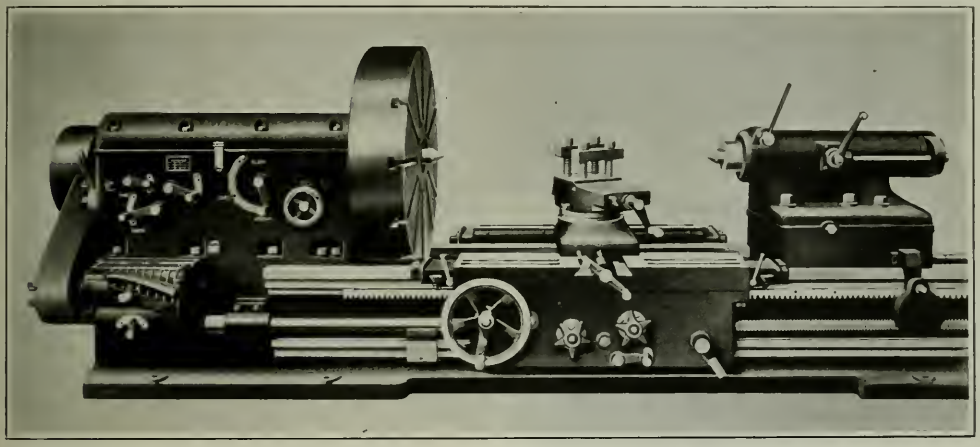
The auxiliary shaft is splined and the change-gears are shifted by two yokes which are actuated by interlocking levers, making it impossible to engage two sets of gears at the same time. Each end of the auxiliary shaft carries a pinion which is permanently in mesh with a bronze-bushed gear on the spindle sleeve. A jaw clutch engages one or the other and effects the drive. The spindle has two keyways cut over its entire length and is driven by two inserted keys in the sleeve. By shifting the levers, all of which are on the head, the operator engages the desired speeds. Sixteen speed changes are available, covering a range from 19 to 310 revolutions per minute, and arranged in geometrical progression. For tapping, the motor is reversed, this action being instantaneous and entirely without shock. The head is completely enclosed and all gears run in oil, a gage keeping the operator informed as to the oil level. All shafts run in S K F ball bearings.

Arrangement of the Feed and Elevating Mechanisms

Two series of eight feeds each are provided on this machine, covering a range of from 0.005 to 0.078 inch and from

0.023 to 0.370 inch per revolution, each series of changes being in practically geometrical progression. These changes of feed are secured by a cone of gears engaged by a driving key that is controlled by a feed indicating dial, and also by engaging in the upper or lower position a clutch controlled by a lever on the handwheel. All feeds are instantly disengaged by a friction clutch on the handwheel shaft, which is actuated by a lever conveniently located on the head. By the use of an automatic or adjustable stop, the feed is disengaged when the desired depth is reached. For raising and lowering the arm, an independent motor is mounted at the top of the column. A pinion is keyed directly to the armature shaft and drives a reducing gear on the elevating screw, the thrust of which is taken up by a ball bearing. This composes the entire elevating mechanism, and limit switches are provided to control the movement, these switches being equipped with a bracket carrying a roller that opens the circuit when struck by the sleeve of the arm. The arm revolves on ball bearings and is carried by a sleeve of exceptional length to which the elevating nut is attached.

Means are provided for clamping the arm securely to the column with equal pressure at the top and bottom. A pneumatic clamping device can be furnished if desired. The center of the spindle is arranged to travel on a radial line passing through the center of the column which is a hollow cast-iron cylinder bolted to the base. Surrounding the base there is a deep flange which serves the double purpose of stiffening the construction and serving as an oil retainer. Both the main driving and elevating motors are of the reversing type, and if the machine is ordered with complete electrical equipment, these motors are furnished to order. They are operated by a control apparatus consisting of reversing contactors, auxiliary units, two knife switches properly mounted in a steel cabinet, and two master control switches for any desired standard current or voltage. Radial drilling machines of this type are built in 4-, 5-, and 6-foot sizes. Joseph T. Ryerson & Son, 16th and Rockwell Sts., Chicago, Ill., have the exclusive sales agency for these machines.



Geared-head Lathe built in Swings from 32 to 48 Inches by the Betts Machine Co.

BETTS-BRIDGEFORD GEARED-HEAD LATHE

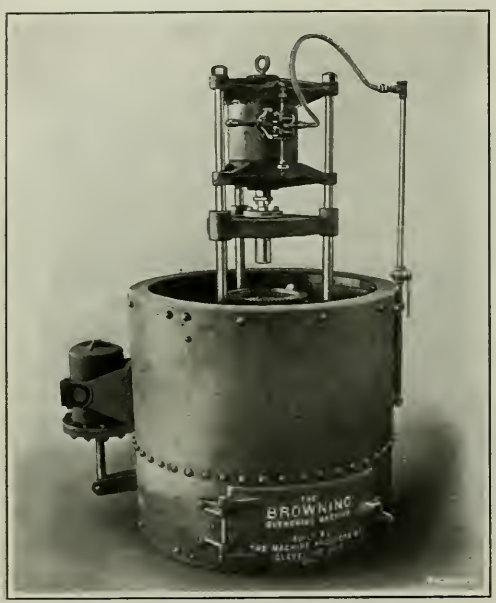
A new type of geared lathe head has been designed by the Betts Machine Co., Rochester, N. Y., and applied to the full line of heavy-duty engine lathes built by this firm in swings from 32 to 48 inches. This headstock is fully enclosed and operated by a powerful expanding ring friction clutch upon which the driving pulley is mounted. Provision is made for operating the clutch from the apron so that its control is always convenient for the operator. A single movement disengages the clutch and automatically applies a friction brake, thereby stopping the machine almost instantly. Nine changes of spindle speed are provided, three changes being obtained by direct drive, while two modifications of each of these speeds are secured through the gearing. These changes are instantly obtained and controlled by three conveniently located levers mounted at the front of the headstock. All speed changes are in geometrical progression and are secured through hardened steel gears and positive clutches running in oil, the edges of the gear teeth being rounded to provide for instant and easy engagement. There are twelve gears in the headstock, including the faceplate pinion and gear. An interlocking device is provided so that no two speeds can be engaged at the same time. Easy access to all of the parts is accomplished by having all of the shafts and gears located in the lower half or base of the headstock, so that the cover can be easily removed to make all of the mechanism accessible. All shaft bearings are bronze bushed, and lubricant is supplied to the bearings by a pump located in the headstock, which distributes oil to all of the bearings eliminating the possibility of any bearing running dry, it being merely necessary to keep the oil at the designated height. When the machine is motor-driven, the motor is mounted on top of the headstock cover and directly connected through gearing to the main driving shaft.

MACHINE PRODUCTS CO.'S GEAR QUENCHING MACHINE

To prevent gear blanks from warping while they are being hardened, the Machine Products Co., E. 179th St. and St. Clair Ave., Cleveland, Ohio, has developed the Browning quenching machine which is here illustrated and described. This apparatus consists of a cylindrical shaped tank in which a plate is secured about one-third of the way up from the bottom, the periphery of this plate being flanged upward and securely riveted to the cylindrical wall, with the seam calked to make it liquid-tight. The upper portion of the tank is filled with any quenching fluid such as water, brine, or oil; and the usual cooling and circulating system keeps the fluid at the desired temperature. At the center of the diaphragm plate there is fastened a casting furnished with three bearings for guiding the die-plates and clamping cylinder, with a bearing and stuffing-box through which a rod passes by means of which submerging of the work is accomplished. This rod is guided in such a way that it always travels in

a straight line, and it is connected at the lower end to a lever supported at the center by a rocking fulcrum, and at the opposite end to the piston-rod of the submerging cylinder.

Ready access to the stuffing-box and mechanism below the diaphragm is obtainable through a large door at the side of the tank. The submerging cylinder is 8 inches in diameter, and it has a stroke of 8 inches, the cylinder being supported by a trunnion casting fastened to the outside of the tank, and the air is supplied through one of the trunnions by a swivel joint which allows the cylinder to adjust itself to any necessary position. Two heads are clamped to opposite ends of the clamping cylinder by means of three long bolts which extend beyond the lower head and through the die-castings, thus furnishing a guide for the movable one and tie-rods for the fixed one, these bolts extending far enough to furnish guides for the whole outfit while being submerged.

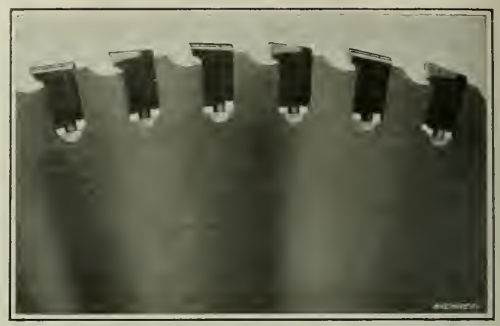


Browning Gear Quenching Machine built by the Machine Products Co.

Radial slots are provided in the dies for fastening the work to them, and also for allowing the quenching fluid to quickly reach all parts of the gear blank. The upper die-plate is movable and is fastened to the piston-rod of the clamping cylinder. A valve governs the operation, and it is conveniently located for the attendant. In its first position, this valve applies air to the submerging cylinder and raises the dies out of the quenching fluid; in the second position, it admits air to the clamping cylinder and raises the upper die; in the third position, it exhausts air from one end of the clamping cylinder and by applying air to the other it securely clamps the dies on the work; and in the fourth position, the valve exhausts air from the submerging cylinder and allows the dies and work to drop into the quenching fluid. This machine is entirely self-contained and requires no special foundation.

HUNTER IMPROVED TOOTH ADJUSTMENT FOR INSERTED-TOOTH SAW BLADES

A new arrangement for adjusting the teeth of inserted-tooth saw blades to the proper distance from the center has recently been developed by the Hunter Saw & Machine Co., Pittsburg, Pa. The high-speed steel teeth are supported by hex-head heat-treated steel screws and one-half round removable steel nuts embedded in the body of the saw blade. A milled tongue in the semicircular nut pocket, fitted into a groove in the nut, holds it firmly in place and prevents any side movement. The clearance hole drilled into the body of the saw blade at the bottom of each nut pocket is made just large enough for the screw and serves as a receptacle for that portion of the screw projecting through the nut when the saw tooth is set in its lowest position.



Improved Type of Tooth Adjustment used on Inserted-tooth Saw Blades made by the Hunter Saw & Machine Co.

An arrangement of this kind permits adjustment of one or more teeth independently of others; and as all teeth will not wear to an equal degree, it may become necessary at times to remove one or more teeth for regrinding. This may also be necessitated through breaking the cutting point of a tooth. In either case, the tooth must be readjusted to its proper relative position with other teeth carried by the saw blade. The screws and nuts are easily removed or replaced, if either should become damaged or worn through service. After setting to the proper height, the tooth is securely clamped in position by a grooved wedge or key made of hardened steel. It will be seen that alternate teeth of the saw blade have round and square noses, the round teeth being set slightly higher than the square ones to act as leaders. The bodies of these Hunter saw blades are made of tough, heat-treated steel to resist the most severe classes of service.

DETROIT HEXAGON DRILLS

For use in cutting square and hexagonal shaped holes, the Detroit Hexagon Drill Co., 27-29 Woodward Ave., Detroit, Mich., is making a line of tools, two types of which

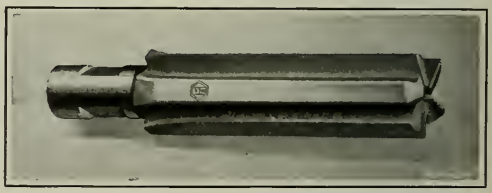


Fig. 1. Tool made by the Detroit Hexagon Drill Co. for boring Hexagonal Holes



Fig. 2. Tool made by the Detroit Hexagon Drill Co. for boring Square Holes

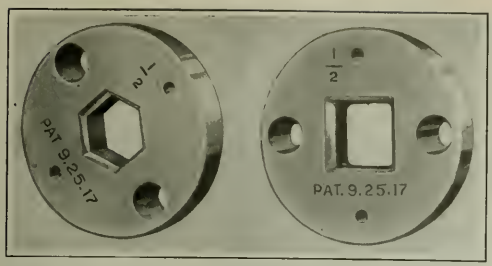


Fig. 3. Guides used with the Tools shown in Figs. 1 and 2 for boring Hexagonal and Square Holes

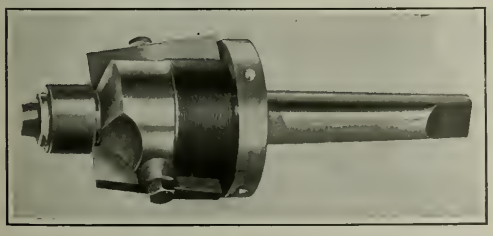
are shown in the accompanying illustrations, Figs. 1 and 2. Tools of this type can be used in various machines; for instance, they may be mounted in a drilling machine spindle where the tool revolves on a stationary piece of work, or the reverse condition may be successfully utilized, that is to say, mounting the tool stationary on a lathe or screw machine and revolving the work in contact with it.

As in the case of other tools of this general type, the principle of operation is to rotate the drill in a guide of the same shape as the hole to be cut. The drill is mounted in a special floating chuck which allows sufficient movement so that the cutting edges of the tool can generate the required shape of hole, the tool rotating successively on the heels of the lands to give the desired result. It is noteworthy that a drill of this kind only cuts with the edges at the front end of the tool, there being no cutting edges at the side. Drills of this type are adapted for speeds up to 350 revolutions per minute, depending upon the size of drill that is used and the kind of material in which it is working. Tools of this type have been successfully employed on steel, iron, brass, aluminum, micarta, bakelite, wood, marble, etc.

In most cases it will be found desirable when using tools of this type to first drill a round hole $\frac{1}{8}$ inch smaller than the finished size of the square or hexagonal hole. This removes most of the excess metal from the hole and allows the use of a higher drilling speed with less strain on the tool. The square or hexagon drill is then put in the floating chuck, and the operation is performed in exactly the same way as when drilling a round hole. The speed should be about the same as for round-hole drilling. The floating chuck is made with a standard Morse taper shank.

GENESEE FACING TOOL

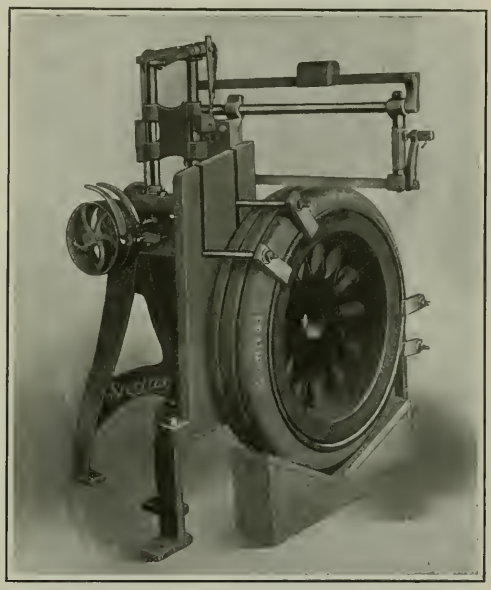
A combination tool has recently been developed by the Genesee Mfg. Co., Rochester, N. Y., which is adapted for the performance of counterboring, facing, forming, and similar operations. This tool is made of chrome-nickel steel, which is heat-treated to give it the best physical properties, and it is claimed that sharpening can be accomplished without requiring a special holder. Sufficient strength is provided to drive high-speed steel tool bits to the limit of its cutting capacity, and the tool-holder principle effects an economy in the use of steel. Tools of this type are made in Styles A and B, the Style A having two blades and the Style B three blades. With the exception of this difference in design, the dimensions are the same for both styles, which are made in four different sizes capable of facing diameters $1\frac{1}{4}$, $1\frac{5}{8}$, $2\frac{3}{8}$, and 3 inches, respectively. Either straight or tapered shanks can be furnished with all sizes of tools.



Combination Counterboring, Facing, and Forming Tool made by the Genesee Mfg. Co.

"STERLING" SAW FOR MOTOR TRUCK TIRES AND RIMS

To provide for cutting tires and rims off motor truck wheels, the Diamond Saw & Stamping Works, 357-361 Seventh St., Buffalo, N. Y., have recently developed the "Sterling" hacksaw machine which is here illustrated and described. It is stated that this machine will cut tires and rims from the largest truck wheels without causing any injury to the hub or spokes. Provision is made for using hacksaw blades from 17 to 25 inches in length, and 2 horsepower is sufficient to drive the machine. The arm that holds the saw blade is adjustable for different lengths according to the width of the tire. In operation, the truck wheel is simply rolled up to the large faceplate and clamped against it. A stop may be set before the cut is started, so that the blade will descend to the required depth, after which the feed movement is stopped, preventing any damage even though the machine is allowed to run indefinitely. Consequently, it is unnecessary to provide for constant attention, and it is also stated that unskilled workers can be employed to run a saw of this type. This hacksaw occupies a floor space of $5\frac{1}{2}$ feet wide by 2 feet 8 inches long, and it weighs 855 pounds.

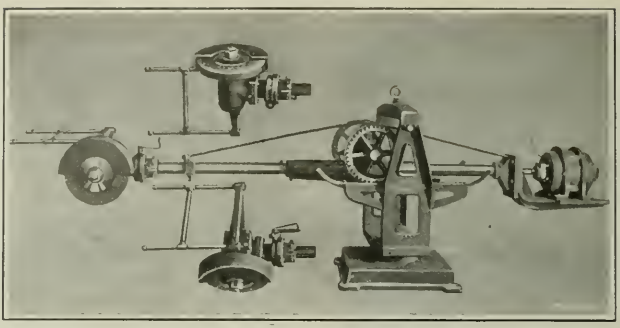


"Sterling" Hacksaw Machine built by the Diamond Saw & Stamping Works for cutting Motor Truck Tires and Rims

MUMMERT-DIXON RADIAL GRINDER

In the February, 1918, number of MACHINERY a description was published of the 8-inch portable radial grinding machine which was developed at that time by the Mummert-Dixon Co., Hanover, Pa. This firm has now added to its

line a 20-inch by 3-inch machine which is intended for the same class of service. General features of this grinder are similar to those of the machine formerly described. It is self-contained and the frame is mounted on a substantial base. A trunnion is connected with the frame and turns in the base, with the thrust supported on ball bearings so that radial movements are easily accomplished. The grinding head is fitted with heavy-duty ball bearings, and the trolley cross-shaft is also mounted on this type of bearing. By turning a crank handle and worm which engages a worm-wheel, the head may be turned through a complete circle and held at any angle. This feature relieves the operator from holding the wheel at the working angle, and the crank is located in a convenient position to be easily turned. The head and motor come to a horizontal poise when released by the operator, due to the weight being suspended beneath the center of the cross trolley shaft. When carrying this machine with a crane, the cross trolley is held in a central position on the frame track by a locking pin in the frame, which engages the teeth of one of the trolley wheels. No moving parts are exposed, all running members being enclosed except the lower half of the grinding wheel.



Radial Grinding Machine built by the Mummert-Dixon Co.

GRAND RAPIDS TAP GRINDING MACHINE

For use in grinding the taper at the end of a tap and the clearance back of its cutting edges, the Grand Rapids Grinding Machine Co., 29 Ottawa Ave., N. W., Grand Rapids, Mich., has recently developed a machine illustrated in connection with the following description. The taper may be long in the case of nut taps, short in plug taps and practically negligible in bottoming taps, but the principle remains the same in each case. It is necessary for each land to have exactly the same angle of taper with just enough clearance or backing off so that it will cut freely. Reference to the illustration will make it apparent that the tap is held inclined at an angle to the side of the grinding wheel to provide for obtaining the desired degree of taper, and an oscillatory movement may be imparted to the work-holder to provide for backing off the lands of the tap.



Grinder built by the Grand Rapids Grinding Machine Co. for Use in grinding the Taper at the End of a Tap and the Relief back of the Cutting Edges

It is claimed that with the Grand Rapids tap grinder any desired angle of entrance taper can be obtained at the point of the tap, and irrespective of the degree of this angle, all flutes will be ground the same regardless of whether there are as few as two, or as many as eight. Either right- or left-hand taps can be ground on this machine, and it is adapted for handling taps of all types with the possible exception of certain staybolt taps. The threads may be U. S. standard, vee, S. A. E., Acme, square, etc. Sufficient capacity is provided for taking taps from $\frac{3}{8}$ inch up to 3 inches in diameter, and it is merely necessary to mount the tap between centers, swing it to the proper grinding position against the movable stop and then oscillate the holder while the tap is in contact with the wheel. A spring tooth-rest provides for indexing from land to land, with the result that a tap can usually be ground in less than one-half the time that it would take to grind it by hand, if an attempt were made to secure a reasonable degree of accuracy.

ATLAS ARBOR PRESSES

In the accompanying illustrations there are shown two arbor presses which have recently been added to the line of machines built by the Atlas Press Co., 323 N. Park St., Kalamazoo, Mich. Fig. 2 illustrates a 15-ton power-driven arbor press, which is adapted for a variety of work, such as forcing arbors in and out of parts to be turned, for the performance of straightening and broaching operations, in assembling parts where forced fits are required, and for many similar purposes. In operating this press, the jaws are adjusted, the work set in place and the screw run down, after which power is applied by drawing down the lever and engaging a catch. As soon as power is applied to the work, the operator becomes sensible of a reaction on the lever which increases with an increase of pressure exerted on the work, and this enables him to "weigh the load," and to disengage the mechanism which applies power by releasing the lever. The rated capacity of this press is 30,000 pounds. It is often possible to accomplish light work by simply operating the handwheel, or on the power traverse machine this may be done by using the screw mechanism. Special bases may be

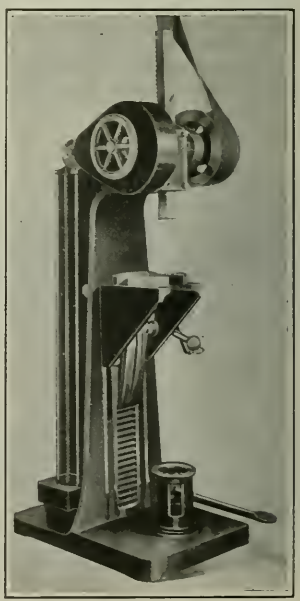


Fig. 1. Quick-acting 6-ton Arbor Press built by the Atlas Press Co.

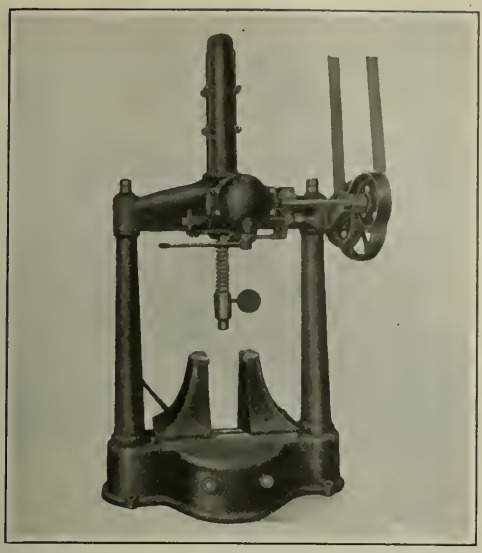


Fig. 2. Power-driven 15-ton Arbor Press built by the Atlas Press Co.

constructed to take care of different requirements and the length of the housings may also be increased.

Fig. 1 shows a quick-acting press for light production and assembly work, which is another recent product of the Atlas Press Co. It is operated by a foot-pedal which engages the friction clutch. All gears are cut with heavy stub teeth while the ram and pinion are made from steel which is heat-treated after machining. This press is always instantly accessible for use, being driven directly from the lineshaft, and pressure being applied by simply depressing the foot-pedal, or released by allowing the pedal to rise. A machine of this type may be used for various operations, such as forcing arbors in and out of parts to be turned, for straightening shafts, for the performance of light broaching operations and for assembling parts where forced fits are required. Should the work be of a delicate nature, a safety clutch is provided in the flywheel, and it may be adjusted by a small set-screw so that a very light pressure is applied, and pressure from this minimum up to the full capacity of the press which is approximately 12,000 pounds.

PEERLESS "DUPLEX" HACKSAW BLADES

While using a hand hacksaw on average work, a mechanic will usually start the cut by drawing the blade backward. This practice is said to dull the blade very rapidly, and it is to avoid this detrimental effect that some builders of hacksaw machines have provided mechanism to lift the saw clear of the work on its return stroke. It is also stated that there is a tendency for a hand hacksaw blade with teeth of the usual pitch to take a heavy bite while starting into the work. This tendency to take off too large a chip often results in "shelling" the teeth or breaking their points if the blade is not actually broken.

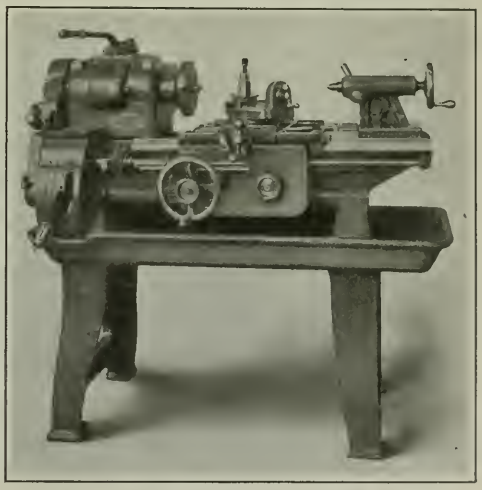


"Duplex" Hacksaw Blade manufactured by the Peerless Machine Co.

To overcome these defects the Peerless Machine Co., 1611 Racine St., Racine, Wis., has developed what is known as a "duplex" hacksaw blade with fine teeth at one end, which can be used for starting the cut. This arrangement effectively prevents the teeth from hogging into the work, and the cut is started easily and accurately. There is also said to be less tendency for the fine teeth to jump sidewise and start the cut inaccurately. Saw blades of this type are made in a combination 16 and 32 pitch in 10-inch and 12-inch lengths, of all hardened tungsten steel or carbon steel with a flexible back.

O. R. ADAMS "SHORT-CUT" LATHE

In the accompanying illustration there is shown one of the "Short-cut" lathes built by the O. R. Adams Mfg. Co., Inc., Norton St., Rochester, N. Y., which is equipped with a gear-box and power cross-feed. Six changes of speed are provided by gearing in the headstock, the range being from 43 to 375 revolutions per minute, and changes of speed can be made while the lathe is in operation. A two-speed starting lever makes it possible to vary the speed according to the diameter of the work, and when this lever is placed in a neutral position it applies a brake to the spindle. All of the gears are made of steel and run in a bath of oil. The spindle runs in adjustable tapered bronze bearings, and the thrust is taken on S K F self-aligning ball bearings.



"Short-Cut" Lathe built by the O. R. Adams Mfg. Co.

Four changes of feed ranging from 0.006 to 0.025 inch are provided by a tumbler type of feed-gear box, and by changing gears in a case at the end of the lathe a second series of feeds is available, ranging from 0.010 to 0.042 inch per revolution. The feed-gear case is assembled as a unit before mounting it on the lathe, and reverse gears are provided for changing the direction of feed. The cover over the gear-case at the end of the lathe remains closed by gravity. In designing the apron, the double-plate type of construction was employed which affords a double bearing for all shafts and studs.

Power longitudinal and cross feeds are provided through quick-acting frictions, and a multiple automatic stop for shoulder work, which is operated through clutches on the feed-shaft. On the carriage there is a lock for the cross-feed, which is conveniently located for the operator. The

cross-bridge is unusually wide and carries a cross-slide designed for either a compound or plain rest. Both the compound and cross-feed screws are graduated to 0.001 inch. Tools ⅝ by 1½ inches are used in the toolpost. A set-over type of tailstock is employed, and a taper attachment adapted for turning tapers up to 1½ inches per foot for the entire length between centers can be furnished as special equipment. When so desired, a front and rear toolpost, a back forming attachment, a draw-in chuck, or individual motor drive can be supplied.

LAPOINTE MACHINE TOOL CO.'S DUPLEX BROACHING MACHINE

A No. 3 duplex machine, which is shown in the accompanying illustration, has recently been added to the line of broaching machines built by the Lapointe Machine Tool Co., Hudson, Mass. It is adapted for use in factories where there are large quantities of work to be broached and where the conservation of floor space is important. As in the single machines of this company's manufacture, the operation is controlled through a patented clutch which affords a positive drive but is easy for the operator to manipulate. The actuating screws work entirely independently of each other, and they may operate separately or in unison, as required. Provision is made for regulating the stroke of either screw so that two different length broaches can be operated at the same time. Both screws are controlled by levers on the right-hand side of the machine, and the left-hand screw can also be independently controlled by a lever at the left-hand side. Either of two cutting speeds is provided by each screw, namely 49 and 74 inches per minute; and the return speed is 196 inches per minute. Thus little time is lost in waiting for the return of the screw.

All gearing is entirely enclosed, and the gears run in a bath of oil. An oil gage on the side of the machine shows the amount of oil in the gear-case. Large roller bearings support the end thrust of the nuts, thus reducing friction to a minimum. Brakes act on the clutches, eliminating any chance of the screws over-running on the return stroke, even while operated at a high rate of speed. The gears are always in motion and running in the same direction so that no additional power is required for stopping or starting. The draw-heads are made from steel billets and have long bearings on the ways of the machine, eliminating the possibility of chatter. These bearings are fitted with bronze shoes, which may be easily replaced when they become worn. A No. 4 B. & S. pump supplies a steady stream of lubricant to the machine while broaching, oil being drawn from a reservoir located in the front pedestal. Ball bearings support the single driving pulley, and if so desired the machine may be arranged for motor drive, the motor being mounted on a bracket at the side of the machine and transmitting power to a sprocket on the driving shaft by means of a silent chain. Sufficient capacity is provided on this machine for cutting, in steel, keyways up to 1½ inches wide, or for broaching square holes up to 3 inches across the flats from a drilled hole. The maximum stroke is 50 inches, and adjustment can be made to suit special requirements of the work. Allowing for the travel of the screw and broach, this machine occupies a floor space of 180 by 28 inches.

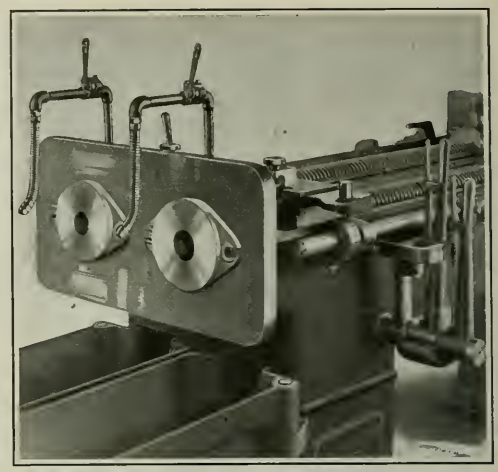


Fig. 2. Close-up View of the Operating Screws and Control Levers on Lapointe Duplex Broaching Machine

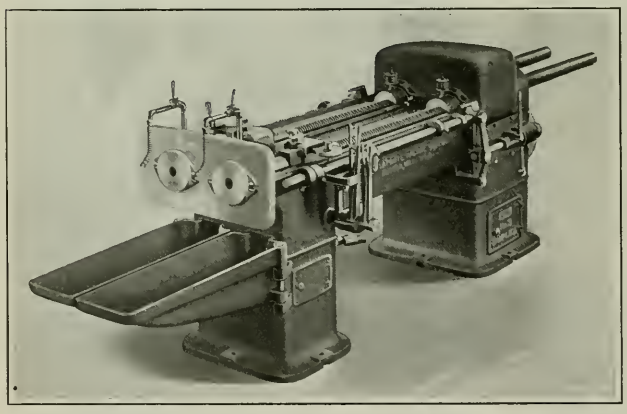


Fig. 1. No. 3 Duplex Broaching Machine built by the Lapointe Machine Tool Co.

QUICK-ACTION DRILL CHUCK

For use on drilling machines where it is required to use several different sizes of drills and other tools for the performance of successive operations on a piece of work, the Superior Collet Chuck Co., Grand Rapids, Mich., has developed a chuck shown in the accompanying illustration. It will be apparent from the illustration that this tool is arranged on the familiar principle of having a collet bored with a tapered hole on the inside to receive the shank of the tool, and furnished on the outside with means of engaging the driving pins or pawls with the collet. On the outside of the chuck body there is an engaging collar which is held in place by gravity and bears against the outer ends of the driving pins, thus holding them in engagement with the collet by which the tool is carried.

To change tools, the operator grasps the collar with his hand; and as this collar is free to rotate about the chuck body, he can lift it without having it turn in his hand. When this has been done, the tool and collet are withdrawn from the chuck and a fresh tool and collet pushed up into



Quick-change Drill Chuck made by the Superior Collet Chuck Co.

place, after which the collar is allowed to drop. An annular projection running around the inside of the collar comes in engagement with the outer ends of the driving pins, forcing them inward through the openings of the chuck body and into engagement with the tool-carrying collet, thus effecting the double purpose of holding this collet in place and affording a driving connection between it and the body of the chuck. In using a chuck of this kind, it is customary to have separate collets for each of the different tools which are used in sequence, so that the time lost in changing tools is reduced to a minimum.

RYERSON-GLADER WIRE NAIL MACHINE

In working out the design of the Ryerson-Glader wire nail machines which have recently been added to the line of machinery for which Joseph T. Ryerson & Son, 16th and Rockwell Sts., Chicago, Ill., are acting as sales agents, the provision of means for rapid operation and the accessibility of all parts for adjustment were regarded as highly important considerations. All members which are subject to severe strain or wear are made of steel and liberally proportioned, and the most important adjustments can be made on this machine while it is in operation. In operation, wire is taken automatically from a bundle or coil and fed between straightening rolls into the gripping dies. The wire is gripped and the head of the nail is formed with one blow of the heading hammer. As this hammer recedes, the straightener carriage moves forward through a distance equal to the length of the nail, and the wire is again gripped while the point cutting dies clip the wire off, making the point at the same time and leaving enough wire outside of the gripping dies to form the head of the next nail. In moving forward once more, the heading hammer operates an ejector which removes the finished nail from the machine. The wire is straightened by rolls moving back over the wire, while it is being held in the gripping dies, and by this method the machine is able to produce absolutely straight nails. To insure smoothness of operation, the crankshaft is counterbalanced to compensate for the thrust of the header crosshead, which is an important feature in high-speed work, as it practically eliminates vibration in the machine and in this way assures long life for the working parts. Equipment furnished with the Ryerson-Glader wire nail making machines consists of one pair of gripping dies for the largest size of wire nail to be produced by the machine and two pairs of point cutting dies. These point cutters can be used on all sizes of wire within the range of the machine, but the gripping dies have to be renewed for each change in the size of wire. No change of the gripping dies or point cutters is necessary in changing the length of nails to be produced.

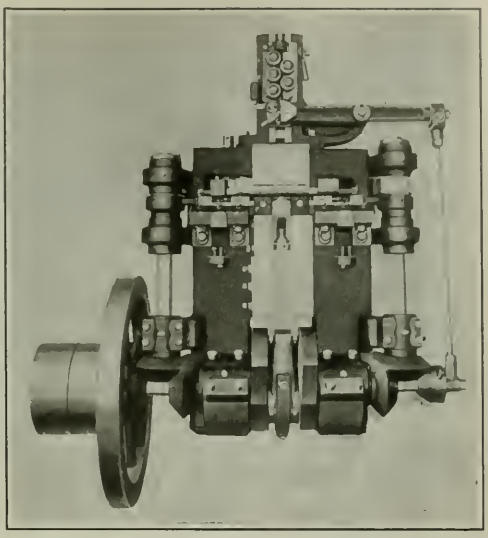


Fig. 2. Plan View of the Ryerson-Glader Wire Nail Machine

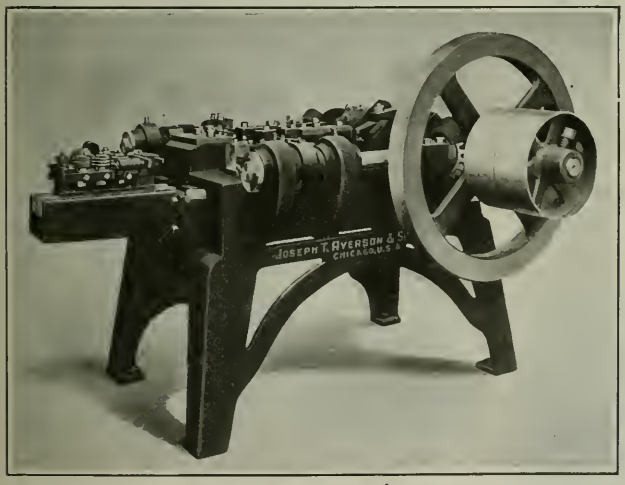


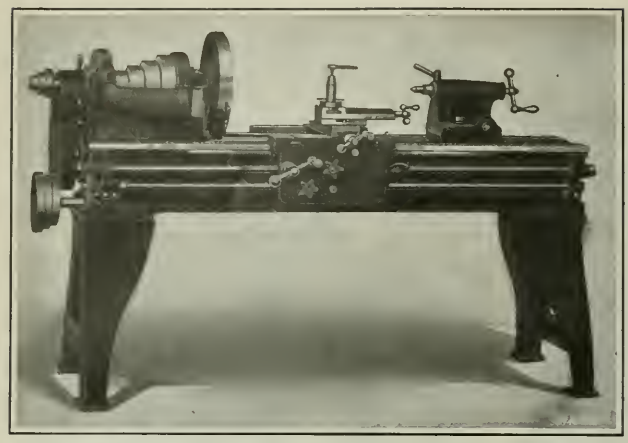
Fig. 1. Ryerson-Glader Wire Nail Machine for which Joseph T. Ryerson & Son have the Sales Agency

EFFICIENCY PIPE WRENCH

In the accompanying illustration there is shown a pipe wrench recently developed by the Efficiency Device Corporation, 203 8th St., Long Island City, N. Y. To prepare for using this tool, the jaws are hooked over the pipe and the wrench is pulled toward the operator, thus automatically opening the jaws and allowing them to pass over the pipe and close down to the working position by spring action. To remove the wrench, the operator pulls the handle toward him until the jaws open sufficiently to allow the wrench to be tipped sidewise, thus disengaging it from the pipe. This wrench is always ready for use on any size of pipe within its capacity without requiring any adjustments to be made. Attention is called to the fact that both the hook jaws and the surface of the cam are smooth, making this wrench desirable for use on smooth or finished pipe. These wrenches are made in two sizes, Nos. 10 and 11, with capacities for from ⅛- to ¾-inch, and from 1- to 1½-inch pipe and coupling, respectively.



Pipe Wrench made by the Efficiency Device Corporation



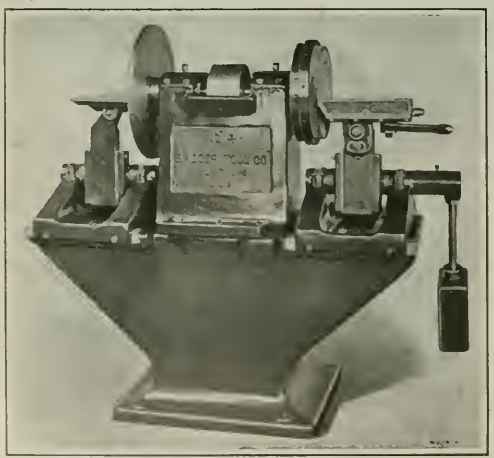
Engine Lathe built by the Sebastian Lathe Co. with a Semi-enclosed Type of Head

SEBASTIAN ENGINE LATHE

The Sebastian Lathe Co., 154 Culvert St., Cincinnati, Ohio, has recently modified the design of its engine lathe, one of the improved machines being shown in the accompanying illustration. The principal change from the preceding construction is in the headstock, which is made of the semi-enclosed type, affording greater rigidity than was attained with the previous design. Other features claimed for the improved Sebastian lathe are that there is not any strain or give between the two journals, because the headstock is so constructed that it ties these two members together. There are other minor changes, such as an improved design of the operating handles and in the construction of the apron, etc.

BADGER GRINDING MACHINE

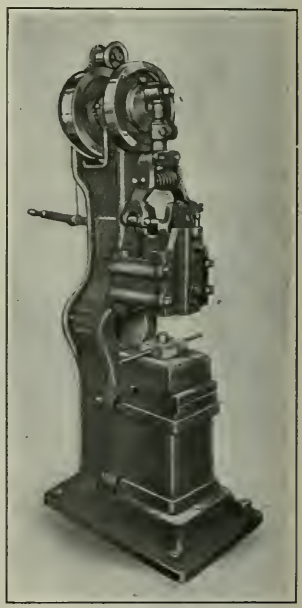
The accompanying illustration shows a No. 4 combination disk and ring wheel grinding machine which is a recent product of the Badger Tool Co., Beloit, Wis. This machine is of quite similar design to the No. 6 grinder of this company's manufacture which was mentioned in the September, 1919, number of MACHINERY. The present machine is adapted for disk wheels up to 18 inches in diameter, and the chuck capacity is for ring wheels 14 inches in diameter. The spindle is 2 inches in diameter and it is driven by a pulley measuring 7½ inches in diameter by 4¼ inches face width. It is mounted in combination radial and thrust ball bearings. The complete weight of the machine, countershaft and disk wheel press is 2300 pounds. It will be noticed that the grinder here illustrated is equipped with one disk wheel and one ring wheel, with a lever-feed table at the right- and a plain table at the left-hand side of the machine. Dust hoods can be furnished for dry grinding, or guards and pump connections for wet grinding.



No. 4 Combination Disk and Ring Wheel Grinder manufactured by the Badger Tool Co.

UNITED POWER HAMMER FOR PULVERIZING PIG IRON

In the accompanying illustration there is shown one of the Fairbanks power hammers built by the United Hammer Co., Oliver Bldg., Boston, Mass., which is equipped with a pulverizer designed for the use of chemical laboratories for preparing pig iron samples for analysis. It is claimed that this equipment is the means of saving a great deal of time and labor, as it is able to reduce ½- to ¾-inch cubes of metal in two or three minutes, producing particles that are fine enough to pass through an eighty-mesh sieve. A machine of this type may be equipped for belt drive or for motor drive. It is provided with a 100-pound ram and a 2-inch pestle and mortar. Operation is controlled by a foot-treadle at the base or by a special hand-operated starting device, either of which affords perfect control at all times. The capacity is for striking a blow of approximately 600 pounds while running at 300 revolutions per minute.



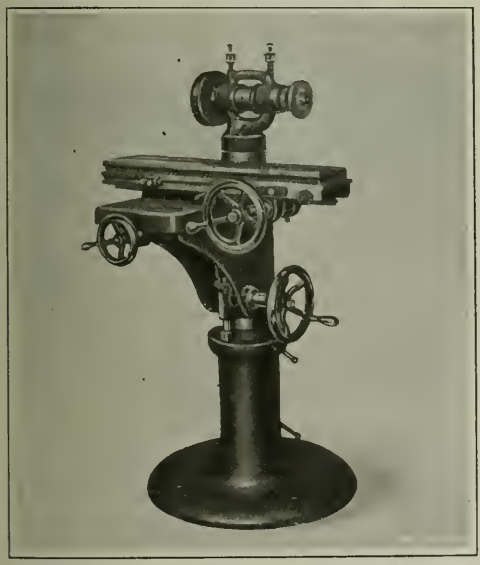
Fairbanks Power Hammer for pulverizing Pig Iron

GREENFIELD UNIVERSAL GRINDING MACHINE

In the accompanying illustration there is shown a No. 2 universal grinding machine which is a recent product of the Greenfield Machine Co., Greenfield, Mass. This grinder is adapted for all kinds of cutter, reamer, and tool grinding in addition to various cylindrical, internal, and surface grinding operations which come within its capacity. It is claimed to be a fully universal machine. The standard is a separate casting from the base on which it swivels, and the knee is splined to the standard so that these two members turn together and carry the slides with them. By tightening the two lower clamps, a positive vertical feed is obtained; and for the further convenience of the operator, the

sleeve of the elevating handwheel is provided with graduations reading to 0.001 inch. The head swivels on top of the standard and is provided with witness marks at 90-degree intervals. Special attention is called to the design of this new head, which is cast in a single piece with a tie-bar across the top. It is also provided with tapered bronze boxes having means of adjustment for wear.

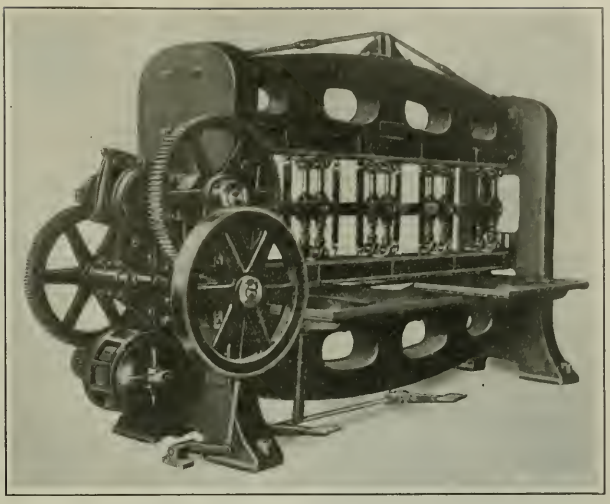
A tapered hole in each end of the spindle receives the wheel-holders, the spindle being ground and supported in bronze bearings which are protected from dust. Provision is made for end adjustment of the spindle bearings. The grinding wheels are held on tapered centers which are accurately ground, so that they may be removed from the spindle and replaced without difficulty in having the wheels run true. A full-length bearing is provided for the table on the longitudinal slide upon which it swivels; and there is a screw adjustment for accurately aligning the centers. Graduations are provided at the right-hand end so that settings may be made for taper turning operations. The graduations indicate tapers in intervals of ⅛ inch per foot. Longitudinal movement is secured by a rack and pinion, and cross movement by a feed-screw which is graduated to 0.001 inch. A wide range of attachments is provided for this machine to adapt it for performing various grinding operations.



No. 2 Universal Grinding Machine built by the Greenfield Machine Co.

STREINE FORMING AND ROOFING PRESS

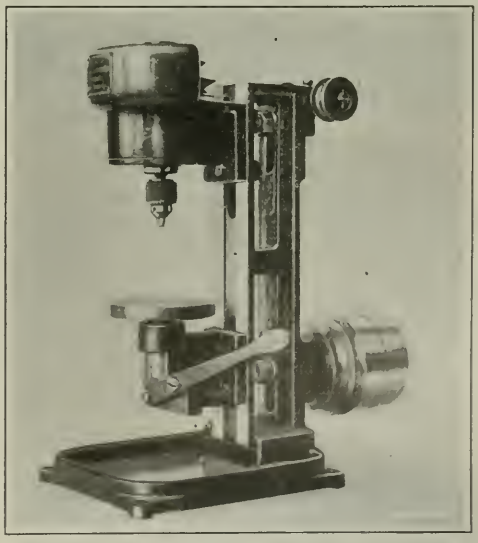
The Streine Tool & Mfg. Co., New Bremen, Ohio, has recently added to its line a toggle type of forming and roofing press which is here illustrated and described. This machine is made in 8-, 10-, and 12-foot sizes, for handling up to 10-gage stock, and in the same sizes for handling stock up to 16 gage. It is adapted for making all kinds of roofing and special shapes in any length up to the full capacity of the press, and ample die space is provided so that a wide range of work may be handled. There are four removable wooden tables supplied with gages on both sides of the machine, making it possible to use two kinds of dies at a single operation. The dies can be removed from either the side or end of the machine, as they are located by means of a tongue and groove arrangement which assures alignment. Both the forming bar and hold-down bar are well balanced with springs, and the toggles and shoes are accurately finished, allowing the machine to work very smoothly, the attainment of this result being furthered by the use of machine-cut gears and a positive clutch. The eccentrics are made of steel and keyed to the eccentric shaft. They are liberally proportioned with a wide face and ample bearing surface. A box type of cam is keyed to the eccentric shaft, making it possible to use a die under the hold-down bar for the forming of light gages of metal.



Forming and Roofing Press built by the Streine Tool & Mfg. Co.

BICKNELL-THOMAS TAPPING MACHINE

The Bicknell-Thomas Co., Greenfield, Mass., has added to its line a vertical tapping machine for bench use, which has

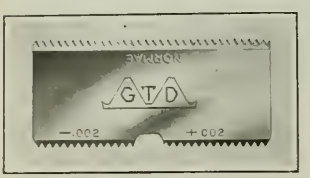


Vertical Tapping Machine built by the Bicknell-Thomas Co. for Use on the Bench

capacity for taps up to 3/16 inch in diameter. This machine is furnished with a sensitive friction driving mechanism that enables the operator to tap to the bottom of a hole without danger of breaking the tap. Driving power is furnished by a two-step cone pulley carrying a ⅜-inch round belt, and tight and loose pulleys for any desired speed. The spindle has a reverse speed of twice the forward tapping speed, and the work-table is easily operated by a lever. If so desired, the work-table can be removed and a special work-holding fixture substituted in its place. This machine is 15 inches high and weighs 48 pounds.

GTD LIMIT SCREW PITCH GAGE

The GTD limit screw pitch gage is a new development wherein the Greenfield Tap & Die Corporation, Greenfield, Mass., has taken the handy screw pitch gage, which has no tolerance but was cut to a normal lead only, and has made it more serviceable by providing two additional surfaces on the reverse side, one of which is cut with a lead 0.002 long and the other 0.002 short per inch, which converts it into a limit gage. When the old style of gage was laid in the thread of a screw, it was only possible to tell whether the lead on the screw was normal, but it was not possible to tell how bad the error was. With the new style of gage, if it is found that the thread tested is not normal, one can readily detect whether it is longer or shorter than the limit portion of the gage or whether the error is in between these limits. These gages are made for the present to control lead limits of plus and minus 0.002 per inch, which is the most generally used lead limit. Eventually it is also intended to supply them with tolerances of 0.001, 0.003 and 0.004 long and short lead.

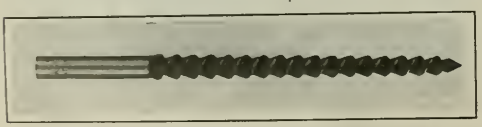


Limit Screw Pitch Gage made by the Greenfield Tap & Die Corporation

As these new limit screw pitch gages are solid and without moving parts, it is claimed that they are not likely to easily get out of order, and are in some ways preferable to flexible types of lead indicators. When using gages of this type, it is essential for the work being tested, as well as the gage, to be clean in the threads and for the gage to be held in the screw in a position parallel to the axis of the screw. In testing the thread with this gage, the work should be held up to the eye in front of a rather bright light, so that any error in lead can easily be noticed.

GAMMONS-HOLMAN TAPER-PIN HOLE REAMER

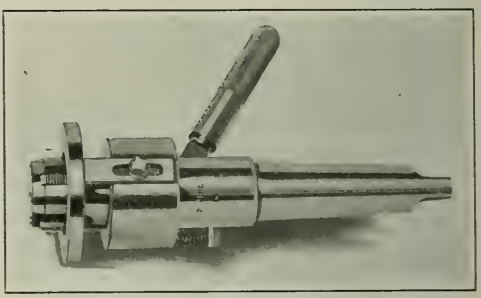
For use in reaming holes to receive standard tapered pins, the Gammons-Holman Co., Manchester, Conn., has recently placed on the market a tool known as the Gammons reamer, which is here illustrated and described. It will ream holes in any metal, and is claimed to be able to perform such operations with rapidity and accuracy. This tool is adapted for use in a vertical-drilling machine or in a portable electric or pneumatic drill, and it may be run at any reasonable speed and feed. This reamer is also said to be useful for certain classes of diemaking. For such work a number of holes are drilled close together, and by enlarging holes with the reamer the intervening metal can be removed, thus producing an opening of any desired shape and providing the proper degree of clearance at a single operation. The standard degree of taper is ¼ inch per foot, but special reamers will be made with any required taper.



Taper-pin Hole Reamer made by the Gammons-Holman Co.

VICTOR COLLAPSIBLE TAP

The Victor Tool Co., Inc., Waynesboro, Pa., has recently placed on the market a collapsible taper-cutting pipe tap. Instead of using tapered chasers for securing the correct taper of the pipe thread, short straight chasers are employed, which automatically recede as they advance into the work. A correct taper is given to the thread by means of cams which regulate the receding of the chasers, so that instead of the entire length of the chasers cutting as it would be necessary for them to do if the job were done with a solid tap, the cutting strain can be taken up by a few threads only, as in cutting straight threads. As a result, no more power is required to cut a tapered thread than would be absorbed in tapping a straight hole. It is stated that this has proved an important factor on some difficult jobs where a considerable amount of power is ordinarily required for tapping tapered holes. This tap is said to have given exceptionally good results in tapping tough steel flanges. Taps of this style are made in any size from 2 to 12 inches.



Collapsible Taper-cutting Pipe Tap made by the Victor Tool Co.

DAVENPORT-SLOCOMB DIRECT-READING MICROMETER

On pages 678 and 679 of the March number of MACHINERY, a description was published of the direct-reading micrometer recently placed on the market by J. T. Slocomb Co., Providence, R. I. In this article a statement was made that the micrometer is equipped with a counting device which permits direct reading of every thousandth from 0 to 0.999 inch. The manufacturers of this tool desire to call attention to the fact that the counting mechanism used for this purpose is of a standard design which has been successfully used in various classes of service for many years. Although direct-reading micrometers are a new product of the J. T. Slocomb Co., instruments of this kind have been made by other manufacturers for several years. The feature of novelty on the new Slocomb direct-reading micrometer is the application of a counting mechanism of standard design for indicating the dimension of the work.

We have been informed by the Nielsen-Barton Chuck Co., 106 S. Jefferson St., Chicago, Ill., that the chuck illustrated on page 582 of the February number of MACHINERY under the name of the Barton drill chuck, was developed by the Nielsen-Barton Chuck Co. and not by the H. E. Barton Tool Co., as stated. The error was due to the fact that the description was sent us by the H. E. Barton Tool Co. and hence the tool was credited to them.

NEW MACHINERY AND TOOLS NOTES

Lathe Center: Senn Tool & Machine Co., 90 Shelby St., Detroit, Mich. A lathe or grinding machine center having interchangeable center points of heat-treated high-speed steel held in a body of carburized machine steel.

Drawing Pen: Bourquin & Co., 1345 Main St., Waltham, Mass. A drawing pen consisting of a swivel socket held in an ordinary pen-holder and supplied with interchangeable tubular pens varying in size from 0.012 to 0.090 inch.

Brake Attachment for Cowan Transveyors: Cowan Truck Co., 16 Water St., Holyoke, Mass. A "Raybestos" lined brake for application on transveyors of this company's manufacture, which can be operated by pressing down on the transveyor tongue.

Self-clamping Lathe Dog: Fraser-Duplex Mfg. Co., 1224 W. 6th St., Cleveland, Ohio. A lathe or grinding machine dog having two jaws supported on two posts. A tail or driver is fitted in the upper jaw which has an eccentric clamping lever for gripping the work.

Electrically Driven Coolant Pump: Fulflo Pump Co., Blanchester, Ohio. An electrically driven pump for use on machines equipped with the drainage systems of this company's manufacture. It can be attached as a unit at almost any convenient place, the current being supplied by attaching the motor cord to a lamp socket.

File Handle: Thurston-Bernay Co., Rialto Bldg., San Francisco, Cal. A line of file handles known as the "Skroo-Zon," made in nine sizes suitable for files from 2 to 16 inches long. As the name implies, the handles are screwed on, suitable threads being cut during the process by two dies contained in a pocket in the handle.

Shaft Coupling: Cincinnati Ball Crank Co., Cincinnati, Ohio. A compression type shaft coupling consisting of five parts, which can be used to connect shafts of various sizes by the use of interchangeable bushing strips. A desirable feature of this coupling is that it requires only the use of a hammer when installing or removing the coupling.

Foundryman's Torch: Mahr Mfg. Co., Minneapolis, Minn. A foundryman's torch for use in drying the skin of molds, which will project a blue flame of intense heat any distance from a few inches up to 5 feet. The torch operates equally satisfactorily on light fuel oil or kerosene, air pressure being supplied by means of a hose connection from any available source.

Semi-automatic Drilling Jig: Automatic Drill Tool Co., 549 W. Washington Blvd., Chicago, Ill. A drill jig for sensitive drilling machines known as the "Adjusto," that will hold and automatically eject, when the drilling operation is completed, round parts up to 1 inch in diameter, or odd-shaped pieces of equivalent size which do not require holes larger than 7/32 inch.

Lock Washer: Klingtite Mfg. Co., 37 Liberty St., New York City. A line of bell-shaped nut-locking washers known as "Klingtite," made in standard sizes from 3/16 to 1½ inches. The locking feature is obtained by first tightening the nut, then placing the washer over the projecting end of the screw and employing a sharp piece of pipe and a hammer to flatten it down against the nut.

Open-side Planing Machine: F. R. Patch Mfg. Co., Rutland, Vt. A 48-inch open-side planer, having a table 15 feet 6 inches long, a bed 23 feet 4 inches long, and a maximum height under the rail of 50 inches, with a vertical feed of 9 inches. A double-deck box type table is used, which is provided with T-slots and stake holes in the top deck only, and with openings at the sides for removing chips. The driving gears of the machine are entirely enclosed and run in a bath of oil.

Alligator Shears: Doelger & Kirsten, Milwaukee, Wis. A new line of automatic-stop alligator shears, designed to cut material on a bevel and supplied with special dies to suit the customer's requirements. Dies for cutting cold-rolled round, square, hexagon, flat, or bars of other shapes at right angles can also be supplied. A foot-lever controls the operation of the shears which are manufactured in sizes suitable for cutting material ranging from 1 to 5½ inches in diameter.

Gasoline Tractor for Industrial Plants: Towmotor Co., Bliss Road, Cleveland, Ohio. A gasoline tractor designed for use in industrial plants, equipped with a four-cylinder motor and provided with three speeds forward and one reverse, giving a speed of from 1 to 15 miles per hour. The wheel-base is 60 inches; length over-all, 90 inches; tread, 44 inches; width over-all, 52 inches; weight, 3200 pounds; and turning radius, 10 feet. The pulling capacity of the tractor under average conditions is sufficient to handle a load of from 10 to 15 tons.

Friction-head Screw Machine: Millholland Machine Co., Indianapolis, Ind. A No. 2 friction-head screw machine, which closely follows the lines of the other sizes made by this company. The swing over the bed is 14 inches, and over the cut-off 7 inches. The capacity of the automatic chuck for square stock is 11/16 inch, for hexagon stock ¾ inch, and for round stock 1 inch. The hole through the spindle is 1 9/32 inches, the number of spindle speeds three, and the number of feeds obtained through the selective-speed gear-box, nine.

Trailer Truck: Warren & Irrgang Co., Springfield, Mass. Three sizes of trailer trucks of 2-, 3-, and 4-ton capacity, respectively. The 30- by 72-inch size has 12- by 3-inch wheels and will turn in a 4-foot circle. The 40- by 120-inch size will turn in a 6-foot circle and is equipped with 14- by 3-inch wheels. The trucks are designed for use in narrow aisles and for turning sharp corners, all four wheels being used in steering. They can be towed from either end, and are suitable for transporting heavy and bulky materials over rough floors and pavements.

Ship Bottom Riveting Rig: Liberty Tool Co., Munsey Bldg., Baltimore, Md. A supporting rig for a pneumatic riveter designed for use in riveting the bottom of a ship. The accessory is attached to the bottom of the ship by a single bolt, and consists of a round radius arm, supported at two points on convex rollers mounted in cross-heads, which may be adjusted up or down by crank handles at the ends of the brackets. The pneumatic riveter, supported by the radius arm, can be applied in any direction within a 20-foot circle. With this arrangement the operator is not required to support the tool, and can therefore maintain greater speed in riveting.

Internal Grinding Machine: Heald Machine Co., Worcester, Mass. A regular No. 70 internal grinding machine of this company's manufacture in which several improvements have been made, the most important of which is the incorporation of the friction clutch in the work-head, with the work driving pulley revolving on the spindle instead of being keyed to it. This feature not only enables the operator to start and stop the work more readily, but also facilitates the installation of these machines in the shop. The right-hand end of the ways has also been lengthened 4 inches. The wheel guard has been redesigned to give the operator better protection, and the handwheel for operating the table has been increased in diameter to give greater leverage.

Horizontal Boring Machines: Moline Machinery Co., Moline, Ill. Two horizontal boring machines especially adapted for boring crank and transmission cases. The No. 4 machine, when equipped with rail and horizontal, adjustable heads, is adapted for boring a series of holes in work which can be conveniently tilted to bring the holes in a horizontal plane. The No. 5 machine is intended for use where two or more holes, not in a horizontal plane, are to be bored. This machine has a solid head furnished with spindles grouped to suit the purchaser's requirements. The spindles of both machines have two speeds, and the tables are provided with three positive feeds and rapid traverse in both directions. The table has a working surface of 24 by 48 inches and a travel of 48 inches.

* * *

AERONAUTIC MEETING OF THE SOCIETY OF AUTOMOTIVE ENGINEERS

The Society of Automotive Engineers held a technical session relating to aeronautics at the Engineering Societies Building, 29 W. 39th St., New York City, March 10, with both afternoon and evening sessions. At this meeting a great number of important papers were read, and interesting motion pictures were a part of the afternoon session. The papers presented were as follows: "Possible Airplane Performance with Maintenance of Engine Power at All Altitudes," by Colonel V. E. Clark; "Consideration of Landing Run and Getaway by Standard Type Airplanes," by Alexander Klemin; "Effect of General Shape of Aviation Engines on Operation of Airplanes," by Grover C. Loening; "Some Factors in the Design of Airplane Radiators," by S. R. Parsons; "The Heat-treating of Brazed Fittings for Aircraft," by Archibald Black; "Flying an Aviation Engine on the Ground," by S. W. Sparrow; "Military Aeronautics," by Major General C. T. Menoher, U. S. A.; "Naval Aeronautics," by Commander G. C. Westervelt, U. S. N.; "Aeronautics from the Commercial Viewpoint," by George H. Houston; "Some Phases of Civil Aeronautics," by Major Maurice Connolly. In addition to these papers a report was presented by the Aeronautical Division of the Standards Committee, of which H. M. Crane is chairman.

Employes' Representation and Shop Committees

The National Industrial Conference Board, 15 Beacon St., Boston, Mass., has published a research report entitled "Works Councils in the United States," containing a great deal of information relating to the results obtained by employes' representation and shop committees in the United States. "Of the numerous plans for improving the relationship between employers and employes and for increasing the efficiency of industrial production," says the report, "few are attracting more widespread interest than that of securing for employes a voice in the adjustment of working conditions through the instrumentality of committees or councils." This movement is variously referred to by such terms as "Employe Representation," "Democracy in Industry," "Industrial Democracy," "Shop Committees," or "Works Councils."

THE report recently published by the National Industrial Conference Board on employes' representation and shop committees presents a description and analysis of this form of industrial organization as it exists today in the United States. In view of the fact that the experience with employes' shop councils has been comparatively brief, the report does not aim to present conclusions, but merely to record, in an impartial manner, the developments of a movement which is demanding the attention of industrial leaders in many parts of the country. The report is not intended to express the opinion of the National Industrial Conference Board on the desirability or value of employes' representation on Works Councils. It is believed that a more extended experience with this form of industrial organization will be required in order to obtain a more reliable basis for judgment.

Up to the period of the war the Works Council was practically unknown either in the United States or in Great Britain. While the number of establishments having Works Councils today is still relatively small, at the present time such organizations are known to exist in this country in more than 200 establishments employing about 500,000 workers, and their organization has progressed even more rapidly in Great Britain.

It is believed that the term "Works Council" best describes this new form of industrial organization. The expressions "democracy in industry" and "employe representation" obviously are too generic in that they designate the movement and not the specific form which it has assumed. The name "shop committee" is misleading in that it does not distinguish between "employe representation," "trade union," or technical shop committees. The term "Works Council" appears to be properly inclusive as well as definite and exact, and is therefore used in the report under review. The recent growth in the number of Works Councils, as well as the importance of their aims, gives to the study of this form of industrial organization a timely and vital interest.

Essential Nature of Works Councils

The Works Council may be described as a form of industrial organization under which the employes of an individual establishment, through representatives chosen by and from among themselves, share collectively in the adjustment of employment conditions in that establishment. The Works Council is intended as one means of satisfying the desire of the worker for a share in the adjustment of his working conditions; as a means of lessening labor difficulties, of allaying industrial unrest, of increasing productive efficiency; and as an opportunity for informing employes on production, and technical and economic questions. It provides, in the individual establishment, an organized form of contact between the employer and his employes.

Works Councils vary widely in their form and in the scope of their activities, but one characteristic is common to all, namely, the election of the employes' representatives by and from among the workers themselves on a democratic basis of representation. For this reason, committees of employes appointed by the management are not considered in this report. Similarly, trade union shop committees are excluded, since, instead of being elected by the workers of the individual establishment on a democratic basis, they are chosen by the organized workers only, or by trade union members irrespective of their employment in the particular establishment.

The institution of the Works Council obviously involves acceptance by the employer of the principle of collective dealing. Under a plan of employe representation, questions previously settled between the employer and his employes individually are handled by representatives of the employes collectively, and moreover, on a systematic basis. Recognition of the principle of collective dealing by the employes of individual establishments with their employer forms the very basis of the Works Council. Such collective dealing is, however, distinct from "collective bargaining" in the sense of collective dealing with labor unions as organizations.

The Works Council, however, is not in its essence a substitute or an alternative for labor union organization. In recognition of this fact, some notable plans of employe representation expressly provide that employes shall not be discriminated against because of labor union membership. While the Works Council tends to restrict the activity of the labor union in matters purely local to the individual establishment, the union may still be potent in settling problems common to the entire craft, industry or locality.

Clear distinction should be made between a Works Council and the occasional meeting of an employer with committees or deputations of his workers, only when some exigency arises. In other words, the contact between management and men established by a Works Council is on a definitely organized and sytematized basis and is continuous.

Evolution and History of Works Councils in the United States

The influences which have resulted in the formation of Works Councils were active long before these organizations themselves developed. For years before the first Works Council was established in the United States, employers had organized or had encouraged their employes to form clubs or associations for social purposes; some employers had provided for the participation of employes in industrial betterment activities. Moreover, for many years prior to the appearance of the first Works Council informal deputations of workers had in many establishments been a customary means of adjusting differences between employer and employes; again, trade unions had maintained shop committees to represent the interests of their members in individual establishments.

What, apparently, was the first suggestion of a Works Council in this country appeared in 1886 in an article on "The Shop Council," by James C. Bayles. The writer laid before employers and wage-earners what he termed "a simple, inexpensive and perfectly practical method" of adjusting labor difficulties. He described in detail the functions and

membership of a Works Council consisting of four members, two elected by the wage-earners and two by the management. The chairman was to be chosen by these four members and he was not necessarily to be otherwise connected with the plant. Apparently this plan was never put into practical operation.

The earliest Works Council in the United States of which any record has been found was introduced in 1904 by the Nernst Lamp Co., in Pittsburg. The plan provided for a "factory committee" composed of representatives from the clerical force, from the factory operatives and from the foremen, with the superintendent of the plant as permanent chairman. The management of the company has since changed several times and the committee has passed out of existence.

In the fall of 1913 the Packard Piano Co. of Fort Wayne, Ind., after experiencing a period of labor difficulties, introduced in its works a plan of industrial representation patterned after the organization of the Federal Government. A "Business Policy" was formulated by the management and submitted to the employes, who voted upon its adoption. It took effect in the late fall of 1913 and is still existent. In 1914 the Printz-Biederman Co. of Cleveland introduced a similar plan, which in somewhat modified form is still effective. Since that time the idea has been constantly growing.

Number of Works Councils in Operation

According to the report here reviewed, there are 225 Works Councils in operation in the United States; Connecticut leading with 58; Ohio, Illinois, and Pennsylvania following with about 20 each; the remainder being mainly in Michigan, New York, Massachusetts, and Wisconsin. In each of the nine industrial states which lead in the number of Works Councils, the majority of these organizations are found in the metal trades, there being altogether 144 Works Councils in these trades, of which 56 are in the machine building and tool making field; 20 in the iron and steel mills; 14 in the sheet metal, wire and wire product industries; and 12 in the machine part making industries.

It is also interesting to note the number of employes in the plants where Works Councils are established. In counting the 122 plants for which the number of employes is reported, it is found that 44 had less than 500 employes; 47 had from 500 to 3000 employes; 18 from 3000 to 10,000 employes; and 13 over 10,000 employes. Altogether Works Councils are established in industries employing about 500,000 workers.

Distribution with Respect to the Extent of Trade Unionism

Of the 81 plants from which information was secured on this point, 71 were reported as open shops, while in 3 others one or more departments were conducted on the open-shop basis; 3 were closed non-union shops (whatever that might mean); another is reported as a closed shop maintained by a company union; 2 were closed union shops; and 1 a preferential union shop.

After having reviewed the extent to which the Works Council idea is employed in the United States, the report continues by giving details of the plans operated in various plants, outlining the authority that is given to the Works Council, showing the functions and activities as well as the results obtained. Anyone who wishes to study this subject in detail, should obtain from the National Industrial Conference Board, a copy of the report, which covers 132 pages and is the most complete review of this movement that has so far been compiled.

* * *

A new journal entitled *The Woman Engineer* has appeared in England, the object of which is to encourage and stimulate the interest of women in the engineering profession and to remove the prejudice and artificial restrictions which now prevent women from taking up engineering as a trade or profession. The journal is published by the Women's Engineering Society, 46 Dover St., Piccadilly, W. 1, London.

CARE AND OPERATION OF A BAND SAW IN A PATTERN SHOP

By M. E. DUGGAN

Patternmakers are, as a rule, accustomed to allowing considerable material beyond the finish line when employing the band saw to cut out wooden parts. This practice makes it necessary to spend considerable time in finishing the parts down with hand tools, such as the plane or chisel, when as a matter of fact the required finish could be obtained by sawing up to the line. It may nevertheless be difficult to convince some patternmakers that this can be done unless they are afforded an opportunity of seeing the practical application of this method.

The benefit to be derived from a properly cared for and operated band saw in the pattern shop may be illustrated by the following experience of the writer. The manager of a certain pattern shop contracted to make several thousand pieces in wood, basing his price on the assumption that the work would all be performed on the band saw, but when the patternmaker was confronted with the work, he decided that the only satisfactory method of producing the pieces would be to first cut them out on the band saw to approximately the correct size and shape, and afterward finish the pieces accurately by means of a cutter-head especially designed for this purpose.

The work proceeded satisfactorily in this way until the band saw broke. As it was necessary to maintain the output, the material and "finished size" templets were sent to a nearby furniture factory where the work was continued, but in a different way. The band saw operator in the furniture factory, knowing nothing about the finish allowance or the cutter-head, cut the pieces out to finish size directly with the band saw, eliminating all additional hand-finishing work. When the foreman found out how the work was being done, and that the parts could be assembled satisfactorily, he became convinced that with the right kind of band saw operated by a careful workman, it was possible to cut right up to the finish line and thus avoid unnecessary hand fitting.

In order to keep the band saw in good condition so that it may be used for accurate work, the following rules should be observed: (1) Always use a roller saw-guide and never a stationary one. (2) Make sure that the saw is only just permitted to touch the roller lightly. (3) Use a ¼-inch saw for cutting light as well as heavy stock. (4) Never use saws which are kinked, bent, or humped at the brazed joints. (5) Test the truth of the saw for cutting square by sawing a 3-inch diameter cylinder from a piece of wood 6 inches thick, an operation which cannot readily be performed with a wide saw, or one that is incorrectly set or filed. (6) See that the bands on the wheel are never allowed to become gummed. (7) Oil every sliding bearing and journal bearing each morning.

* * *

A writer in a contemporary journal is rather amused by a story published in a recent number of a British journal, in which the making of automobiles turned out in quantity at $250 a piece is described. The story is dated 1930 and the idea that automobiles may be built at so low a price is apparently considered beyond possible expectations. It should not be forgotten, however, that there are automobiles sold in the United States today by the hundred-thousands at a price, which, figured at the value of a dollar on a pre-war basis, would not be much, if any, in excess of $250. In fact, this very automobile was sold in 1917 for slightly over $300, and certainly it was produced for less than $250 in order to make such a selling price possible. Hence, the British writer is not so much ahead of his time after all, and it is reasonable to expect that with the constantly increasing use of automatic machinery, improved methods of efficiency, and simplification in design, automobiles will be produced in the future at a price much lower than the average cost today.

APPLICATIONS OF PRESTWICH FLUID GAGES

The interchangeable manufacture of numerous parts that must be machined within close tolerances, such as automobile engine and ball bearing parts, has led to the development of many types of gages and measuring instruments for testing the accuracy of the finished product. Three applications of the well-known fluid gage or prestometer made by the Coats Machine Tool Co., Inc., 110-112 W. 40th St., New York City, are shown in Figs. 1, 2, and 3.

Fig. 1 shows the prestometer adapted for ascertaining the size, concentricity, and parallelism of the bore of the inner race of a ball bearing. This instrument is provided with an anvil block having a special nose-piece *A* upon which the part is placed for inspection. This nose-piece is detachable so that one of another size can be readily substituted when it is desired to use the instrument for inspecting races of a different size. There is a floating lever inside the anvil, one end of which comes in contact with the bore of the race. Another surface of this lever registers contact with anvil *B* attached to the diaphragm of the fluid chamber so that when a part is being measured the fluid is raised in the usual manner. The pencil indicates the position of the end of the straight portion of the anvil nose-piece. The limits on this work are very close, being 0.0002 inch plus and 0.0001 inch minus, and so a glass tube having a very fine bore is used which magnifies 3000 diameters. Each graduation on the scale represents 0.0001 inch, the actual distance between each graduation being 0.3 inch, so it is evident that very slight inaccuracies of the work can be readily detected by this instrument. The total range of this scale is 0.001 inch.

Another example of prestometer application is illustrated in Fig. 2. The instrument in this case is employed in inspecting the external cylindrical surfaces of a 4½-inch diameter automobile engine piston. The difference between the minimum diameter allowed for the first land, which is the smallest dimension to be checked, and the maximum diameter allowed for the body of the piston, which is the largest dimension, is 0.022 inch. The tolerance on each measurement is 0.001 inch, and so the scale is graduated to represent measurements of 0.001 inch, there being twenty-two graduations so that the measurements of all the surfaces are within the capacity of the scale. The maximum and minimum points between which the fluid must be raised for each surface are marked on the scale. The glass tube provided on this machine magnifies 250 diameters, and the scale graduations are actually ⅛ inch apart.

Attention is called to the ball in the base toward which the pencil in the illustration is being pointed. This ball is ⅜ inch in diameter and is provided with an adjustment so that it can be projected a certain amount above the surface of the base. This amount should be slightly greater than one-half the total variation between the diameters of the different surfaces to be measured, so that the piston will always be resting on the surface being inspected and not on the body portion which, as was previously mentioned, is larger in diameter than any of the other surfaces. As the total variation between the surface diameters in this case is 0.022 inch, the ball is projected slightly more than 0.011 inch above the base surface. The piston is inspected by sliding it along the base so that the various surfaces to be measured come between the ball in the base and the ball point *A* which is attached to the front end of a floating lever. As this lever is raised by coming in contact with any of the piston surfaces, a rear portion of it comes in contact with the anvil on the diaphragm of the fluid chamber which, in turn, causes the fluid to be forced up into the glass tube. A single pointer is provided with this arrangement to indicate the normal position of the fluid. The piston should be placed with the wrist-pin holes in a horizontal position for the inspection. The piston is relieved on the two sides adjacent to the piston-pin holes. When these holes are brought into a vertical position, the fluid in the glass tube rises to between the points marked "clearance."

Another interesting application of this instrument is illustrated in Fig. 3. The various attachments supplied in this case are for the purpose of adapting the instrument to the inspection of an internal surface of an automobile pinion-shaft housing. The work is slipped over mandrel *A*, which is provided with strips to suit the diameter of a smaller internal surface of the work, and the accuracy of the bore to be measured is determined by means of pins *B*. These pins operate a floating lever that also contacts with the anvil of the fluid chamber diaphragm so that the fluid is raised in the glass tube by the usual method. One advantage of this method of inspection for a part of this type is that the bore can be accurately measured regardless of whether it is concentric with the periphery of the part. Another reason for placing the work on a mandrel is because the outside surface of the housing is slightly tapered, which does not readily permit it to be supported on V-blocks for the inspection.

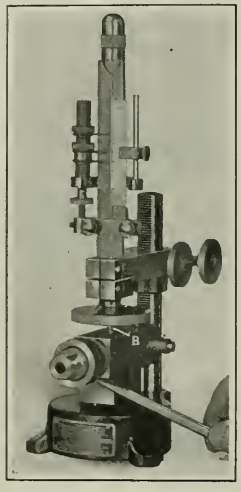


Fig. 1. Prestometer being used in inspecting the Bore of Ball Bearing Races

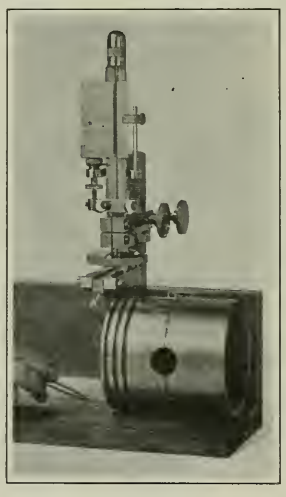


Fig. 2. Application of the Fluid Gage in determining the Accuracy of Automobile Pistons

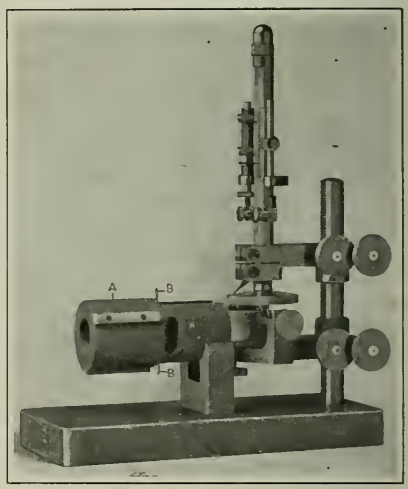


Fig. 3. Adaptation of the Prestometer to the gaging of an Internal Surface of an Automobile Pinion-shaft Housing

BRITISH GEAR-SHAPING MACHINE

The illustration Fig. 1 shows a new gear shaper brought out by Jones & Shipman, Ltd., Leicester, England. The machine operates on very simple lines, and has been designed for all classes of repetition work on internal and external gears or ratchets. It is entirely automatic in operation, and is claimed to need little attention beyond setting the work and tools. The main frame of the machine is a single casting bolted to a circular cast base which can be mounted on a bench or column. The base is cast with a deep channel for cooling liquid. Fig. 2 shows a side elevation and an end view of the machine. A single belt drive is used, a tight and loose pulley being provided at *A* to permit the machine to be stopped and started by simply shifting the belt. The shaft on which the pulleys are mounted is equipped with a handwheel, which provides a convenient means of operating the machine by hand when setting up. The tool-slide *B* runs in guides, one of which is adjusted by a taper gib. The sliding position relative to the bed can be varied to suit different classes of work, and is effected by the squared end on a screwed shaft mounted in the slide. The position is locked by the handle on top of the slide.

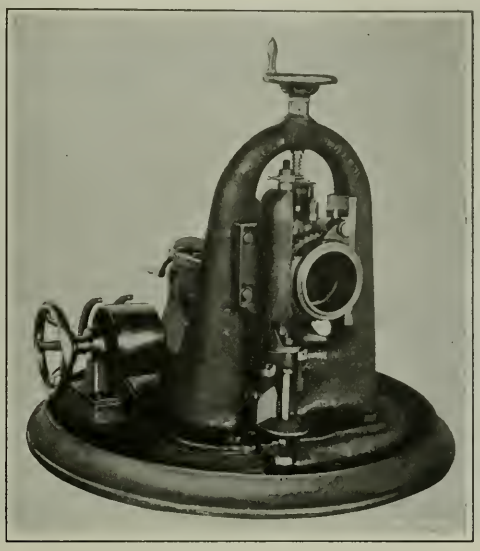


Fig. 1. Gear-shaping Machine designed for cutting Spur and Internal Gears

The tool-slide is reciprocated by a slotted lever *C* pivoted in the main frame. The length of stroke is between 0 and 4 inches, and is varied by adjusting the position of the block *D* along a slot in the driving wheel *E* driven by a 3 to 1 reduction from the pulley shaft. The division around the work is carried out by means of a ratchet, clearly seen in Fig. 1. The pawl *F*, engaging the ratchet, is carried by a rotating sleeve provided around part of its circumference with teeth which engage a rack cut in the vertical plunger *H*, normally pressed downward by the coil spring seen above the rack. The toe of the plunger is engaged by a horizontal cam *J*, driven through a train of bevel and spur gears from the shaft operating the tool-slide. The cam makes one revolution for each complete reciprocation of the tool, and is timed to raise the rack when the tool is at the back end of its stroke. Thus the pawl advances the work to allow each succeeding tooth to be cut.

The handled nut and locknut, seen at the top of the plunger, provide adjustment by raising or lowering the normal position, so that a shorter or longer length of cam face contacts with the plunger, giving a corresponding variation to the feed of the pawl, according to the number of divisions required around the work. Once in every revolution of the work the feed-finger *K* engages with the adjustable pin *L*, and advances the feed-pawl *M*, which is mounted on a rocking arm. The feed-pawl engages a feed-wheel *N* having 100 teeth. Each tooth advance feeds the work carriage downward between the frame uprights

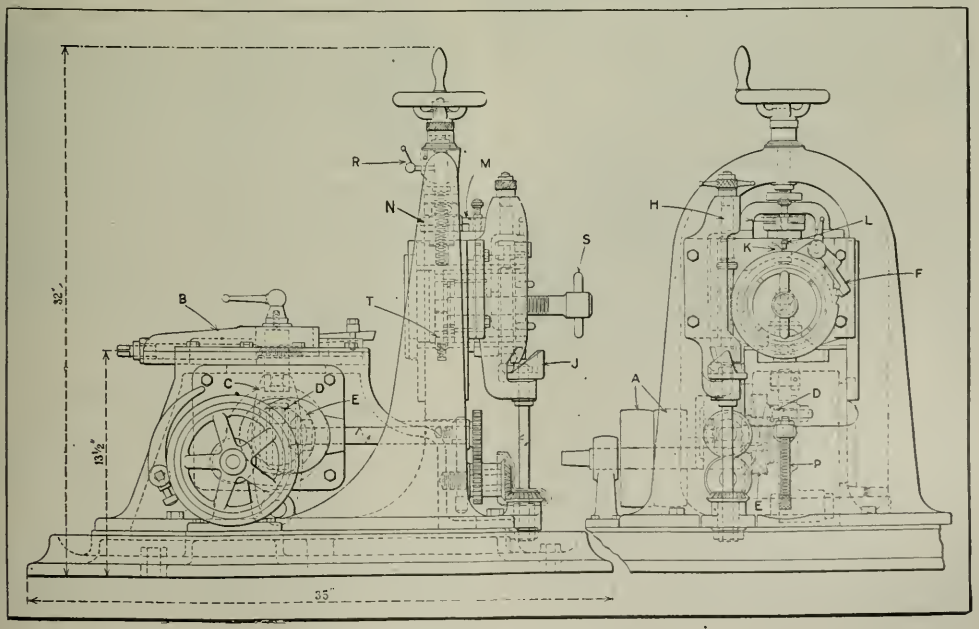


Fig. 2. Side and End Elevation of Gear-shaping Machine

0.0025 inch. When the work has rotated a sufficient number of times to give the requisite depth of tooth, the adjustable stop *P* prevents the cut going deeper. If the machine should be left running at this stage the feed-wheel *N* would rotate idly between fiber friction washers which are in contact with its sides without advancing the carriage. By unlocking *R* the carriage can be raised or lowered by the handwheel shown on top of the machine, a micrometer disk being provided to facilitate setting. Three methods of holding the work can be used, which adapt the machine for cutting either internal or regular spur gears.

Internally cut gears are mounted in a chuck screwed into the large hollow spindle, and secured by a screwed lock-ring. The extremely large hole of 5 inches through the spindle enables the work in many cases to be inserted from the back of the machine, a threaded pin bearing on a clamp plate being used to secure the work. The block carrying the pin is inserted in the spindle and secured by a quick-acting gate lock. A friction brake *T* is provided to prevent the spindle over-running after rotation by the ratchet.

The following are the dimensions and capacity: Chuck capacity, 5 inches diameter; number of teeth with one cam, 16 up to any number required; diametral pitch of teeth, 10; vertical feed, which is always downward, 3½ inches; stroke of tool-slide, 0 to 4 inches; pulley size, 6 by 2 inches face, 360 revolutions per minute; over-all height, 32 inches, without column; bed, 35 inches in diameter.

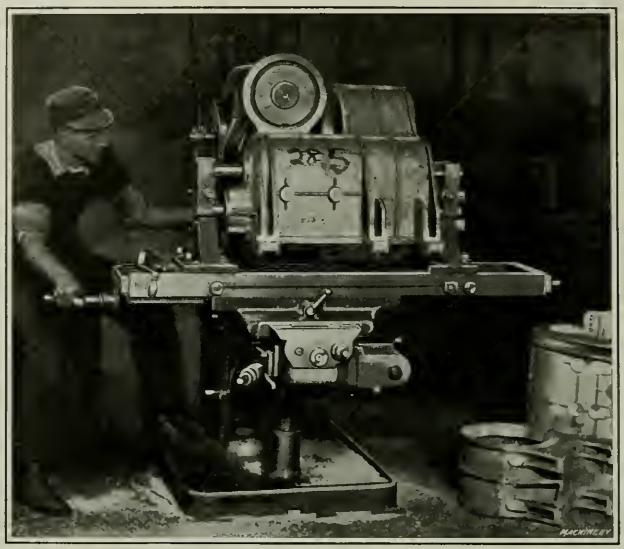
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A COMMERCIAL AIRPLANE

A monoplane known as the *Butterfly* and said to be America's smallest flying craft, recently successfully completed its trial flight at College Point, Long Island. The *Butterfly* was developed by the L. W. F. Engineering Corporation to meet the requirements of civilians who desire a machine of low first cost and low operating expense. It is understood that the machine will be manufactured on the quantity production basis to sell at $2500. On its trial flight, the machine fulfilled all the predictions made for it by the engineers who had previously made wind tunnel tests of a model. The weight of the machine is 595 pounds, the maximum carrying capacity, 383 pounds, the wing span, 29 feet 9 inches, the length over all 19 feet, and the height over all 5 feet, 10 inches. The maximum speed, when in horizontal flight, is about 72 miles per hour, and the minimum speed at which the machine can be flown without loss of altitude is about 22 miles per hour. The climbing speed is 4800 feet in 10 minutes, and the radius of action 6 hours. The power plant, weighing 154 pounds, consists of a two-cylinder horizontally opposed, four-cycle, air-cooled, valve-in-head motor which develops 72 horsepower running at 1825 revolutions per minute.

SPOT-FACING ALUMINUM GEAR-CASES

In the Cotta Transmission Co.'s plant at Rockford, Ill., No. 2 single-pulley-driven Rockford millers are employed for the performance of spot-facing operations on aluminum gear-cases. The accompanying illustration shows one of these cases set up on the machine and there is a second case standing on the floor, which shows the six surfaces that have been spot-faced. From the illustration, it will be apparent that the fixture is of quite simple design, consisting of two arbors which support the work. These arbors are furnished with collars of suitable size to enter holes that have already been finish-bored. The two arbors are supported at either end by brackets bolted to the milling table, the arbors being held in place in the V-notches in the brackets by means of two straps. Obviously an end-mill is employed for the performance of this work, the cutter being 9 inches in diameter and driven at a speed of 300 revolutions per minute. On this job the six faces on a gear-case can be spot-faced in two minutes.



Rockford No. 2 Miller used for spot-facing Gear-cases

* * *

THE INCREASING USE OF STEEL PIPE

According to an editorial in the *American Metal Market and Daily Iron and Steel Report* reprinted in the National Tube Co.'s *Bulletin* for December, the production of wrought iron pipe decreased from 276,000 tons in 1913 to 203,000 tons in 1918, while the production of steel pipe increased from 1,969,000 tons in 1913 to 2,087,000 tons in 1918. The statistics covering pipe production do not give any data prior to 1913, but figures are available showing the skelp production as far back as 1905. From these statistics it is evident that from 1905 to 1918 there was an almost continuous decline in the tonnage output of iron skelp while there was a very large increase in the production of steel skelp. The decline in the iron skelp was from 453,000 tons in 1905 to 258,000 tons in 1918; while the increase in steel skelp was from 983,000 tons in 1905 to 2,305,000 tons in 1918.

* * *

RESOLUTION IN FAVOR OF BUREAU OF FOREIGN AND DOMESTIC COMMERCE

At the convention of the Material Handling Machinery Manufacturers Association, held at the Waldorf-Astoria Hotel, New York City, February 26 and 27, a resolution was adopted to the effect that the expanding commerce and industry of the United States demands the support to the industry furnished through the instrumentality of the Bureau of Foreign and Domestic Commerce and that Congress therefore must be urged to appropriate the sum of $1,900,000 originally applied for by the Department of Commerce for this service to the industry.

THE LARGEST SAWS EVER MADE

What are believed to be two of the largest circular saws ever made have been completed by Henry Disston & Sons, Inc., of Philadelphia, Pa. They are of the spiral inserted-tooth type and are to be used by a well-known concern in the West for cutting shingle-blocks from the large trees of that section. Each of the saws shown in the accompanying illustration measures 108 inches in diameter and has 190 teeth inserted in the rim. Some idea of the great size of these saws may be had by comparing them with a 54-inch saw which is usually thought of as a large saw. The regular 54-inch saw is made from an ingot of steel weighing approximately 180 pounds, and its weight when finished is about



Circular Saws 108 Inches in Diameter for cutting Shingle-blocks

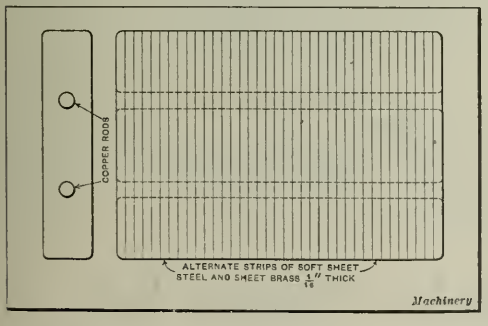
125 pounds. The 108-inch saw requires an ingot weighing 1140 pounds, which after reheating, rolling, and trimming, weighs about 795 pounds. The quality of steel and workmanship required in making these saws may be more fully realized when it is known that the teeth must travel at a speed of 130 miles per hour when the saw is in operation.

* * *

AUXILIARY MAGNETIC CHUCK

By JOHN LeLASH

As the holding surfaces of magnetic chucks become uneven through wear, frequent grindings are necessary to maintain accuracy if the chucks are used continuously. When small work must be ground to within very accurate limits a small auxiliary chuck, such as here illustrated, is of great advantage, as its surface can be trued up more quickly than that of the main chuck. The use of such an



Magnetic Chuck for Use when grinding Small Flat Work

auxiliary chuck will also prolong the life of the regular chuck as well as provide a means of holding small work to better advantage. The chuck shown is constructed from strips of soft sheet steel and sheet brass, 1/16 inch thick, alternately arranged and riveted together by two 5/16 inch copper rivets. Such a chuck about 4 inches long, 2½ inches wide and ¾ inch thick will be found a convenient size.

GERMAN MACHINE TOOL INDUSTRY

First-hand information obtained from Germany at a recent date indicates that a number of the new machine tool plants in Germany that sprang up during the war, appear to have either given up manufacturing or to have largely limited their production, owing to the present difficulties in obtaining materials and the high cost of labor. While the machine tool building business in Germany was profitable during the war, the numerous increases in labor costs and in the cost of materials since the armistice have largely swallowed up the profits of the past. Many machine tool builders and manufacturers of general machinery, noting the increases in the prices of machine tools, began to act as dealers, purchasing machine tools apparently for their own requirements, and then reselling them later at the higher prices, either for domestic consumption or for export. The iron and steel industries have made large profits since the armistice and have also secured controlling interests in a great many machine tool building firms. Recently, there have been a great many mergers of machine tool firms with manufacturers in other machine building lines, some of the larger and better known companies having absorbed the smaller concerns.

In spite of the difficulties with material and labor, a recent letter from Germany indicates that in the early part of March the machine tool industry there was exceptionally busy. The factories had so many orders on hand that many of them refused to accept new orders until the end of the present year. The low exchange rate is favorable for export, and almost all of the machine tool builders are working for the export trade. The price for medium-sized machine tools, expressed in marks, is forty times the price previous to the war, and hence, even in foreign currency, these machine tools command a price which is becoming nearly equal to the prices in the world's markets. The present prices of machine tools are prohibitive as far as the domestic market in Germany is concerned, and the re-equipping of German factories cannot be thought of by manufacturers, as the expense would necessitate such a large investment that reasonable returns on this investment would be improbable if not impossible.

* * *

INCREASE IN BRITISH EXPORTS

The recent efforts to stimulate the export trade of Great Britain to assist in righting the exchange position are indicated in the Board of Trade figures for January. These figures show that the exports, for the first time on record, totaled more than £100,000,000, or, in exact terms, £105,879,000, this being an increase of £58,000,000 over January of last year. Exports of manufactured articles increased 100 per cent, including an advance of £15,000,000 in cotton textiles, £6,000,000 in woolens and £4,000,000 in iron and steel products. While imports were still large, totaling £183,000,000, or £48,000,000 over January of last year, these were largely essential products, such as food imports which showed an increase of £18,000,000 and raw cotton, which increased £22,000,000.

* * *

PLANS FOR AMERICAN FOUNDRYMEN'S CONVENTION

The American Foundrymen's Association has decided to hold its 1920 annual convention and exhibit during the week beginning October 4, at Columbus, Ohio. The exhibition buildings on the Ohio state exposition grounds at Columbus afford the most extensive and best accommodations that have ever been provided for the display of foundry, machine shop, and metal-working equipment at any of the association's conventions. The adjoining buildings provide the necessary lecture and meeting rooms. This arrangement will make it possible to hold all of the activities of the convention in one place.

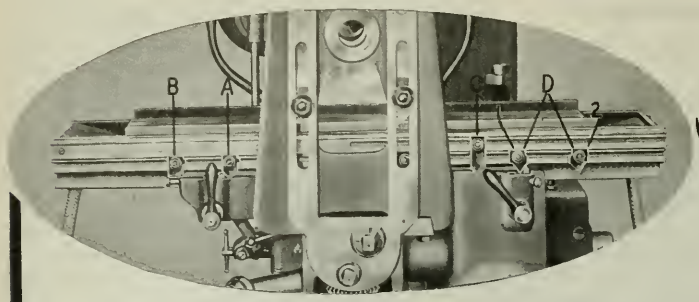


Table Dogs Control All Movements

There are only four different style dogs necessary to operate all the automatic controls of the machine; for all ordinary milling operations two or three of the styles are usually sufficient.

A long dog used at "A" or "B" controls the reversing of the table and may also be used for stopping same. When the table is moving at its constant fast travel a short dog "B" is employed for stopping the table.

Dog "C" controls the constant fast travel and may be set to operate in either direction.

Dogs "D" control the variable feed and may be set to operate in either direction; arrangement 1 when moving to the right—arrangement 2 when moving to the left.

The table always moves at its constant fast travel when reversed.

When the machine is set for reversing the spindle, the spindle is reversed when the table is reversed. When the machine is set for stopping the spindle, the spindle stops when the table is reversed and starts with the variable feed. No extra tripping dogs are required for either reversing or stopping.

Continuous milling operations may be performed by employing two "A" dogs and two "D" dogs.

Intermittent milling operations may be performed by employing dogs "A" and "B" and several pairs of dogs "C" and "D", depending upon the number of pieces of work on the table.

Brown & Sharpe Mfg. Co., Providence, R. I.

BROWN & SHARPE No. 21

A New Machine for Greater Production

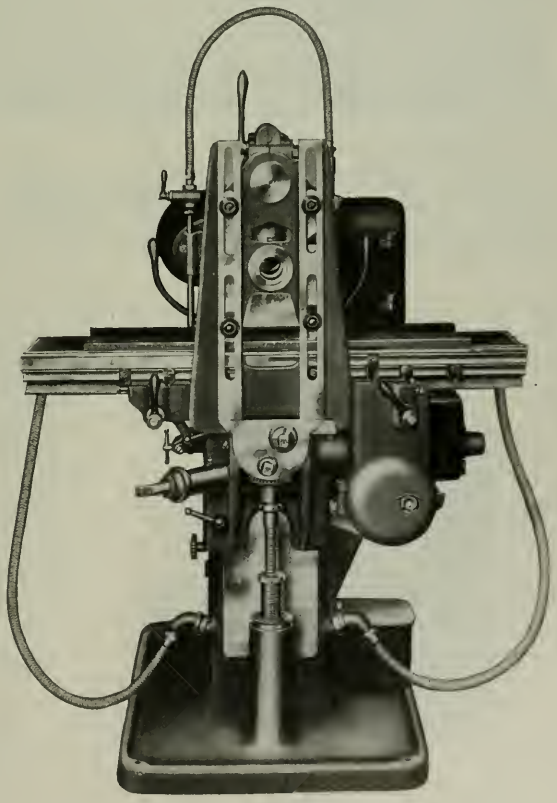
All Movements of Table and Spindle Entirely Automatic

These Movements, or Combination of Movements are Controlled by the Table Dogs, and include—

TABLE { Variable Feed, Constant Fast Travel, Stop

SPINDLE { Start, Right Hand, Left Hand, Stop

Table and spindle may be operated independently of each other. These movements may or may not be intermittent in either or both directions and may take place one or more times.



Automatic Milling Machine

PERSONALS

HARRY C. O'NEILL, for several years commercial agent with the American Express Co. at Detroit, Mich., has recently become associated with the J. R. Stone Tool & Supply Co., of Detroit.

K. J. EVANS, of Joseph T. Ryerson & Son, Chicago, was elected a member of the publicity committee of the Engineering Advertisers' Association at the annual meeting, March 9.

R. W. ELLINGHAM, formerly works manager of the Heald Machine Co., Worcester, Mass., is now associated with the Van Norman Machine Tool Co., Springfield, Mass., in a similar capacity.

EARLE M. PORTER, formerly tool efficiency engineer of the Willys-Overland Co., Toledo, Ohio, has been appointed mechanical engineer of the Giern & Anholtt Tool Works, Inc., Detroit, Mich.

E. KENNEDY, formerly with the Chicago branch of Manning, Maxwell & Moore, Inc., 119 W. 40th St., New York City, has been transferred to the Buffalo office to fill the vacancy made by the death of F. C. Meyer.

R. M. CARTER, for seven years connected with the Gisholt Machine Co. of Madison, Wis., is now manager of sales for the Giddings & Lewis Mfg. Co., Fond Du Lac, Wis., manufacturer of horizontal boring machines.

J. B. SMYTHE, formerly superintendent of A. O. Norton, Ltd., Coaticook, Quebec, Canada, is now general manager of the new office of the George F. Foss Machinery & Supply Co. at 174 Lafayette St., New York City.

W. S. RUGG, manager of the railway and marine departments of the Westinghouse Electric & Mfg. Co., East Pittsburg, Pa., and CHARLES ROBBINS, assistant sales manager, have been made assistants to the vice-president.

S. F. WALL, formerly secretary and treasurer of the Michigan Tool Co., 268 E. Jefferson Ave., Detroit, Mich., and T. M. OLSON, manager, have become associated with the Continental Tool Works of Detroit, which was recently organized.

H. W. CLARK, of the Chicago Pneumatic Tool Co., Chicago, Ill., was elected chairman of the membership committee at the annual meeting of the Engineering Advertisers' Association of Chicago, March 9. Mr. Clark is also a director of the association.

CHARLES M. MANLY and C. B. VEAL have established offices at 250 W. 54th St., New York City, as industrial engineers, specializing in the coordination of engineering and manufacturing requirements in the design, production, and operation of automotive power plants and vehicles.

EDWARD F. BUIE has been appointed Pacific coast representative of the Victor Saw Works, Inc., Springfield, Mass., to succeed Victor Pezzini, who has gone into business for himself. Mr. Buie was formerly connected with the Union Hardware & Metal Co. of Los Angeles, Cal.

J. M. COOK, formerly sales representative for the Norton Co., Worcester, Mass., is now sales and service representative of the Waltham Grinding Wheel Co.'s line of abrasive products, and will be located in the general offices of the Republic Tool & Mfg. Co., selling agent for the company, at Cleveland, Ohio.

W. E. FINKBEINER has joined the Production Engineering Co., 212 Center St., New York City, in the capacity of consulting engineer. Mr. Finkbeiner was formerly employed by Edison & Co., Orange, N. J., as toolmaker, tool foreman, and superintendent. He is a specialist in the designing and building of automatic machinery, plant reorganization, plant appraisal, etc., and has been engaged in consulting engineering work for the last fifteen years.

GEORGE T. CHAPMAN, formerly chief designer and master mechanic of the Flaxen Fibre-Down Co., Inc., North Tonawanda, N. Y., has been instrumental in organizing the Frontier Engineering Co. of North Tonawanda. Mr. Chapman, besides being chief designing engineer of the company, will also maintain an engineering office in Buffalo for the purpose of designing automatic labor-saving machinery and equipment, tools, jigs, and fixtures.

W. J. ELLIOTT, formerly manager of the St. Catharines factory of the Whitman & Barnes Mfg. Co., St. Catharines, Ontario, Canada, has recently been elected vice-president of the company and will have entire charge of the Canadian division of the business, both selling and manufacturing. Mr. Elliott has been connected with the company for twenty-seven years; advancement from one position of importance and responsibility to another was rapid, until in January 1908 he was made manager.

RAY T. MIDDLETON, formerly general sales manager of the Standard Steel Castings Co., Cleveland, Ohio, has become vice-president and director of sales and advertising of the Kelly Metals Co. of Chicago, Detroit, and Los Angeles. Mr. Middleton's headquarters will be in Chicago, where the principal production plant of the company will be established in the near future. The company will continue its present plants in Detroit and Los Angeles and expects to establish a third branch plant at a point in the East.

OBITUARIES

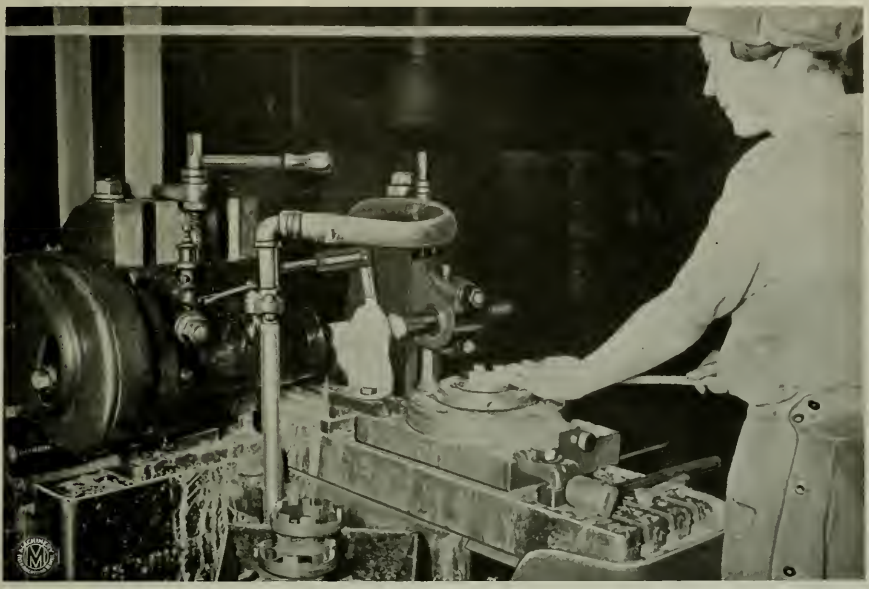
ARTHUR WILZIN, for more than twenty years director of the E. W. Bliss Co.'s Paris works, died of pneumonia, January 2, in his fifty-ninth year, at Nice, France. Mr. Wilzin was sent to France in 1889 to take charge of the E. W. Bliss Co.'s exhibit at the Universal Exhibition. He remained there as selling agent for the company, and from the sales office of which he was in charge developed the present extensive French works of the company at Saint-Ouen, near Paris, where about 500 people are at present employed. Mr. Wilzin developed the Wilzin process for flat ware manufacture and invented several types of presses.

MELVIN B. NEWCOMB, chief engineer of the rubber machinery department of the Wellman-Seaver-Morgan Co., E. 70th St. and Central Ave., Cleveland, Ohio, died March 13 at his home in Akron, Ohio, aged thirty-one years. Mr. Newcomb was born in Bridgeton, N. J. He studied mechanical engineering at the University of Wisconsin, and was engaged in engineering work with the I. P. Morris Co., Philadelphia, Pa.; Allis Chalmers Mfg. Co., Milwaukee, Wis.; Wisconsin Engine Co., Corliss, Wis.; and the Firestone Tire & Rubber Co., Akron, Ohio. In January, 1918, he joined the hydraulic turbine engineering department of the Wellman-Seaver-Morgan Co., and a few months later was appointed to the position which he held at the time of his death.

JOHN JEPPSON, superintendent and one of the founders of the Norton Co., Worcester, Mass., died on March 26 in Havana, Cuba, where he had gone for a rest. Mr. Jeppson was born in Sweden in 1844 and came to this country at the age of twenty-four. Soon after he landed, he went to Worcester and became affiliated with F. B. Norton, who was then engaged in the pottery trade, from which developed the grinding machine and grinding wheel business now known as the Norton Co. In 1885, he was taken into the company, which was then called the Norton Emery Wheel Co. He designed much of the machinery used in making the grinding wheels and took an active part in the management of the company until about seven years ago, from which time he served merely in an advisory capacity. Mr. Jeppson is survived by his wife and one son, George N. Jeppson, who is the present works manager of the Norton Co.

ANTOINE T. LANGELIER, treasurer of the Langelier Mfg. Co., Cranston, R. I., died at his home in Cranston, March 1. Mr. Langelier was born in St. Hyacinth, Quebec, Canada, in 1834. His early life was spent in Canada, and he completed his education at the St. Hyacinth College, from which he graduated in 1852. He moved to Concord, N. H., in 1869, and while there perfected his inventions for car coupling. In 1882, Mr. Langelier went to Providence where, with his son, he established the Langelier Mfg. Co., designers and builders of special machinery and tools. From a small beginning the business grew until, in 1917, it became necessary to build a larger plant, and the firm moved from Providence to Cranston. Mr. Langelier held the position of treasurer until the time of his death, and took an active part in the business up to about four years ago. He is survived by one son, Antoine J. Langelier, president and general manager of the Langelier Mfg. Co., and two daughters.

JOHN N. DERBY, first vice-president of Manning, Maxwell & Moore, Inc., of New York, died suddenly of heart disease on March 28, at his home in Port Chester, N. Y. Mr. Derby was born in Saginaw, Mich., and was in his fifty-fourth year. He was a graduate of the University of Michigan. His business career began in the state where he was born, and there he developed the Metropolitan injector, the manufacture of which was begun in 1888 by the Hayden & Derby Mfg. Co. About thirty years ago Mr. Derby became identified with Manning, Maxwell & Moore, and has been associated with that firm ever since, at first in connection with their steam specialties and later in charge of the sales of the Ashcroft Mfg. Co., the Consolidated Valve Co. and the United Injector Co. having plants at Bridgeport and Boston. The Hayden & Derby Mfg. Co. was absorbed by the United Injector Co. when the Hancock Inspirator Co. was taken over. In addition to being vice-president, Mr. Derby was a member of the executive committee of Manning, Maxwell & Moore, Inc., and lately devoted his attention to the railroad trade. Mr. Derby leaves a wife, two daughters and a son.



Cincinnati Automatic Millers

May Be the Solution of Your Production Problems

QUANTITY production of duplicate parts with the Cincinnati Automatic Miller is merely a matter of routine. One operator can attend a battery of machines, and girls are readily trained to do the work.

The photograph—taken by courtesy of the Autocar Co., Ardmore, Pa.—illustrates the milling of eight slots in the edge of malleable iron bearing retainers. Each slot is ¾″ wide, 7/16″ deep, the wall of the casting being 5/16″ thick.

Write us for production figures on this sort of work.



THE CINCINNATI MILLING MACHINE COMPANY

CINCINNATI OHIO, U. S. A.

COMING EVENTS

April 19-22—Convention of the National Metal Trades Association at New York City: headquarters, Hotel Astor. Secretary, Homer D. Sayre, Peoples Gas Bldg., Chicago, Ill.

April 29—Monthly meetiog of the Rochester Society of Technical Draftsmen, in Rooms 131-137 Sibley Block, 328 Main St. E., Rochester, N. Y. Secretary, O. L. Angevine, Jr., 547 Arnett Blvd., Rochester, N. Y.

April 29-May 1—Annual convention of the American Gear Manufacturers Association at Detroit, Mich.; headquarters, Hotel Statler. Secretary, F. D. Hamlin, 4401 Germantown Ave., Philadelphia, Pa.

May 12-15—Seventh national foreign trade convention in San Francisco, Cal. Secretary of the National Foreign Trade Council, O. K. Davis, 1 Hanover Square, New York City.

May 17-19—Joint meeting of the American Supply & Machinery Manufacturers' Association, the Southern Supply & Machinery Dealers' Association, and the National Supply & Machinery Dealers' Association at Atlantic City, N. J.; headquarters, Hotel Marlborough-Blenheim.

May 20-21—Spring convention of the National Machine Tool Builders' Association at Atlantic City, N. J.; headquarters, Hotel Traymore. Secretary, Charles E. Hildreth, Worcester, Mass.

May 24-27—Spring convention of the American Society of Mechanical Engineers at St. Louis, Mo.; headquarters, Hotel Statler. Secretary, Calvin W. Rice, 29 W. 39th St., New York City.

June 21-26—Annual meeting of the American Society for Testing Materials at Asbury Park, N. J.; headquarters, New Monterey Hotel. Secretary and treasurer, C. L. Warwick, 1315 Spruce St., Philadelphia, Pa.

October 4-9—Annual convention and exhibit of the American Foundrymen's Association at Columbus, Ohio.

SOCIETIES, SCHOOLS AND COLLEGES

Clarkson College of Technology, Potsdam, N. Y. Catalogue for 1920 which contains calendar for 1919—1920, courses of study, and other information relating to the college.

Engineering Advertisers' Association of Chicago held its annual meeting March 9 at the Auditorium Hotel, electing the following officers: President, A. H. Hopkins; vice-president, J. J. Arnsfield; secretary, G. S. Hamilton; and treasurer, E. I. Pratt.

BOOKS AND PAMPHLETS

Heat-treatment of Duralumin. By P. D. Merica, R. G. Waltenberg, and H. Scott. 46 pages, 7 by 10 inches. Published by the Department of Commerce, Washington, D. C., as Scientific Paper No. 347 of the Bureau of Standards. Price, 10 cents.

Use of Modified Rosenhain Furnace for Thermal Analysis. By H. Scott and J. R. Freeman, Jr. 7 pages, 7 by 10 inches. Published by the Department of Commerce, Washington, D. C. as Scientific Paper No. 348 of the Bureau of Standards. Price, 5 cents.

A Study of the Deterioration of Nickel Sparkplug Electrodes in Service. By Henry S. Rawdon and A. I. Krynitzky. 16 pages, 7 by 10 inches. Published by the Department of Commerce, Washington, D. C. as Technologic Paper No. 143 of the Bureau of Standards. Price, 10 cents.

Constitution and Metallography of Aluminum and its Light Alloys with Copper and with Magnesium. By P. D. Merica, R. G. Waltenberg and J. R. Freeman, Jr. 14 pages, 7 by 10 inches. Published by the Department of Commerce, Washington, D. C., as Scientific Paper No. 337 of the Bureau of Standards. Price, 10 cents.

Mechanical World Year Book—1920. 328 pages, 4 by 6¼ inches. Published by Emmott & Co., Ltd., 65 King St., Manchester, England. Price, 2 shillings, net.

This is the thirty-third year of publication of this reference book for mechanical engineers, and considerable new material has been added to the present edition. There is a new section dealing with water and hydraulic work, in which much information is given on the friction of water in pipes, and on pumps and pump fittings. The applications of hydraulic power are described, and particulars are given of hydraulic accumulators, hydraulic press cylinders, flanging presses, punching presses, hydraulic pipes, flanges, etc. Another new section is that on "Heating and Evaporating Liquids," which describes tubular heaters, feedwater heaters, and evaporators, as well as details of pipes and fittings. Additions have been made to the section on compressed air, and to the screw thread tables.

American Machinists' Handbook. By Fred H. Colvin and Frank A. Stanley. 758 pages, 4 by 6¾ inches. Published by the McGraw-Hill Book Co., Inc., New York City. Price, $4, net.

This is the third edition of this reference book for the machine shop and drafting-room. Considerable new material has been added to bring the book up to date, the present edition containing seventy-seven more pages than the previous edition. The general arrangement of the book remains the same. The data given cover the following subjects: Screw Threads; Pipe and Pipe Threads; Twist Drills and Taps; Taps; Files; Work-benches; Soldering; Gearing; Milling and Milling Cutters; Cold Saws; Turning and Boring; Grinding and Lapping; Millstones and their Uses; Screw Machine Tools; Speeds and Feeds; Punch Press Tools; Broaches and Broaching; Bolts, Nuts, and Screws; Miscellaneous Tables; Calipering and Fitting; Tapers and Dovetails; Shop and Drawing-room Standards; Miscellaneous Information; Wire Gages and Stock Weights; Horsepower, Belts, and Shafting; Steel and Other Metals; Steam Hammers and Drop-forging; Knots, Eye-bolts, Ropes, and Chains; General Reference Tables; Shop Trigonometry; and Dictionary of Shop Terms.

The Model T Ford Car. By Victor W. Page. 410 pages, 5 by 7 inches. Published by the Norman W. Henley Publishing Co., 2 W. 45th St., New York City. Price, $1.50.

The 1920 edition of this instruction book for drivers and owners of Ford cars has been thoroughly revised and considerably enlarged. The new matter covers the Fordson farm tractor, the F. A. starting and lighting system, and the wormdrive one-ton truck. All parts of the Ford Model T car and Fordson tractor are described and illustrated in a comprehensive manner. The construction is fully treated and the operating principles clearly described. Complete instructions for both driving and repairing are given. Practically no mechanical chaoges have been made in the Ford car mechanism for 1920, except the addition of an electrical starting and lighting system, which is fully described in Chapter VI; consequently the instructions given apply to the new models as well as to those that have preceded them. As many Ford owners fit various attachments to the chassis to convert it into a truck or tractor, a brief review of these converters is included in the edition. The chapter headings are as follows; The Ford Car, its Parts and their Functions; the Engine and Auxiliary Groups; Details of the Ford Chassis Parts; Driving and Maintenance of Ford Cars; Overhauling and Repairing Mechanism; the Ford Tractor and Tractor Conversion Sets and Genuine Ford Tractor; Operation Maintenance of Fordson Tractor; Repairing and Using Fordson Tractor.

Design and Construction of Heat Enginea. By William E. Ninde. 704 pages, 6 by 9 inches; illustrated. Published by the McGraw-Hill Book Co., Inc., New York City. Price, $6, net.

The object of this book, as stated by the author in the preface, is to supply in one volume the material most essential to the well-equipped, independent designer of heat engines, and to give this material in the form most convenient for use in the classroom and in practice by a separate treatment of the different phases of the subject. The author has included in the contents material from his notebooks on engine design, covering his practice and observation for over twenty years, and the revisions and additions which were made to adapt the notes to his teaching work for the last ten years, as well as material from technical books and periodicals necessary to fill the gaps in first-hand information. In the derivation of formulas, abstruse methods have been avoided as much as possible, but it has been the aim to omit no important element which permits of practical treatment, and the formulas and fundamental principles have been arranged in a form suitable for direct application. The book is divided into six parts covering the Heat Engine; Thermodynamics; Friction and Lubrication; Power and Thrust; Mechanics; and Machine Design. The two appendixes give the moment of inertia of irregular sections, and a table of U. S. standard bolts and nuts. Steam tables and other tables found in all handbooks are omitted.

Graphic Production Control. By C. E. Knoeppel. 477 pages, 6 by 9 inches; illustrated. Published by the Engineering Magazine Co., 6 E. 39th St., New York City. Price, $10.

The publication of this book is timely in view of the fact that production (and means of increasing and controlling it) is one of the most prominent subjects under discussion today, and the matter here presented should in consequence be of considerable interest. The book outlines a system of controlling production by the use of charts and other graphic means, the purpose being to place before industrial executives a complete description of the mechanisms of graphic production control. The presentation has been arranged in five parts: Section I deals with the philosophic aspect of graphic production control, calling attention to the present need for production, the relation of management to production, the use of graphics in warfare and industry, the laws of graphic production control, as well as the fundamental considerations which must be recognized in the installation of this plan. Section II deals with the preliminary steps in organizing for the installation of graphic production control. Section III takes up the practical installation of the plan. Section IV treats of the managerial features of the syatem in its relation to organization, standardization, and costs, and the relation of graphics to the labor problem. Section V discusses the pitfalls and economic aspects of graphics in industry. The universal applicability of graphical methods is indicated by the fact that the material in the book is based on experience in the development and use of graphics in the following lines: Textile machinery; gas traction engines; gray iron castings; brass castings; steel castings; steel plate construction; metal furniture; automobile axles and transmissions; small motors; taps, dies, reamers, and gages; hardware; clothing; rubber tires and tubes; truck axles; oil producing and refining; fiber board; and automobiles.

Electric Furnaces in the Iron and Steel Industry. By W. Rodenhauser, J. Schoenawa, and C. H. Vom Baur. 460 pages, 6 by 9 inches. Published by John Wiley & Sons, 432 Fourth Ave., New York City. Price, $4.60, postpaid.

This book, which was originally published in German in 1911, is now in its third English edition, and the present volume has been entirely rewritten. The great strides made in all forms of industry during the war are also apparent in the development of the electric furnace and in its operation. This has made it necessary to revise this book in order to include the latest information on the design and construction of these furnaces and their use in the manufacture of steel and iron. The book is intended for the practical man, but it also explains the electric laws and phenomena involved and the scientific principles upon which the work rests. It states the principal laws which the construction and operation of electric furnaces entail without entering into long mathematical discussions, short arithmetical examples only being given, dealing with actual furnace problems. The types of furnaces most extensively used are described in detail. The book is divided into two parts, the first of which deals with questions relative to the construction of electric furnaces and the apparatus used, while the second part takes up the practical use of these furnaces in the steel mill, treating of the materials for furnace construction and costs of operation, as well as the electro-metallurgy of iron and steel. The chapter heads are as follows: Historical; Some Laws and Fundamental Principles of Electricity; Effects of the Electric Current; Power Factor and Alternating Current Theory in General; General Conditions for the Operation of Electric Furnaces; The Arc Furnaces in General; the Stassano Furnace; the Heroult Furnace; the Girod Furnace; the Rennerfelt Furnace; the Induction Furnace in General; the Kjellin Furnace; the Roechling-Rodenhauser Furnace; the Electric Shaft Furnace; General Review; Final Considerations; Materials for Furnace Construction; the Costs of Operation; the Electric Smelting of Iron Ores with the Production of Iron and Steel; and the Use of the Electric Furnace for Melting, for the Refining of Pig Iron, and for the Production of Ordinary and Special Quality Steel.

NEW CATALOGUES AND CIRCULARS

Henry G. Thompson & Son Co., New Haven, Conn. Price list of Milford hacksaw blades and band saws.

Link-Belt Co., 910 S. Michigan Ave., Chicago, Ill. Circular advertising Link-Belt roller chain for driving power farm machinery.

National Machinery Co., Tiffin, Ohio. National Forging Machine Talk No. 37, describing the making of pipe couplings on the forging machine without welds.

Saint Louis Machine Tool Co., 932 Loughborough Ave., St. Louis, Mo. Pamphlet illustrating and giving specifications for the No. 7 Saint Louis polishing machine.

Cashman Tool Co., Waynesboro, Pa. Catalogue A, illustrating and describing Cashman adjustable shell reamers. Tables are given, listing the sizes, number of blades, and prices.

F. C. Brand & Co., 27 Warren St., New York City. Circular advertising white metal pattern letters and figures for the use of foundrymen, machinists, and patternmakers.

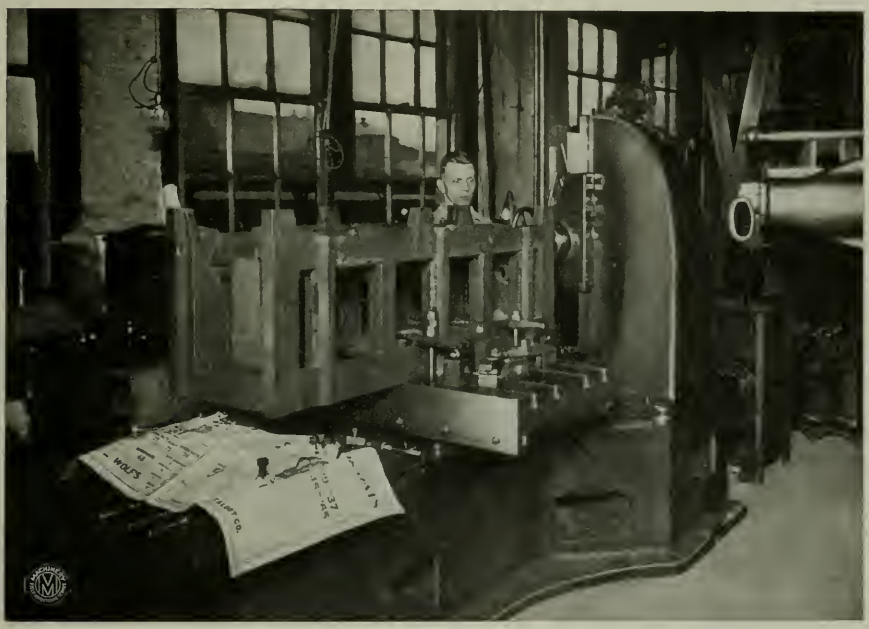
Hooven, Owens, Rentschler Co., Hamilton, Ohio. Catalogue treating of Hamilton Corliss rolling mill and blowing engines, and their application in the iron and steel industry.

E. M. Dart Mfg. Co., Providence, R. I. Catalogue M, giving dimensions and prices of Dart union fittings and flanges. Copies of the catalogue will be sent upon request.

Nice Ball Bearing Co., Nicetown, Philadelphia, Pa., is issuing a monthly publication entitled "Nice News," published by and in the interests of the employes of the company.

New Departure Mfg. Co., Bristol, Conn. Loose-leaf circulars 126 FE, 127 FE, and 128 FE, illustrating installations of ball bearings in die forming machines, band saws, and planers.

LUCAS "PRECISION" BORING MACHINES



Fine Machines In a Fine Shop

For more than three years, two Lucas "Precision" Boring Machines have been used exclusively for jig work by John Bath of Worcester—builder of fine tools. One of these machines is here shown boring holes in a very heavy box jig—so long that the end supports of the machine had to be removed to accommodate it.

There are 42 holes in the body of this jig and 29 in the cover—a total of 71—and diameters vary from $\frac{5}{8}$″ to 2″. All must be correctly located—diameters and center distances being held to plus and minus limits of 0.0005″.

Work of this kind is nothing unusual for these machines.

ASK FOR COMPLETE DESCRIPTION

LUCAS MACHINE TOOL CO. NOW AND ALWAYS OF **CLEVELAND, OHIO, U.S.A.**

FOREIGN AGENTS: Alfred Herbert, Ltd., Coventry. Societe Anonyme, Alfred Herbert, Paris. Societe Anonyme Belge, Alfred Herbert, Brussels. Allied Machinery Co., Turin, Barcelona, Zurich. Benson Bros., Sydney, Melbourne. V. Lowener, Copenhagen, Christiania, Stockholm. R. S. Stokvis & Zonen, Rotterdam. Andrews & George Co., Tokyo.

William H. Haskell Mfg. Co., Pawtucket, R. I. Catalogue D, giving dimensions and price lists of this company's line of bolts, screws, studs, nuts, punchings, and screw machine products.

Wagner Electric Mfg. Co., St. Louis, Mo. Bulletin No. 122, describing the construction and application of Wagner polyphase motors, of the squirrel-cage and wound-rotor or slip-ring types.

Cisco Machine Tool Co., Cincinnati, Ohio. Catalogue covering the line of Cisco lathes, which are made in belt- and motor-driven styles, with either plain or geared head in sizes from 12 to 26 inches.

Carlyle Johnson Machine Co., Manchester, Conn. Catalogue of Johnson friction clutches, showing types of machines on which this clutch has been successfully applied, which includes all classes of machine tools.

Electric Controller & Mfg. Co., Cleveland, Ohio. Bulletin 1037 B, giving dimensions and other data for Type B limit stops for direct-current motors, applicable to electric cranes or other motor-driven machines which must be stopped automatically.

Production Engineering Co., 212 Center St., New York City. Circular entitled "Prenco Tools, Dies, and Fixtures," outlining "Prenco" tool service and containing a synopsis of the personnel of the company and the method of handling work.

Nickle Engineering Works, Saginaw, Mich. Bulletin 1-C entitled "Agitator Driving Yokes," describing a standard power transmission device, made in several styles and sizes, for driving agitator or stirrer shafts in chemical tanks and kettles.

Walter A. Zelnicker Supply Co., St. Louis, Mo. Bulletin 278, containing a list of new and second-hand rails, cars, tanks, heavy machinery, and equipment used in operating and maintaining railroads, power plants, mines, and industrial plants of all kinds.

H. H. Arnold Co., Rockland, Mass. Circular giving prices and dimensions of Arnold shell reamers, chucking reamers, hand reamers, counterbores, and side milling cutters. These tools are made with high-speed steel blades, brazed to low-carbon steel bodies.

Geometric Tool Co., New Haven, Conn., has published a book to serve as a memorial to the employes of the company who enlisted in the service of the Government during the war. The book contains portraits of the men and a brief outline of their records in service.

Griscom-Russell Co., 90 West St., New York City. Bulletin 1120, descriptive of the construction and operation of the Stratton Jr. oil separator. Bulletin 311, illustrating and describing the Reilly evaporator, of the submerged type, for use in marine and stationary power plants.

Seneca Falls Mfg. Co., Inc., 381 Fall St., Seneca Falls, N. Y. Catalogue 27, illustrating and describing the "Star" screw-cutting engine lathes, which are made in 9-, 11-, 12-, and 13-inch sizes, for belt or motor drive. The various attachments for use on these lathes are also illustrated and described.

Gale-Sawyer Co., South Weymouth, Mass. Catalogue 3, giving dimensions, prices, and other data for the line of small tools manufactured by the company, which includes end-mills, T-slot cutters, side milling cutters, etc. The catalogue also gives tables of cutting speeds, and weights of round bars of high-speed steel and carbon steel.

Ingersoll Milling Machine Co., Rockford, Ill. Bulletin 39, illustrating the line of continuous milling machines made by the company for high-quantity production on special classes of work. The machines shown include the differential type, drum type, rotary and circular table machines, reciprocating type, and semi-automatic machines.

Wilton Tool & Mfg. Co., 84 Linden Park St., Boston, Mass. Booklet entitled "A Message of Measurements," by H. L. Van Keuren, describing the use of Wilton master gage-blocks, which are made to an accuracy of 0.000010 inch. These sets of gage-blocks can be assembled into built-up combinations which will be accurate to 0.0001 inch.

Cutler-Hammer Mfg. Co., Milwaukee, Wis. Loose-leaf bulletins giving ampere ratings of direct- and alternating-current motors, and price lists, dimensions, etc., for automatic starters, elevator reversing switches, elevator controllers, gage-type pressure regulators, push-button master switches, limit switches, brake magnets, speed regulators, etc.

Duke Steel Co., 191 Pearl St., New York City. Catalogue containing tables of weights, dimensions, and price lists of "Duranium" high-speed steel, and Duke high-speed and tungsten steel, in bars, billets, blocks, disks, rings, and special shapes. The heat-treatment employed for each of the various brands of tool and alloy steel made by the company is described.

R. K. LeBlond Machine Tool Co., Cincinnati, Ohio. Catalogue describing the construction and operation of the LeBlond "Multi-cut" lathe, which is built in two sizes—6 inches swing, with 10 inches capacity between centers, and 9 inches swing with 16 inches capacity between centers. The catalogue also shows typical tool lay-outs for jobs performed on these machines.

Heald Machine Co., Worcester, Mass., is now issuing a series of pamphlets on the Heald magnetic chuck, the first of which shows various applications on lathes, planers, millers, and grinders; the second describes the features of these chucks, treating of the holding power, unit construction, magnetism, waterproof and oilproof properties, etc.; and the third contains specifications and prices.

Greenfield Tap & Die Corporation, Greenfield, Mass., manufacturer of tools for cutting and gaging screw threads, is issuing a new publication entitled "The GTD Helix." The company has been publishing an employes' edition for two years, but now thinks it desirable to make the distribution more general. Besides the editorials, there is a section devoted to dealers' service, which should be of interest to the trade.

Esterline Co., Indianapolis, Ind. Bulletin 395, treating of power factor recording instruments. The book points out the evils of low power factor on the central station, the isolated plant and the power customer, and tells how to locate and eliminate the causes of low power factor. The Esterline power factor recorders are illustrated and described. Copies of the bulletin will be sent to any engineer interested in power factor problems.

H. B. Underwood Corporation, Philadelphia, Pa. Catalogue of portable tools for use in railway repair and machine shops. Among the tools illustrated and described are cylinder and valve-seat boring-bars, boring-bars for turbine engines, boring-bars for lathe work, and other special types of boring-bars, facing arms, planer tools, flue cleaners, crankpin turning machines, milling machines, pipe-bending and straightening machines, etc.

Greenfield Machine Co., Greenfield, Mass. Catalogue 7, illustrating and describing Greenfield universal grinders for tool, cutter, and general machine shop grinding. The catalogue contains views showing the variety of operations for which these machines are adapted, which include cutter grinding, internal grinding, grinding flutes of taps, cylindrical grinding, flat and beveled work, form grinding, and surface grinding. Special attention is called to the new No. 2 universal grinder, which is an improved design.

Detroit Hexagon Drill Co., 27-29 Woodward Ave., Detroit, Mich. Booklet entitled "Cutting the Corners," describing the drills made by this company for cutting hexagon or square holes. These tools, which are known as the "Detroit Hex" drills, will drill square or hexagon holes in steel, iron, brass, aluminum, micarta, bakelite, wood, marble, etc. They can be used in any drilling machine, screw machine, milling machine, or lathe, and may be operated at speeds up to 400 revolutions per minute.

Wheeler Condenser & Engineering Co., Carteret, N. J., has issued the fifth edition of its handbook "Steam Tables for Condenser Work." The book gives the properties of saturated steam from 29.8 inches vacuum to atmospheric pressure in increments of tenths of an inch. A complete table is given of the properties of saturated steam above atmospheric pressure. The book also tells how to make measurements by means of the mercury column and barometer, and gives constants and tables for making corrections in readings.

Golden Co., 405 Lexington Ave., New York City. Catalogue 230, describing a high-precision micrometer made by the Societe Genevoise d'Instruments de Physique of Geneva, Switzerland, measuring 100 millimeters to 0.001 millimeter, or 4 inches to 0.00005 inch. Catalogue 239, illustrating and describing test comparators made by the Societe Genevoise d'Instruments de Physique for making comparisons to an accuracy of 0.001 millimeter or 0.00005 inch. The comparators are shown in use measuring balls, disks, cylinders, and rings.

Gould & Eberhardt, Newark, N. J. Bulletin 45, illustrating Gould & Eberhardt automatic gear-cutting machines, designed especially for intensive production on automotive gears. The line includes vertical gear-cutting machines, continuous-ring gear-cutting machines, four-spindle bevel gear roughing shapers, worm-wheel generating machines, worm roughing machines, continuous cam milling machines, and multiple-spindle hobbing machines. Views are shown illustrating installations of the various types of machines at work in a number of large automobile and gear-cutting plants.

Gisholt Machine Co., 9 S. Baldwin St., Madison, Wis. Circular entitled "Machining Parts Economically," illustrating the Gisholt standard turret lathe, which is built in six sizes, ranging from 13 to 41 inches swing, and is adapted for boring, turning, facing, and thread-cutting of parts made from cast iron, steel castings, steel forgings, and bronze or malleable iron. Circular entitled "Gisholt Method of Tool Grinding," illustrating the Gisholt universal tool grinder, which is adapted for grinding all kinds of tools, including bent tools, inserted cutters and small tool bits, as well as larger tools.

Boston Gear Works, Norfolk Downs (Quincy), Mass. Catalogue F-10, containing a complete list of the standardized gears carried in stock by this company. The line comprises 1200 sizes, including the standard styles of spur, bevel, miter, spiral, and helical gears, worm-gears and worms, sprockets, pinion wire, and rack in brass, iron, and steel. This catalogue shows a new line of hardened steel spiral and worm gears, with the threads ground and with extra long faces, as well as some new sizes of thrust ball bearings for small size shafts. Copies of the booklet will be sent upon request.

Hyatt Roller Bearing Co., 1 Madison Ave., New York City. Circular entitled "A Vision Realized," advertising the use of Hyatt roller bearings in industrial plants, mining apparatus, machinery of all kinds, motor cars, trucks, and tractors. Circular entitled "Over Fifteen Million a Year," describing the development of the manufacture of Hyatt roller bearings, which was begun in two small buildings, fifteen years ago, and has grown so that today the plant comprises twenty-three buildings containing 1,000,000 square feet of floor space, and turns out over 15,000,000 roller bearings a year.

Allied Machinery Co. of America, 51 Chambers St., New York City. Catalogue Section 1110I, illustrating and describing the turning machines made by the American Tool Works Co., Cincinnati, Ohio. Section 15601, illustrating and describing the milling machines made by the W. B. Knight Machinery Co., St. Louis, Mo. Section 16201, showing the grinding machines made by the Greenfield Machine Co., Greenfield, Mass. Section 16210, illustrating the grinding machines made by the Oakley Machine Tool Co., Cincinnati, Ohio. Section 18401, illustrating and describing the cutting-off machines made by the Hurlbut, Rogers Machinery Co., South Sudbury, Mass.

American Kron Scale Co., 430 E. 53rd St., New York City. Catalogue 6, illustrating the use of the Kron scale for weighing materials in warehouses, factories, transportation offices, industrial plants, etc. The catalogue shows the regular line of Kron scales and gives the capacity and platform dimensions. Opposite each scale is shown a typical installation. These scales are of the automatic type, equipped with a direct-reading dial, which makes it unnecessary to adjust weights or make mental calculations in weighing, resulting in a considerable saving of time. They are said to be the only scales constructed on the self-sealing principle, with all parts interchangeable.

TRADE NOTES

Chrobaltic Tool Co. has moved from Chicago, Ill. to Michigan City, Ind.

Hyatt Roller Bearing Co., has moved to larger quarters at Sixth Ave. and 41st St., New York City.

Chicago Pneumatic Tool Co., 1060 Fisher Bldg., Chicago, Ill., announces that its general offices were transferred April 1 to 6 E. 44th St., New York City.

Republic Tool & Mfg. Co., Cleveland, Ohio, has taken over the exclusive sales agency for northern Ohio for the abrasive products of the Waltham Grinding Wheel Co., Waltham, Mass.

F. C. Brand & Co., 27 Warren St., New York City, has been organized by Frank C. Brand, formerly manager of A. G. Butler, Inc., of New York, to handle patternmakers' and foundry supplies.

Ellenwood & Doyle, 29 Great Jones St., New York City, distributors of tin plate, black and galvanized sheets, copper, brass, zinc, etc., have been incorporated under the laws of New York state with a capital of $150,000.

Canton Foundry & Machine Co., Canton, Ohio, announces that its export department is now located on the fifth floor of the Grand Central Palace, International Machinery Exposition, New York City.

Van Norman Machine Tool Co., Waltham, Ave., Springfield, Mass., has moved its New York sales office from 320 Fifth Ave. to 50 Church St., Room 1856. J. D. Apgar is in charge of the New York office.

Ford of France, Inc., 79 Wall St., New York City, announces that it has been appointed sole agent for the export of the hexagon and square-hole drills made by the Detroit Hexagon Drill Co., Detroit, Mich.

Murchey Machine & Tool Co., 34 Porter St., Detroit, Mich., manufacturer of threading tools, has opened an office in Cleveland at 511 Schofield Bldg., in charge of L. W. Arnold. An office has also been opened in New York City at 99 Warren St., with Charles M. Neth in charge.

Lafayette Tool & Equipment Co., Inc., Lafayette, Ind., at its last directors' meeting held at the general sales office, 21 S. 12th St., Philadelphia, Pa., elected the following officers: William M. Manion, president; Joseph M. Strybal, vice-president; and Dudley Shoemaker, secretary and treasurer.

Buffalo Forge Co., Buffalo, N. Y., at a recent meeting of the stockholders, appointed the following new officers: Henry W. Wendt, president; Edgar F. Wendt, vice-president and treasurer; Henry W. Wendt, Jr., vice-president and secretary; and C. A. Booth, vice-president and sales manager.

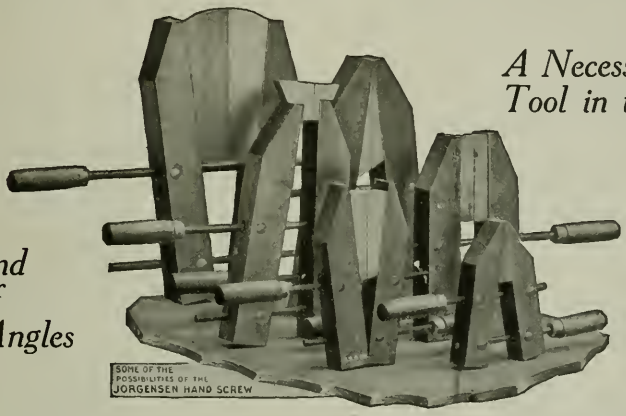
Joseph T. Ryerson & Son, Chicago, Ill., has been made representative of the Camden Iron Works in the sale of their hydraulic machinery

Your Pattern Shop Should Be Interested in the

JORGENSEN ADJUSTABLE HAND SCREW

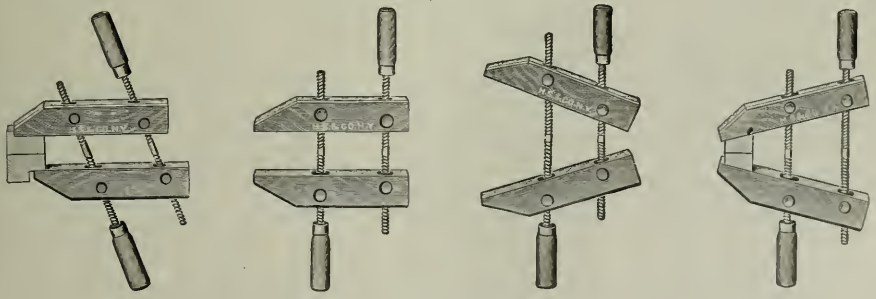
A Necessary Tool in the Shop

The Hand Screw of Many Angles



A SINGLE CLAMP will adjust to any of the positions shown, or any modification of them. One jaw can also be made to overlap the other.

More than that, these Adjustable Hand Screws have Steel Spindles which are practically indestructible. They have a Right and Left thread, and open and close almost twice as fast as old style clamps—more time saved.



Send for Circular No. 551 and read more about them

HAMMACHER, SCHLEMMER & CO.

HARDWARE, TOOLS AND FACTORY SUPPLIES

NEW YORK, SINCE 1848 **4th AVENUE AND 13th STREET**

products. In addition to a complete line of hydraulic tools, this company also makes centrifugal pumps, cast-iron pipe and fittings, and kindred products.

Whitman & Barnes Mfg. Co., Akron, Ohio, announces that the following officers were elected at its last annual stockholders' meeting: A. D. Armitage, president; W. H. Eager, A. B. Hall, and W. J. Elliott, vice-presidents; E. A. Fisher, treasurer; W. E. Rowell, secretary; and S. H. Tuttle, assistant secretary.

Morse Chain Co., Ithaca, N. Y., manufacturer of frictionless rocker joint chains, and high-speed silent-running flexible gearing, announces that the company has opened new offices at 1402 Lexington Bldg., Baltimore, Md., in charge of E. R. Morse, and also at 302 Harrison Bldg., Philadelphia, Pa., in charge of M. H. Rodda.

Ray D. Lillibridge, Inc., 111 Broadway, New York City, has established a foreign department for the purpose of giving advice and assistance to its clients in the matters of export advertising and sales. Maurice Legori, for the last two years manager in Argentina for Viele, Blackwell & Buck of New York, will be manager of the new department.

Oxweld Acetylene Co., Newark, N. J., has recently extended its manufacture of oxy-acetylene apparatus and equipment to include "Evereadу" welding and cutting outfits. The "Evereadу" apparatus is essentially the same as that previously known as "Prest-O-Lite" apparatus, except for certain refinements in design that have been introduced.

Foster-Johnson Reamer Co., Elkhart, Ind., has been incorporated under the laws of Indiana with a capitalization of $200,000, for the manufacture of the Johnson expansion reamers, which have been made in the past by the Foster Machine Co. The officers of the new corporation are W. H. Foster, president; W. R. Johnson, vice-president; and Oscar Kylin, secretary.

Republic Tool & Mfg. Co., Cleveland, Ohio, because of the rapid growth of its business, has found it necessary to expand its main offices, and the entire second floor of its present building has been remodeled to provide private and general offices of ample capacity. The ground floor and the floors above the second will be utilized for greater warehouse capacity.

Blevney Machine Co., Greenfield, Mass., manufacturer of grinding, polishing, and finishing machinery, announces that the firm name has been changed to Production Machine Co. The company has decided that the word "production" has more significance in connection with its product than the name Blevney. There will be no change in the officers or management of the business.

Golden Co., 405 Lexington Ave., New York City, announces that it has the exclusive American agency for Societe Genevoise d'Instruments de Physique, Geneva, Switzerland, maker of comparators for gaging steel balls, ball bearings, and machine parts; universal measuring machines; reference gages; scientific instruments; and dividing engines for cylindrical, conical, and linear work.

Electric Furnace Co., Alliance, Ohio, has opened a middle western office at 301 Frisco Bldg., St. Louis, Mo., with W. E. Prosser in charge. The increasing demand for Baily electric furnaces for melting non-ferrous metals and the fact that there are at present sixty units of this type in operation within a radius of 500 miles of St. Louis have made it necessary to open an office in this vicinity.

Erie Crucible Steel Co., Erie, Pa., announces the appointment of the Cleveland Steel Supply Co., Cleveland, Ohio, as its agent for the Cleveland district. C. E. Schnibbe, manager of the Cleveland Steel Supply Co., was associated with the Halcomb Steel Co. for twelve years, five of which he was connected with the Cleveland branch of the company and hence is well known in the Cleveland district.

Maher Engineering Co., 30 N. Michigan Blvd., Chicago, Ill., has opened a branch office at 706 Schofield Bldg., Cleveland, Ohio, to handle the distribution of Erie Engine Works' constant- and variable-speed, high- and low-pressure engines; Dayton-Dowd Co.'s centrifugal pumps; and Galland-Henning Mfg. Co.'s hydraulic balers and presses. The office will be under the management of Lincoln E. Maher.

Lafayette Tool & Equipment Co., Inc., Lafayette, Ind., announces that it has appointed the Societe Anonima Italiana Alfred Herbert, 42 Via Sajezzo, Milan, Italy its sole agent in Italy for the sale of the Lafayette universal grinder. The Sherritt & Stuer Co., Inc., 2006-2008 Market St., Philadelphia, Pa., has been appointed exclusive representative for the sale of the Lafayette universal grinder in the Philadelphia district.

Westinghouse Electric & Mfg. Co., East Pittsburg, Pa., has acquired a financial interest in the George Cutter Co. of South Bend, Ind. The management and policies of the company will remain unchanged, but advantage will be taken of the Westinghouse engineering and other facilities to expand the George Cutter Co.'s lines. The Westinghouse Electric & Mfg. Co. will operate as sole distributor for the George Cutter Co.'s products.

Driver-Harris Co., Harrison, N. J., is erecting a three-story building, 52 by 100 feet, to which will be added a 100-foot extension. The upper floor of the building will be used for a general office, the second floor for a spooling and testing room, and the ground floor for the cleaning and shipping departments. It is planned to erect another large building later in the year. The capitalization of the company has been increased to $3,000,000.

Hobart Bros. Co., Troy, Ohio, maker of battery-charging equipment, announces the placing on the market of a new product, consisting of an outfit of 250-watt capacity, capable of recharging from one to four automobile starting and lighting batteries at one time. The outfit is provided with ball bearing equipment, automatic voltage control, ample capacity for rating, and a panel board mounted on top of the motor generator. It is especially designed for the use of small garages.

Toledo Steel Products Co., formerly the Lewis Steel Products Co., is now located in its new plant at 3300 N. Summit St., Toledo, Ohio, which comprises two brick buildings, each being over 400 feet long. The company is at present working with a full force, manufacturing valves for automobiles and marine, stationery and airplane engines. The officers are as follows: A. P. Closs, president; W. P. Childs, vice-president and manager; and M. A. Albaugh, secretary and treasurer.

Manning, Maxwell & Moore, Inc., 119 W. 40th St., New York City, has opened a new store in San Francisco, Cal., at 40-42 Fremont St. This firm has maintained an office in San Francisco for many years, but as the demand for its machines has increased it has been found necessary to open a store to carry a line of machine tools for quick delivery. The store is in charge of C. H. Overkamp, who has been with the company for some years. Additional selling organization is being provided at this time.

Rickert-Shafer Co., 612 W. 12th St., Erie, Pa., manufacturer of the Boehm automatic die-head and the Rickert-Shafer line of automatic tapping machines, announces the following appointments in its organization: A. A. Shafer has been made secretary and general manager; C. W. Howard, formerly with the General Electric Co., has been made general sales manager; A. J. Patterson, formerly with the Crucible Steel Co., has been made general superintendent; and George Paterson has been made production manager.

Meldrum, Semon, Greiner, Lowry Co., Syracuse, N. Y., manufacturer of limit gages and tools, announces that the company has been reorganized under the name of the M. S. G. L. Co., Inc., which has also taken over the Lowry-Knise Tool Co., of Syracuse. The management and the officers of the new company remain the same as in the older concerns. The new company is capitalized for $200,000, and is planning to increase its present manufacturing facilities and to manufacture gages, special tools, and machinery.

Auburn Ball Bearing Co., 33 Elizabeth St., Rochester, N. Y., manufacturer of regular and special ball bearings with steel, brass, and bronze balls, has moved its offices into an adjoining building which has been renovated and equipped for the purpose. The company is now devoting the entire former floor space of its past quarters to manufacturing purposes. New storage space has also been added, providing additional space for the manufacturing departments, and thereby making it possible to considerably increase the company's manufacturing capacity.

Oakley Chemical Co., 26 Thames St., New York City, is offering $500 in prizes for the best articles written on the importance of cleaning as an essential manufacturing operation. The four best articles will receive prizes of $100, $75, $50, and $25, respectively, and the next twenty-five articles $10 each. The winning articles will be published in the "Oakite News Service," issued by the Oakley Chemical Co. The articles are not to exceed 2000 words in length, and preference will be given to those of about 1500 words. The contest closes April 19. Further information will be furnished by the contest editor, Oakley Chemical Co., 26 Thames St., New York City.

F. W. Lindgren Co., Rockford, Ill., manufacturer of sensitive drilling machines, has been absorbed by the **Mechanics Tool Co.** of Rockford. The combined capitalization is $150,000. The Mechanics Tool Co. is now located in its new plant on 23rd Ave. and 7th St., and will manufacture, on a large scale, the Lindgren sensitive drilling machines in 16-, 20-, and 24-inch sizes, with tapping attachment. The company will also continue its own line of hand tools and automobile parts. Considerable new equipment has been installed. The officers are E. S. Ekstrom, president; F. W. Lindgren, vice-president; O. N. Swangren, secretary; and Levine Faust, treasurer.

Cincinnati Automatic Machine Co., Oakley, Cincinnati, Ohio, manufacturer of automatic screw machines, announces that the company has acquired the manufacturing, selling, and patent rights to the Gridley automatic multiple-spindle drilling machine formerly made by the Windsor Machine Co., Windsor, Vt. This machine will be sold by the Cincinnati Automatic Machine Co. under the name Cincinnati-Gridley automatic multiple-spindle drill, and will be manufactured in quantities along with the company's multiple-spindle automatic screw machines. The manufacture will be handled in a new shop, which will largely increase the productive capacity of the present plant.

Black & Decker Mfg. Co., Towson Heights, Baltimore, Md., has sold its Baltimore plant at 105-115 S. Calvert St. to the Dieffenbach-Westendorf Mfg. Co., which is composed entirely of former employes of the Black & Decker Mfg. Co. The officers of the new company are as follows: O. W. Dieffenbach, formerly manager of the Baltimore plant, president; William Westendorf, formerly superintendent, vice-president and general manager; John Sonnenleiter, formerly foreman of the milling machine department, secretary. George M. Kimberly, who has been treasurer of the Black & Decker Mfg. Co., for a number of years, will also occupy the position of treasurer with the new company.

Westinghouse Electric & Mfg. Co., East Pittsburg, Pa., has contracted with Westinghouse, Church, Kerr & Co. to build four new buildings at South Philadelphia, Pa. This expansion is intended to take care of the immediate needs incident to the removal of the Machine Works (formerly the Westinghouse Machine Co.) from East Pittsburg. The four buildings will comprise a one-story machine shop, 500 by 130 feet, which will be used for building small turbines for operating pumps and generators; a one-story machine shop, 750 by 130 feet, which will be used for building large steam turbines; an extension to the erecting shop of 300 feet adjoining the new machine shops; and a three-story warehouse 600 by 50 feet, the third floor of which will be used for manufacturing purposes.

American Chain Co., Inc., Bridgeport, Conn., has purchased the control of the Page Steel & Wire Co. with mills at Monessen, Pa. and Adrian, Mich. It is the intention of the American Chain Co., Inc., to continue the business of the Page Steel & Wire Co. as heretofore, taking only its surplus products. The new officers of the company are: Walter B. Dashar, president; William T. Morris, vice-president; Wilmot F. Wheeler, treasurer; John E. Carr, assistant treasurer; and William M. Wheeler, secretary. E. C. Sattley, general manager of the Page Steel & Wire Co., will continue in that capacity with offices in Pittsburg, Pa. The general sales offices of the American Chain Co. are in the Grand Central Terminal Bldg., New York City, and it maintains district sales offices in Chicago, Boston, Philadelphia, San Francisco, Portland, and Pittsburg.

George D. Roper Corporation, Trahern Pump Division, Rockford, Ill., announces that the amalgamation of the Trahern Pump Co. with the George D. Roper Corporation will enable an increase of 50 per cent in the production of Trahern pumps. As yet only the foundry section of the new plant being built is complete and in operation. The entire plant, when completed, will cost approximately $1,500,000, and is located on a tract of land purchased for the purpose at Rockford, Ill. The Trahern Pump Co., which started in business in 1857 and has built up a nationally known name and reputation, will not lose its individuality through the merger, and all correspondence addressed to it should be directed to the George D. Roper Corporation, Trahern Pump Division, Rockford, Ill. The Trahern pump line includes the rotary geared circulating pump well known in the machine tool industry, and also large rotary pumps for general uses.

Gage Engineering Service Co., 1422 F St., N.W., Washington, D. C., is organized and equipped to extend to manufacturers technical service, and as a means of keeping them regularly informed regarding recent developments is issuing a monthly report known as "Technical Service Report," which gives the names and nature of contents of articles appearing in current American and several foreign trade and technical journals and of papers presented before technical societies pertaining to gaging, inspection, testing; tools, jigs, and fixtures; cutting and finishing of metals; and composition, structure, and heat-treatment. The report also gives the names and brief reviews of new books which have a bearing on inspection and production; brief descriptions of new equipment such as gages and inspection fixtures, production tools and fixtures, and cutting tools; and photostat copies of patents which apply to gages, measuring instruments, tools, jigs, and fixtures, as published in the "Official Gazette" of the United States Patent Office.

J. H. Williams & Co., 61 Richards St., Brooklyn, N. Y., announces that a special meeting of the stockholders of the company, in conjunction with the stockholders of the Whitman & Barnes Mfg. Co. of Akron, Ohio, has been called for April 2, for the purpose of ratifying an agreement entered into by the respective presidents of the companies, made subject to the approval of the stockholders, for the merging of the Chicago, Ill., and the St. Catharines, Ontario, Canada, plants of the Whitman & Barnes Mfg. Co. with J. H. Williams & Co. When ratified, this plan will contemplate the operation by J. H. Williams & Co. of drop-forging and drop-forged tool plants at Brooklyn, N. Y., Buffalo, N. Y., and West Pullman, Chicago, Ill., in the United States, and at St. Catherines, Ontario, Canada, which is located close to Buffalo; the business will be operated by the same management as is now connected with these plants. The plans of J. H. Williams & Co. under this arrangement call for a considerably extended capacity. The Whitman & Barnes Mfg. Co. will continue its business of making twist drills, reamers, and collateral lines on an extended scale at Akron.

VOLUME 26 **MACHINERY** NUMBER 9

MAY, 1920

THE INDUSTRIAL PRESS, 140-148 LAFAYETTE ST., NEW YORK CITY

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Principal Articles to Appear in June MACHINERY

Electric Arc Welding with Alternating Current..*Fred R. Daniels*

Testing and Heat Indicating Equipment for Hardening Rooms *S. P. Rockwell*

Machining Packard Connecting-rods.....*Edward K. Hammond*

Designing a Special Drilling Machine .....*F. E. Johnson*

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FOREIGN MACHINERY MERCHANTS PAGES, 512-513—ADVERTISERS INDEX, 547-548—PRODUCT INDEX, 514-544.

The Editor's Talk With MACHINERY'S Readers

SOME fifteen or twenty years ago mechanical journals frequently published discussions on the subject of Planing versus Milling. That was in the days when the milling machine was just finding its place as a manufacturing machine in the industries. Today, discussions of that kind are superfluous. The place of the milling machine and that of the planer are both quite well defined. The development of the milling machine, however, has by no means reached its final stage. Large special milling machines for unusual applications are constantly being built, especially for the automobile and tractor companies. The May number of MACHINERY takes up the application of milling machines of this type in two articles which review in a comprehensive manner the field for which the milling machine is now being adapted as a single-purpose machine. One of these interesting articles deals with the application mainly to the automobile and tractor field, while the other covers special milling machines built for the manufacture of gun-sights.

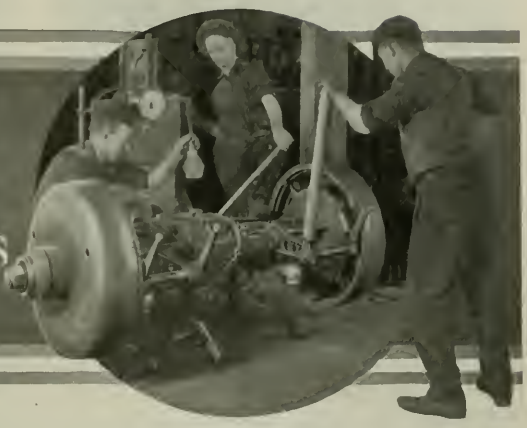
FEW persons not actually engaged in the automobile industry realize the enormous proportions and ramifications of this vast and relatively new industry. The plans of the automobile companies in the United States for this year call for 2,500,000 cars. One concern alone means to produce a million cars. More than 200,000 men are directly engaged in the building of motor cars and doubtless an equal, if not a larger, number are engaged in the making of parts and accessories for automobiles, not to mention the large number employed in the production of raw materials for automobile manufacture. Thus the great and increasing importance of the automobile industry in the mechanical field need not be emphasized. Appreciating the importance of shop practice in this great and progressive industry, MACHINERY collects and publishes what amounts to a complete and continuous record of the interesting methods. The articles on automobile shop practice in May MACHINERY deal with the Making of Clark Rear Axles and the Machining of Camshafts.

IN these days when quantity production is the order of the day, the production engineer tends to over-shadow the designing engineer, and the work of the former may sometimes appear to be the more important. Every mechanical executive knows, however, that to secure the best results the production engineer and the designing engineer must work hand in hand. A mechanical journal, to be of real help to both, must recognize their equal importance in maintaining the supremacy of our industries. The articles in May MACHINERY of particular appeal to machine and tool designers are those dealing with the Design and Construction of Sub-presses; Dies for Shaping a Motorcycle Part; and the Manufacture of Sewing Machine Needles.

AN unusual article for the designer, featuring the vital question of design in relation to cost of production—a question that must be considered by the designer if he is to achieve real results in his chosen work—will appear in June MACHINERY under the title: "Designing Special Drilling Machines." In addition, the June number will contain articles on the Designing of Recessing Tools, and Dies for a Double-flanged Shell.

IN surveying the great mechanical field, and especially the basic machine tool and machine building industries in general, one is impressed with the thought that all the comforts of our modern life would be wiped out, should the wheels of these industries stop for but a few months. For these are the fundamental industries upon which all others depend. Without the machine tool, indispensable for the making of other kinds of machinery, there could be no material progress, no development, no civilization in the sense in which we have learned to consider civilization.

Manufacturing Clark Rear Axles



A Description of the Methods Used by the Clark Equipment Co., Buchanan, Mich., in the Manufacture of Rear Axles, Including the Machining Operations on the Dead and Live Axles, Axle Housings, Brake Supports, Brake-drum, and Gear-cases—First of Two Articles

By EDWARD K. HAMMOND

OWING to the urgent demand for the product of our mills and factories, those responsible for the management of manufacturing plants are usually compelled to concentrate their attention upon matters essential to the maintenance of production schedules. Years ago, means for safeguarding the operators of dangerous machinery, and the furnishing of ventilating systems, drinking fountains, etc., were not regarded as essential elements of industrial management; but as time went on, the demand for such provisions became sufficiently urgent so that they are now to be found in practically every American factory. The men who hold important positions in such organizations still find their time so fully occupied, however, that there has been little thought given to such questions as beautifying the surroundings of manufacturing plants.

Established practice in factory construction has led to a quite general belief that the exterior of such buildings inevitably must be of rather unprepossessing appearance. For that reason, men familiar with the appearance of the average factory experience a pleasant surprise upon arriving at the plant of the Clark Equipment Co. in Buchanan, Mich. The buildings are of the usual modern factory construction, with abundant window space on all sides and monitor roofs. So far there is nothing unusual. But the management of this corporation was unwilling to regard its work as finished when the buildings were turned over by the construction company and fully equipped for the manufacture of rear axles and steel disk wheels for motor trucks, and of twist drills, quick-change chucks, and similar small tools for use in the machine shop. The buildings which house this firm's manufacturing facilities were constructed in a natural amphitheater, surrounded by beautifully wooded hills, and it may have been that it was this environment that first suggested the possibility of improving the immediate surroundings of the plant.

It is believed by the management that the time and money which have been expended in covering the outside of its buildings with beautiful vines, and converting the factory grounds into a park of lawns, flower beds, and shrubbery has a deeper significance than merely improving the physical aspect of the plant. The idea is held that men who

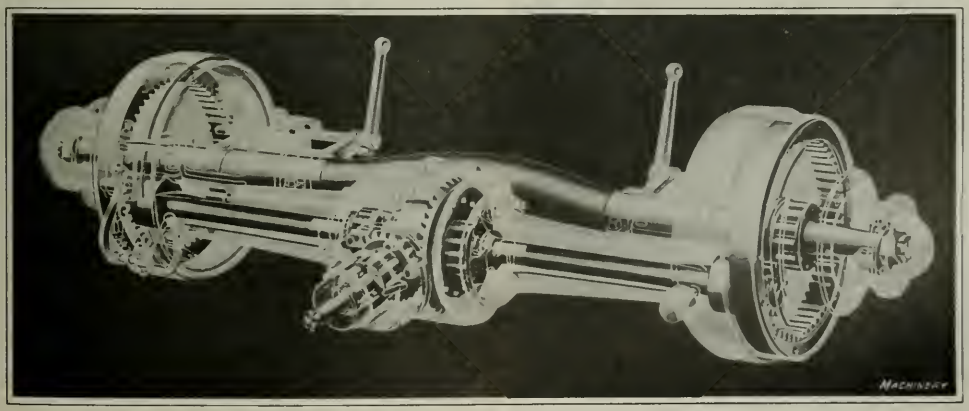


Fig. 1. Internal Gear Type of Axle manufactured by the Clark Equipment Co.



Fig. 2. Bulldozer equipped for bending Load-carrying Members for Clark Rear Axles



Fig. 3. After being bent all Load-carrying Axles receive a Careful Heat-treatment

pass through well-kept grounds will unconsciously take to their jobs a desire to have the product of their labor possess the same degree of perfection that is evident in nature's handiwork.

Manufacturing Rear Axles

Brief mention has already been made of the various products of the Clark Equipment Co., and in starting to describe the way in which manufacturing operations are conducted, it may be mentioned that there is one building occupied by the steel foundry, one that is equipped for the machining of the disk wheels for motor trucks, two buildings engaged in manufacturing parts of rear axles for trucks, and two devoted to the production of various chucks, twist drills, and other tools used in machine shops. About one-half of the men employed in these shops are stockholders in the company, and the attitude of these stockholding employes toward the employing organization is more that of partners engaged in the prosecution of a common enterprise than that of men who are working for a daily wage. This point is clearly brought out by the frequent reference which a visitor hears made by men to "our" quick-change chucks or "our" twist drills. The degree of pride with which the personal pronoun is used is sure to bring forth a question from the visitor who hears it, unless he happens to be familiar with the plan in vogue by which men are able to acquire stock that gives them this personal interest in the company; this plan was described in the February number of MACHINERY.

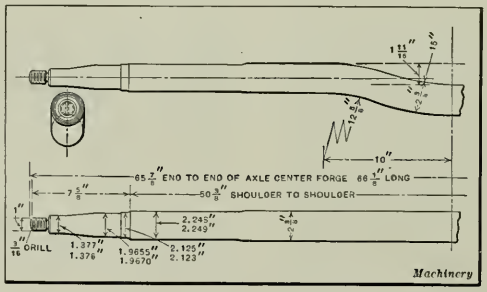


Fig. 4. One End of the Axle "Center" or Load-carrying Member

It is proposed to present in this article a general outline of the operations performed on some of the more important rear axle parts, together with detailed descriptions of machining operations which involve the use of tools and methods of exceptional interest. In all cases, the jobs which have been selected for the subjects of these detailed descriptions were chosen because of the possibility of employing similar principles of tool design or methods of machining in manufacturing parts of many other products besides rear axles. A general idea of the nature of the parts to be made will be secured by referring to Fig. 1 which shows a phantom view of a Clark internal gear axle. By looking over the arrangement of parts in this illustration the reader will not only obtain a general knowledge of the individual pieces of the axle but also of the way in which they are assembled together. Then at the beginning of the description of how the operations are performed on the various important members of the axle, will be found an illustration of the part that is under discussion.



Fig. 5. Each Axle receives a Scleroscope Test after the Heat-treatment



Fig. 6. Before Machining Operations are commenced the Axles must be straightened

TABLE 1. SEQUENCE OF MACHINING OPERATIONS ON DEAD AXLES[1]

Oper. No.	Operation	Located from	Type and Size of Machine	Tool Equipment
1	Forge	.....	C. C. Bradley 200-pound helve hammer	Forging dies
2	Bend	.....	Williams, White & Co. bulldozer	Bending dies
3	Heat-treat	.....	American Shop Equipment Co.'s oil furnace	Oil and water tanks, and Hoskins pyrometer
4	Test for hardness	.....	Shore scleroscope	.....
5	Center	.....	Heudey centering machine	Center drills
6	Straighten	.....	Lucas straightening press	Pressure gage and straightedge
7	Rough-turn at ends	Centers	American 20-inch lathe	Special steadyrest
8	Grind at ends	Centers	Norton plain grinding machine	Carborundum wheel

Machinery

[1]Note: See Fig. 4

TABLE 2. SEQUENCE OF MACHINING OPERATIONS ON LIVE AXLES[1]

Oper. No.	Operation	Located from	Type and Size of Machine	Tool Equipment
1	Forge	.....	C. C. Bradley 200-pound helve hammer	Forging dies
2	Normalize (heat-treat) to give desired physical properties	.....	American Shop Equipment Co.'s oil furnace	Oil-tanks and Hoskins pyrometer
3	Heat-treat	.....	American Shop Equipment Co.'s oil furnace	Oil-tanks, Hoskins pyrometer, and scleroscope
4	Center	.....	Heudey duplex centering machine	Center drills
5	Straighten	Centers	Lucas straightening press	Pressure gage, and straightedge
6	Rough-turn at ends and chase threads A	Centers	American 16-inch lathe	Turret tool-post
7	Grind turned surfaces	Centers	Norton grinding machine	Carborundum wheel
8	Generate spline grooves B and C	Centers	Barber-Colman gear-hobber	Special spline-grooving hob
9	Inspect	.....	.....	Gages, etc.

Machinery

[1]Note: See Fig. 7

Machining Load-carrying Axles

Fig. 4 shows the so-called "dead" axle which supports the load, and Table 1 gives a complete outline of the sequence of operations performed on this piece. The preliminary operation in making these parts is to perform a forging operation on a 200-pound Bradley helve hammer equipped with dies for drawing the ends of the forging down to approximately the desired shape and size. Each hammer used for this purpose is equipped with two pairs of dies, one pair being proportioned to enable the end of the work to be "broken down," after which it is transferred to the second pair of dies which completes the forging operation. Next the forgings are transferred to a Williams, White & Co. bulldozer, shown in Fig. 2, equipped with dies that provide for bending the center of the axle to the desired form. For both of these forging operations, the work is heated in an oil furnace to a temperature of from 1550 to 1600 degrees F.

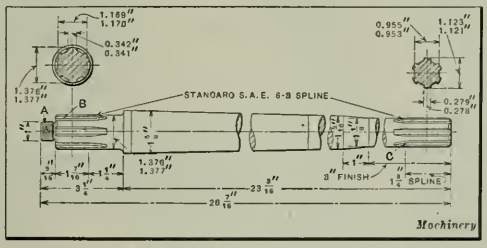


Fig. 7. The Main Driving Shaft or So-called "Live" Axle

After the axles have been bent and while they still retain the greater part of the heat, they are transferred to an oil furnace, Fig. 3, for a heat-treatment, which consists of first raising the temperature to 1550 degrees F. and quenching in water, after which the temper is drawn in oil at a temperature of from 900 to 1050 degrees F., according to the carbon content of the steel.

All furnaces used for raising the temperature of the work for forging or heat-treatment are equipped with Hoskins pyrometers that enable the temperature to be accurately regulated within the required limits. The service required of a motor truck load-carrying axle inevitably causes it to be subjected to very severe shock and strains, and for that reason it is of the utmost importance for the heat-treating to be done in a manner that will give the steel in the axle the desired physical properties. After the heat-treating operation has been performed, the next step is to polish a spot

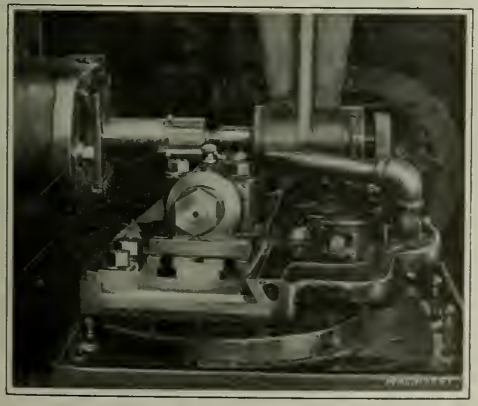


Fig. 8. Gear-hobbing Machine equipped with a Special Hob for generating Splines in Driving Shafts



Fig. 9. Pouring a "Heat" from One of the Special Five-ton Heroult Electric Furnaces in the Steel Foundry

TABLE 3. SEQUENCE OF MACHINING OPERATIONS ON LIVE AXLE HOUSINGS[1]

Operation No.	Operation	Located from	Size and Type of Machine	Tool Equipment
1	Sand-blast	.....	Pangborn sand-blasting machine	.....
2	Chip	.....	"Little Giant" chipping hammer	.....
3	Visual Inspection	.....	.....	.....
4	Anneal	.....	American Shop Equipment Co.'s oil furnace	.....
5	Turn O.D. of flange A; face lugs B down to shoulder C; face end D; turn O. D. of shoulder C; and chamfer	Special centers entering end openings	Lodge & Shipley 20-inch lathe	Turret toolpost equipped with turning and facing tools
6	Rough-, intermediate- and finish-face flange A, and take three cuts in bore E	Shoulder C and special center in large end	American 20-inch lathe	Turret toolpost; special tailstock center; driving dog on faceplate
7	Rough- and intermediate-bore, and ream bearing seat F	Bore E and steadyrest on shoulder C	American 20-inch lathe	Pilot on faceplate, special steadyrest, and turret toolpost
8	Mill seats G for spring pads	Locate from bore F and backs of flanges G	Cincinnati No. 4 plain milling machine	String type of work-holding fixture and special testing fixture
9	Drill holes H	Bore F and milled faces G	"Natco" six-spindle drilling machine	Twist drills
10	Spot-face bosses surrounding holes H	Pilot entering holes H	Cincinnati-Bickford upright drilling machine	Piloted spot-facer
11	Drill holes L in spring pad seats G	Bore F and milled faces G	Baker Bros. upright drilling machine	Twist drills
12	Mill internal brake support pads	Milled spring pad seats G and pilots in holes L	Kempsmith No. 2 plain milling machine	Indexing milling fixture to locate work in two positions
13	Mill external brake support pads I	Bore E and spring pad seats G	Kempsmith No. 2 plain milling machine	Simple work-holding fixture
14	Drill and tap four holes J	Bore F and milled faces G	Cincinnati-Bickford upright drilling machine	Jig; Clark quick-change chuck; twist drill and tap
15	Drill holes K	Bore F and milled faces G	Cincinnati-Bickford upright drilling machine	Piloted work-holding fixture and twist drill
16	Chamfer holes L	.....	Van Dorn portable electric drill	Countersink
17	Rough-grind seat around hole M	.....	Diamond grinding stand	Carborundum wheel
18	Drill holes N	Adjusting hole	"Avey" sensitive drilling machine	Piloted jig plate
19	Tap holes N	.....	"Avey" sensitive drilling machine	Wahlstrom tapping chuck
20	Drill and tap hole O	Pilot in hole O	Cincinnati-Bickford upright drilling machine	"Celfor" quick-change chuck, twist drill, piloted spot-facer and tap
21	Inspect	.....	.....	Gages, etc. *Machinery*

[1]Note: See Fig. 12

near the center of each axle and test the hardness with a scleroscope, as shown in Fig. 5. Axles which pass the hardness test satisfactorily (showing a hardness of 42 to 45) are taken to a Lucas straightening press, Fig. 6, on which they are straightened until they line up with a straightedge.

Machining Operations on the "Live" Axles

The terms "dead" and "live" axle are used in the machine shops of the Clark Equipment Co. to designate the load-carrying axle and the driving axle, respectively, because one of these members is held stationary and the wheels rotate on it, while the other is a driving member which transmits power from the motor. Both of these axles are made from chrome-nickel steel conforming to the Society of Automotive Engineers' standard, which has the following analysis:

Chromium	0.45	to	0.75	per cent
Nickel	1.0	to	1.5	per cent
Carbon	0.35	to	0.45	per cent
Manganese	0.50	to	0.80	per cent
Phosphorus	Not over		0.04	per cent
Sulphur	Not over		0.045	per cent

As in the case of the dead axle, the first operation performed on the live axle, Fig. 7, consists of a forging operation under a Bradley helve hammer to bring the forging to approximately the desired form. The forgings are then subjected to a process of heat-treatment known as "normalizing" to remove all strains from the metal that have been introduced during the process of forging. This treatment consists of raising the temperature of the forgings to 1550 degrees F. and holding the work at that temperature for at least one hour. The work is then quenched in oil, after which the temper is drawn at a temperature of 900 to 1050 degrees F. The order in which subsequent machining operations are performed on the live axles will be gathered from Table 2. Before leaving this subject, attention is drawn to Fig. 8 which shows a Barber-Colman gear-hobbing machine equipped with a special work-holding spindle that allows the axle forging to project through it. On this machine a special form of hob is used that has a tooth form developed by working back from the outline of the spline to be generated. With a hobbing machine equipped in this way, it is possible to not only cut very accurate spline grooves, but also to obtain a highly satisfactory rate of production.

Facilities of the Steel Foundry

Mention has already been made of the severity of service to which motor truck axles are subjected, and for this reason many of the castings which enter into the construction of Clark axles are made of steel. Figs. 9 and 10 show views in the steel foundry, which is equipped with electric furnaces for melting and refining the steel, and all such auxiliary apparatus as sand-blasting machines, air chipping hammers and other apparatus that is required for efficiently handling work of this character.

Machining Operations on the Live Axle Housings

Fig. 12 shows the live axle housing which is an example of a part that is cast in the steel foundry; and complete tabulated information concerning the machining operations that are involved in finishing this part is presented in Table 3. After the castings have been sand-blasted, inspected, snagged, and annealed in the foundry, they are transferred to the machine shop, where the first operation is performed on a 20-inch Lodge & Shipley lathe equipped with special ball-bearing centers. The machining operation is adequately outlined in Table 3, and in referring to the illustration of the lathe set-up shown in Fig. 13, attention is directed to the special ball-bearing centers on which the work is supported. It will be apparent from the illustration of the work, that a hollow piece of this kind must be handled in a special way if it is to be sup-



Fig. 10. In casting Steel, a Practice is made of "bottom-pouring" the Metal to avoid Slag in Castings

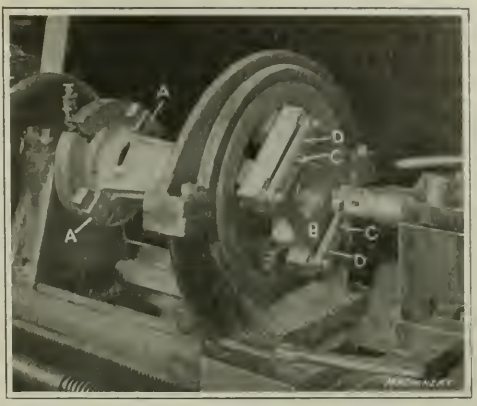


Fig. 11. Engine Lathe equipped for boring Bearing Seat in the Driving Shaft Housing

ported between centers; and in the present case, the means adopted consisted of making two ball-bearing centers, which not only run without frictional resistance and are practically proof against wear, but are also provided with three hardened knife-edges *A* on each center, which bite into the work and secure a firm grip that prevents the work from shifting its position on the centers while being machined.

Fig. 14 shows the next operation on the live axle housing, which is performed on a 20-inch "American" lathe. In this case the work to be done consists of facing the large end of the work and also boring the opening at this end of the casting. Roughing, intermediate, and finishing cuts are taken. Here again the method of supporting the work is the point of interest. Reference to Table 3 will show that a shoulder has already been turned at the small end of the work, and this is utilized as a locating point. On the faceplate of the lathe there is a boss *A* which is counterbored to receive this turned shoulder on the casting, while a dog *B* provides for driving the work. At the opposite end, a special ball-bearing pipe center *C* is carried by the tailstock, and this center enters the small cored opening in the casting, leaving sufficient clearance so that a turret tool may be utilized to bore out the pocket that must be finished at this end.

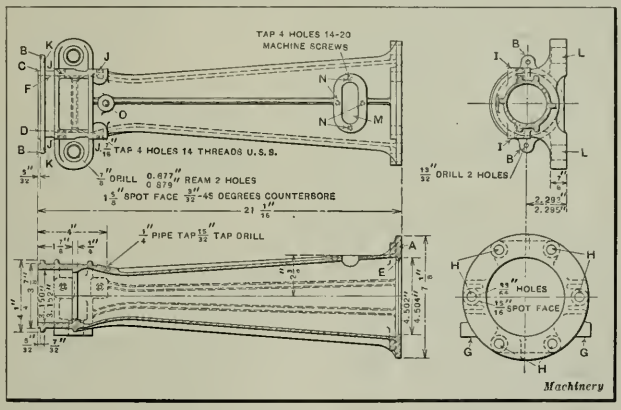


Fig. 12. Housing Tube for Driving Shaft of the Clark Rear Axle

Next in the sequence of operations performed on this part is the boring of a bearing seat in the small end of the work, and Fig. 11 shows the 20-inch "American" lathe on which this job is handled. In setting up the work for this operation, there is a pilot on the lathe faceplate which enters the bored hole at the large end of the work, and two straps *A* engage the flange to hold the work back against the faceplate. At the unsupported end, a special steadyrest is employed that is furnished with a hardened bearing plate *B* which fits over the

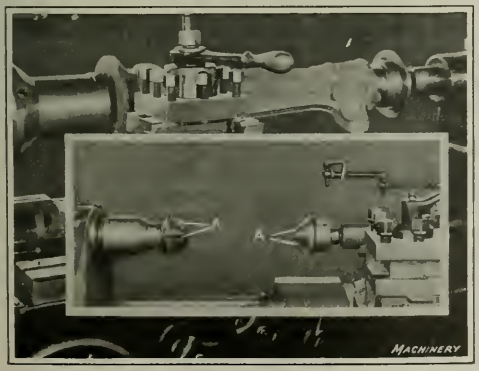


Fig. 13. Engine Lathe equipped with Special Ball-bearing Centers for supporting Driving Shaft Housing

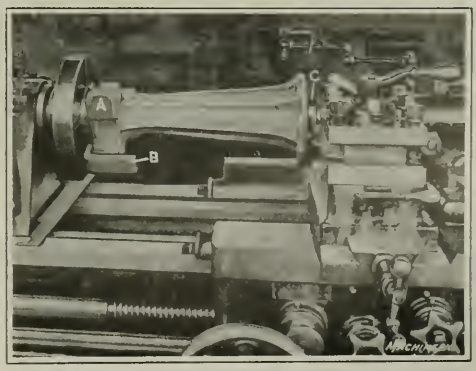


Fig. 14. Engine Lathe equipped for boring and facing Flange of Driving Shaft Housing

turned outside diameter of the casting. After it has been located on the work, this plate is clamped in place by means of two T-head screws *C* that are supported by bars *D*. Bearing plate *B* can be slipped under these bars, and after it has been located over the turned outside diameter of the work, screws *C* are tightened to clamp the bearing plate firmly on the steadyrest. While set up on this equipment, a rough and an intermediate boring operation and a final reaming operation are performed.

In the second installment of this article, to be published in the June number of MACHINERY, we will deal with the milling of the spring pad seats; the drilling of the flange bolt holes; the milling of the pads for the internal brake supports; the drilling and tapping of the holes in the external brake support pads; and the machining operations on the gear-cases and the brake-drum.

* * *

SPECIFICATIONS FOR WELDING WIRE

The following specifications for welding electrodes are recommended by J. Churchward, metallurgist of the Wilson Welder & Metals Co., New York City. All electrodes, except special ones, should be tested, regardless of chemical analysis, by depositing metal in three positions: An even flat bead should be deposited overhead without undue trouble, by an operator who is accustomed to welding in this position. It is not required that the metal start to flow at once, but after the arc has started, a reasonable amount (about 6 inches) should be deposited without breaking the arc. A bead should be laid down horizontally at least 4 inches long, which when ground flush with the plate, should not show any gas pockets or oxide inclusion, either at the conclusion of the grinding operation or during its completion. A vertical weld should be made, laying the bead upward without bunching up.

Electrodes for use where a tensile strength of not more than 50,000 pounds per square inch is required and where ductility is not an important factor should have the following composition: Carbon, 0.18 per cent; manganese, 0.60 per cent; phosphorus and sulphur, 0.05 per cent each; silicon, 0.08 per cent. These percentages are maximum values.

Electrodes for use where a tensile strength of between 50,000 and 60,000 pounds per square inch is desired and where ductility is not an important factor, should have the following chemical analysis: Carbon, from 0.25 to 0.35 per cent; manganese, from 0.60 to 0.80 per cent; phosphorus, sulphur, and silicon, not over 0.05 per cent each.

Electrodes where tensile strength of over 60,000 pounds per square inch is required, or where great ductility must be had, should conform to the following specifications; Carbon, from 0.35 to 0.45 per cent; manganese, from 0.80 to 1.10 per cent; phosphorus, sulphur and silicon, not over 0.05 per cent each.

Special electrodes for hard wearing surfaces should meet either of the two following specifications, and are to be used on flat surfaces only and not on any vee section. No. 1: Carbon, from 0.90 to 1.15 per cent; manganese from 0.35 to 0.55 per cent; phosphorus, sulphur, and silicon, not over 0.05 per cent each. No. 2: Carbon, from 0.70 to 0.90 per cent; manganese, from 0.80 to 1.00 per cent; phosphorus, sulphur, and silicon, not over 0.05 per cent each.

* * *

In a paper read before the American Electric Chemical Society by Oliver P. Watts, it was mentioned that as far back as 1843 George Stephenson called attention to the fact that the rails on the main track of a railway are not as likely to rust as those of the sidings. It is believed that the reason for this is that the rails carrying the main line traffic are kept free from rust mainly by the hammering on the rail of the wheels passing over it. Rust forming on sidings has an opportunity to collect and to hold moisture.

DESIGNING CUT-OFF CAMS FOR AUTOMATIC SCREW MACHINES

By JOHN A. CRABTREE

In the case of automatic screw machines having independently controlled front and back cross-slides, it is often advantageous to finish the forming work during the early part of the cutting-off operation. This practice is, in fact, recommended by a well-known manufacturer of automatic screw machines. However, if the cams which control the cross-slides are not properly designed, trouble is likely to arise when this method is employed on high-class forming work, particularly where the cut-off tool is used to finish off or complete a forming operation such as required to finish the part shown at *M*, Fig. 1.

Trouble Experienced in Cutting off Work

The trouble frequently encountered is the breaking off of the work before it might reasonably be expected to break off, thus leaving a very objectionable teat on the piece at the point of cut-off. In one instance it was found that work which was required to be finished as shown at *M* broke away as indicated at *N*, and as a result, it was necessary to perform a second operation to produce the required finish. When working on extruded brass rods the work frequently broke off, leaving a teat about ⅛ inch in diameter, which necessitated relegating the work to the scrap heap. When this trouble was first experienced, it was thought that the

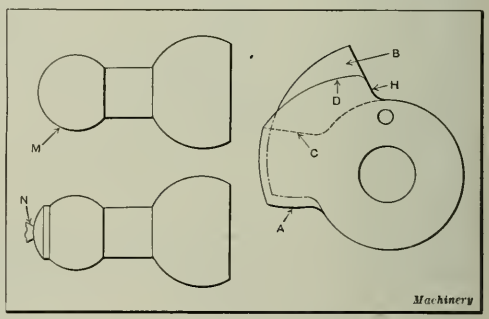


Fig. 1. Work produced on Automatic Screw Machine, and Cams which control Feed of Forming and Cutting-off Tools

cams of the machine were inaccurate, giving an excessive feed to the cut-off tool at the point where the work fell away. The cams were found to be considerably worn, and were therefore replaced by a redesigned set. These cams were tried out before hardening, on a new machine, and were found to work satisfactorily. They were then case-hardened and placed in storage.

Some weeks later the cams were sent to the shop and set up on a machine. The same trouble was once more experienced, but if anything, to a greater extent. Naturally the draftsman and the machine setter who had previously tried out the cams were criticized for passing them. Both declared that the cams had operated satisfactorily during the experimental trial, but both admitted that they were certainly not producing the required results on the second trial. Hours were spent in checking the calculations involved in designing the cams but no error of importance could be found. Naturally, minor faults were pointed out, but nothing to explain the cause of the main trouble was discovered. The machine on which the cams were first tried was in operation on another job at this time, so a different automatic was set up in order to give the cam another trial. On this trial the cams again ran satisfactorily. Thus the same cams and the same tools set up for the same work on a different machine gave satisfactory results. This led to the discovery of the cause of the trouble which may be more easily explained by referring to Fig. 2.

The Cause of Cut-off Trouble

The cross-sectional view in Fig. 2 shows the cross-slides of an automatic screw machine, with the two cams *A* and *B* and the operating levers *C* and *D*, their gear segments meshing with the racks in their respective cross-slides *E* and *F*. For convenience it will be assumed throughout that the machine is running forward on the cutting stroke with the forming tool at *G* carried in slide *E*, and the cut-off tool *H* in slide *F*. In the illustration, the forming cam *A* has nearly reached the end of its rise, and the cut-off cam *B* has completed a considerable portion of its work. It will be apparent that with only a few additional revolutions of the work, cam *A* will reach a position which will permit lever *C* to reverse and that this movement is produced by the action of the cross-slide spring keeping the trundle-roll of the lever *C* in contact with the cam after passing the toe. This is where the trouble occurs, that is, the point at which the cut-off tool digs into the work, breaking it off too soon and often leaving an excessively large teat.

The front camshaft on the machine is driven by bevel gears and a worm-wheel from the back-shaft. It is therefore evident that a certain amount of backlash will develop no matter how well the machine may be made or how good a condition it is kept in. Under ordinary circumstances this is of no consequence, machines having been run quite satisfactorily after having been worn by years of service

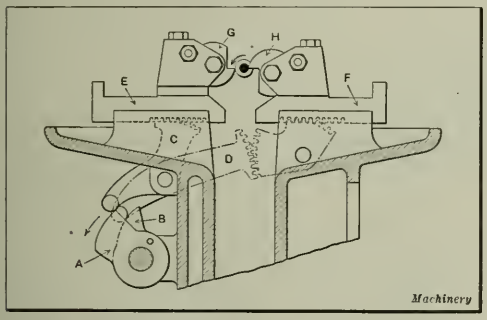


Fig. 2. Cross-sectional View, showing how Movements of the Forming and Cutting-off Tools are controlled

resulting in a backlash of 3 or 4 degrees. However, when one has a job on hand similar to that described, trouble is inevitable. What happens is that the forming cam lever *C*, Fig. 2, as it abruptly reverses and the trundle starts to drop, forces the cam forward taking up the backlash of the gearing. This causes the cut-off cam to be driven forward suddenly so that the cut-off tool digs into the work an amount equal to the suddenly increased throw of the cam. This jump may be several thousandths of an inch, which is quite sufficient in some cases to break off the work.

Method of Eliminating Cut-off Trouble

The obvious remedy for trouble of this kind is to take up the backlash. This plan at first seems feasible, but experience has shown that on automatics which are in continuous operation, it is impossible to prevent the development of more or less backlash in the gears. The amount of backlash may seem insignificant and yet be sufficient to give considerable trouble when performing delicate machining operations on close-limit jobs. The weakening of the front cross-slide spring was then suggested as a remedy, but this was objected to for the reason that the slide would be liable to stick, leaving the forming tool in the advanced position. Such in fact, proved to be the case, although the two opposing forces acting on the camshaft were then more nearly equalized. The third method considered was to alter the camming of the job, and by finishing the forming at an earlier stage, get the tool well back before its withdrawal could in any way affect the cut-off. This method was objectionable in that it resulted in a loss of considerable time on the job, an important consideration when many thousands of pieces are to be produced, as the loss of only two seconds per piece under these conditions soon seriously affects production.

The method which was finally decided upon and which proved satisfactory was to make a special forming cam with the "fall-back" designed to be more gradual, thereby eliminating the sudden forward motion imparted to the cutting-off tool-slide. Such a cam is shown at *A*, Fig. 1, and the cut-off cam is shown at *B*. While the original fall of the forming cam was as indicated by the dotted line *C*, the fall on the new cam was made more gradual as shown at *D*. Care must be taken when making this change to ascertain that surface *D* slopes back sufficiently to bring the forming tool out of contact with the work when the cut-off takes place; otherwise a badly gashed piece will result, and while some of the work will be cut off clean, other pieces will run eccentric at the point of cut-off, being bent forward by the cut-off tool. If the forming tool has not then cleared the work, the work will catch on the cutter edge of the forming tool and drop off after being badly gouged. The chance of this happening will be readily apparent when trying out the cam before hardening, and any additional clearance which may be required can then be provided for. It is better, however, to keep this point in mind when designing the cam, as it is one of the chief factors governing the slope. If this were not the case, it would be preferable to design the cam with a comparatively long dwell and to time the fall to occur after the cut-off cam completes its work. The gradual fall also serves to leave the way clear for a stop or other tool held in the turret which may have indexed and which may be advancing into position ready to perform its work as soon as the chuck opens and the stock feeds forward. The sharp final fall at *H* should concide with that of the cut-off cam *B* thus causing both cross-slides to be brought back simultaneously.

* * *

PRACTICE IN ASSEMBLING AUTOMOBILE WORM-GEAR DRIVES

In the assembly of worm-gear drives for automobiles it is the custom to offset the wheel relative to the worm a few thousandths of an inch sidewise. The object of this is to counteract the inevitable looseness which there is in the ball or roller bearings, not only of the differential but of the worm itself. There necessarily must be a very slight looseness in any bearing, otherwise it could not run freely. According to an engineer well versed in the design of worm drives, this sidewise assembly is of little importance in ordinary commercial truck work, but in gears for electric vehicles where the elimination of noise is an important factor, this sidewise assembling has to be very carefully done. It is generally supposed that worm-gears run quietly, and compared with internal gear drives they do, but they produce enough noise so that this factor must be considered in the design of drives for electric pleasure cars, which must run almost noiselessly.

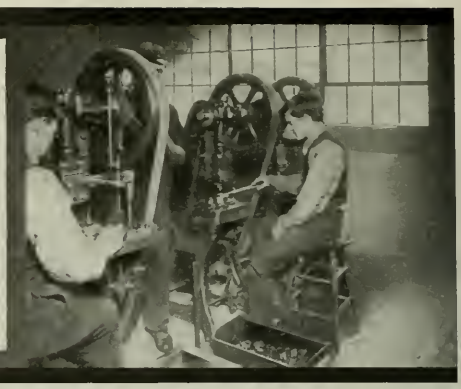
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UNITED STATES EXPORTS TO BRAZIL

The United States, during the last five years, has become the chief factor in Brazil's import trade. In 1918, when Brazil's total imports aggregated $247,000,000, the United States supplied commodities valued at $89,000,000. British shipments to Brazil amounted to $50,000,000; Argentine, $47,000,000; and French, $12,000,000. In 1913 the United Kingdom led in exports to Brazil, supplying her with goods valued at $80,000,000 out of total imports of $326,000,000. Germany sent goods amounting to $57,000,000; the United States, $51,000,000; France, $32,000,000; and Argentina, $24,000,000.

Dies for Shaping a Motorcycle Part

By J. BINGHAM
President, The B. J. Stamping Co., Toledo, Ohio



THE manufacturer of a muffler cap of unusual shape which is used on a certain type of motorcycle requires seven drawing and forming dies which are here illustrated and described. A view showing the appearance and dimensions of the work after each operation has been performed is shown in every illustration beneath the die used to produce that particular shape. The blanking and trimming dies employed in producing this part are of simple design and for this reason are not illustrated. All the steel parts of the dies are hardened and ground. The sheet steel blank from which the part is produced is 3/32 inch thick and 6 3/16 inches in diameter. The first operation in the manufacture of this part consists of cutting the blank to these dimensions on a plain blanking die of standard construction.

The first shaping operation is performed by the plain push-through drawing die illustrated in Fig. 2. In this operation, the blank is laid upon the die ring *A* and drawn to the shape illustrated as punch *B* descends into the die ring. Three stripping devices *C*, which are equally spaced around the die, force the drawn shell from the punch on the return stroke of the press ram. This die is of the same construction as a die illustrated and described in an article in the October number of MACHINERY, page 165, and for this reason a complete description is deemed unnecessary.

The die used in the next operation is shown in Fig. 3. It reduces the diameter of the shell, forms a slanting surface around the greater part of the closed end, and leaves a tapering flange on the open end. This die is of the same construction as that shown in Fig. 2, except that the stripping devices incorporated in the latter have been eliminated in this case, because the punch only descends into the die to the position shown, and therefore the shell is not pushed through the die. Punch *B*, however, is of a different shape and has a stripping device that operates in hole *C* which forces the shell from the punch on the return stroke of the press ram. Another device is provided for ejecting the shell from the die.

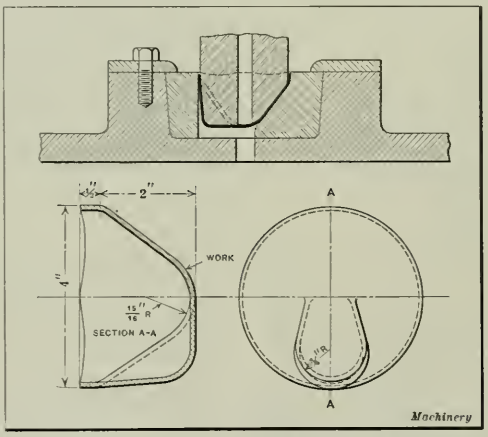


Fig. 1. Die which forms a Pocket preparatory to Formation of Boss

Fig. 1 shows the forming die employed in the next operation, which increases the diameter of the open end of the shell and straightens its rim. It also forms the main part of the shell into a conical shape except at one point where

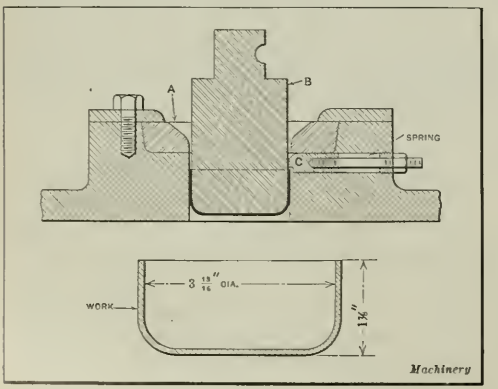


Fig. 2. Die which draws the Blank to the Shape illustrated

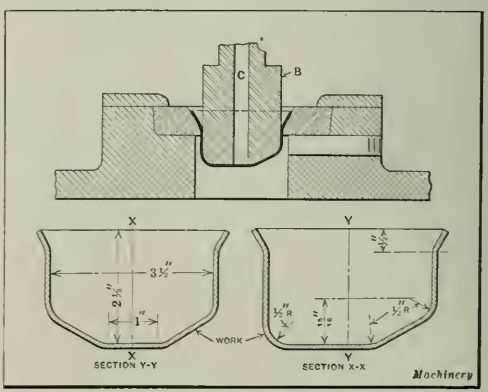


Fig. 3. Die used for the Second Drawing Operation

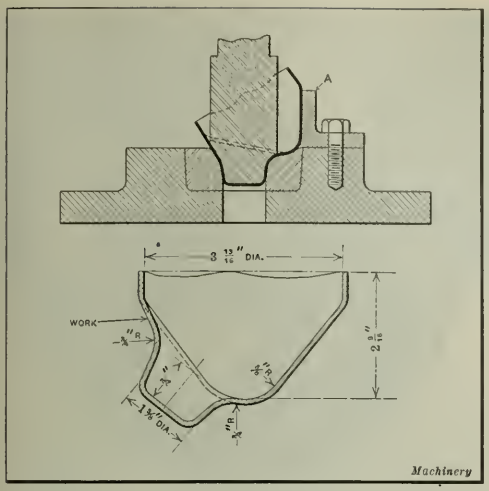


Fig. 4. Punch and Die which produces a Boss on the Conical Surface of the Shell

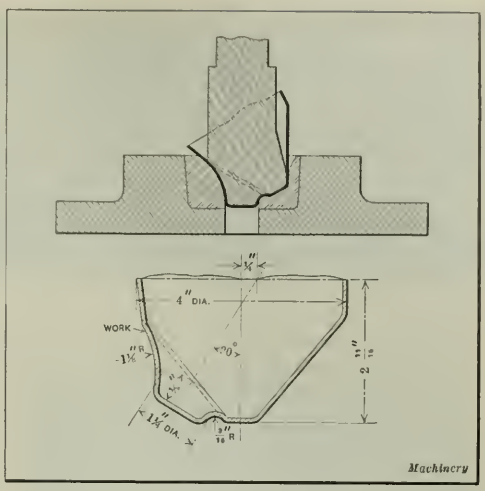


Fig. 5. Forming Die employed to lengthen the Conical Surface and flatten ite End

a pocket is formed preparatory to the formation of a boss, which is produced by subsequent operations. This punch and die are also equipped with devices for removing the shell after the performance of the operation.

The forming die shown in Fig. 4 is used to produce the boss just mentioned, on the conical portion of the shell. Gage *A* is provided to locate the shell properly prior to the operation. No devices are required to remove the shell from either the punch or the die in this case, as the shape of the shell readily permits its removal without the employment of special devices.

The forming die which is employed to perform the next operation is illustrated in Fig. 5. The results of this operation are a lengthening of the conical portion of the shell and a flattening of its end, and a decrease in the angle between the center lines of the shell and the boss. The diameter and depth of the boss are also decreased, which serves to increase the thickness of the shell at this point. By this means, the thickness of the metal can be kept approximately uniform throughout the entire shell.

The forming die shown in Fig. 6 performs the final forming operation on all parts of the shell except the boss and part of the surface adjacent to it. It straightens the rim at the open end of the shell to a uniform depth of 5/8 inch and finishes the conical shaped part. Both the punch and the die are equipped with devices for removing the shell.

Fig. 7 shows the die which is employed to perform the final shaping operation on the shell. It increases the depth of the boss and also straightens its sides and the slanting surface which connects part of the boss with the rim of the shell. This punch and die is also equipped with devices to effect the removal of the shell from these parts after the operation. It will be noticed that during the various operations, the edge of the rim on the open end of the shell becomes quite irregular, it being very difficult to prevent this from happening on the class of work being dealt with. In order to remove this irregular edge, the shell is operated upon by a trimming die or shear, after the last forming operation. The final operation on the shell consists in punching a small hole through the center of the boss.

* * *

The *National Safety News* points out that, acting upon the suggestion of a member of the Shop Safety Committee, the Goulds Mfg. Co. has painted all the crane hooks of the large traveling cranes in one of its machine shops white so that they may be more easily seen from the floor.

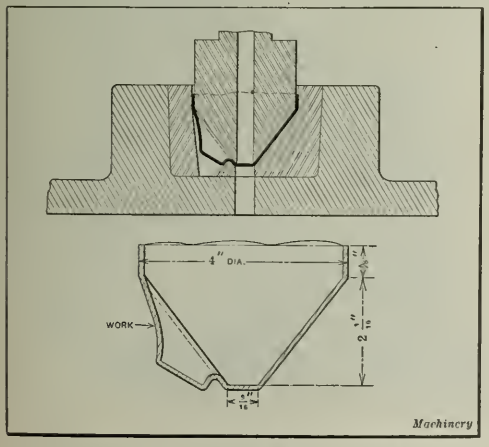


Fig. 6. Die used to perform the Final Shaping Operation on the Conical Surface and Rim

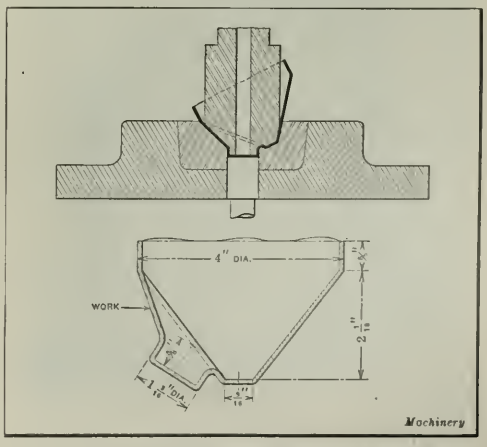


Fig. 7. Final Shaping Operation on the Shell which completes the Formation of the Boss

Application of New Ingersoll Milling Machines



If maximum efficiency is to be attained in milling operations, it is necessary that the non-productive time of both the machines and their operators be reduced to a minimum. With this object in view, the new Ingersoll milling machines are equipped with two or more work-holding fixtures so that a machine is milling a casting held in one fixture while the operator is setting up work in another, thus preventing idle machine time.

READERS of MACHINERY who have had experience in the operation of milling machines for the quantity production of duplicate parts, or in designing work-holding fixtures for use on millers employed in this class of service, are familiar with the so-called multiple-spindle or planer type of machines built by the Ingersoll Milling Machine Co. of Rockford, Ill. Until recently this firm has specialized in the construction of such equipment, but to meet the requirements of certain classes of work for which the planer type machine of large size is not ideally adapted, a number of smaller units provided with special means for facilitating the milling of duplicate parts have been developed and placed on the market. It has always been the policy of the Ingersoll Milling Machine Co. to build machines to meet the special requirements of individual jobs rather than to manufacture standard millers and carry them in stock ready for delivery; and in taking up the construction of machines for milling pieces of smaller sizes, this principle of building machines especially suited for the work on which they are to be employed is still followed.

However, it must not be understood that the building of each machine involves a completely new problem of machine design, for such is not the case. There are certain recognized principles of construction employed in the various sizes and styles of Ingersoll millers, and when a customer submits blueprints of a piece to be machined, together with data concerning such matters as the amount of stock to be removed from the different finished surfaces and the rate of production that is required, it is possible for the Ingersoll designers to make recommendations for the construction of a machine of recognized type, the details of which have been modified to fulfill the peculiar requirements of the work. In the present article it is proposed to briefly explain the fundamental principles of several new types of Ingersoll millers that have been developed to enable small parts to be milled in quantities, with the attainment of a high degree

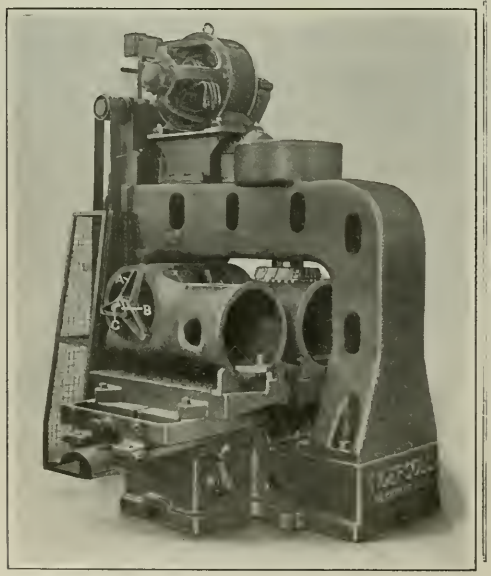


Fig. 1. Ingersoll Reciprocating Type of Miller, designed and built for Use in milling Tractor Transmission Housings

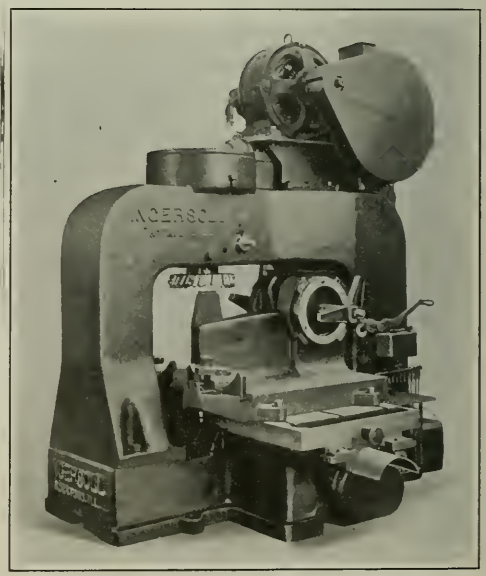


Fig. 2. Opposite Side of Machine illustrated in Fig. 1, showing Method of locating and clamping Work Ready for milling

of efficiency in production and economy of labor, floor space, etc.; and in order to show the possibilities of each machine from the standpoint of production, information will be presented in regard to the rate of output that is attained in each case, in handling a milling operation, the exact nature of which will be made clear by the description.

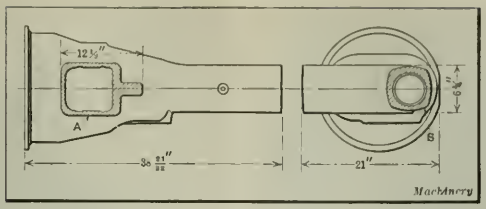


Fig. 3. Tractor Transmission Housing milled on Machine shown in Figs. 1 and 2

It is of interest to note that all of the milling cutters and work-holding fixtures used on the machines that are shown in the illustrations presented in connection with this article were made by the Ingersoll Milling Machine Co.

nately machining castings held by fixtures that are set up at opposite ends of the table. Bearing in mind the fact that the machine was built to meet the requirements of a special repetition milling operation on which it is to be used continuously, it will be evident that no advantage would be secured through providing an expensive mechanism for obtaining the several selective changes of cutting speed. But it is highly important to provide means for quickly reversing the table to bring the second piece of work into engagement with the cutters, after the milling operation has been completed on the first

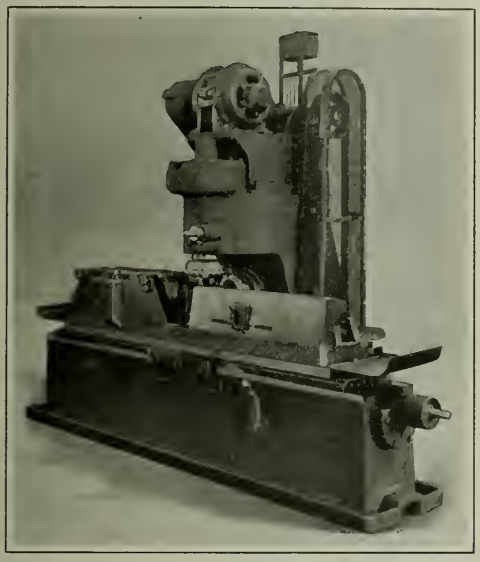


Fig. 4. Another Type of Ingersoll Reciprocating Miller, designed and built for machining Four Surfaces on Motor Car Cylinder Blocks

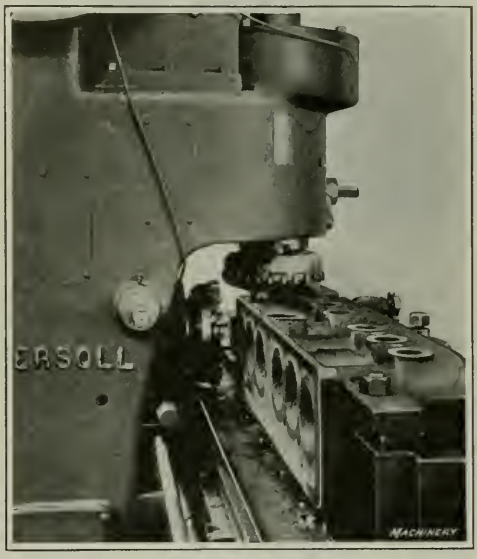


Fig. 5. Close-up View of Cutters and Work on the Miller illustrated in Fig. 4, showing Flanged Surface and Manifold Seat to be milled

Milling Tractor Transmission Housings on Ingersoll Reciprocating Millers

The name "reciprocating milling machine" has been applied to a new Ingersoll miller shown in Figs. 1 and 2, because the table moves back and forth to provide for alternate machining castings held by fixtures that are set up at opposite ends of the table. Bearing in mind the fact that the machine was built to meet the requirements of a special repetition milling operation on which it is to be used continuously, it will be evident that no advantage would be secured through providing an expensive mechanism for obtaining the several selective changes of cutting speed. But it is highly important to provide means for quickly reversing the table to bring the second piece of work into engagement with the cutters, after the milling operation has been completed on the first piece. For this reason the machine is designed to feed the work under the cutters at a rate of 4½ inches per minute, and as soon as the operation on one piece of work has been completed, a fast power reverse movement is engaged to quickly withdraw the first piece of work from the cutters,

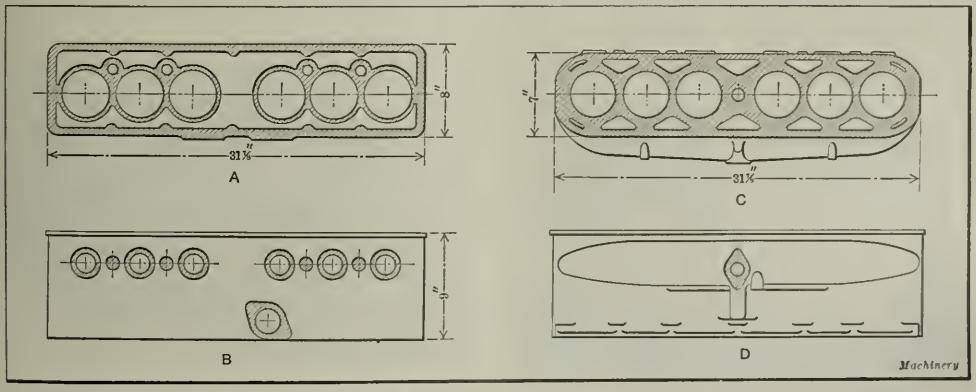


Fig. 6. Four Views of Cylinder Block to be milled. The Cross-sectioned Areas A and B are finished at the First Setting, and Shaded Areas C and D are finished at the Second Setting of the Work

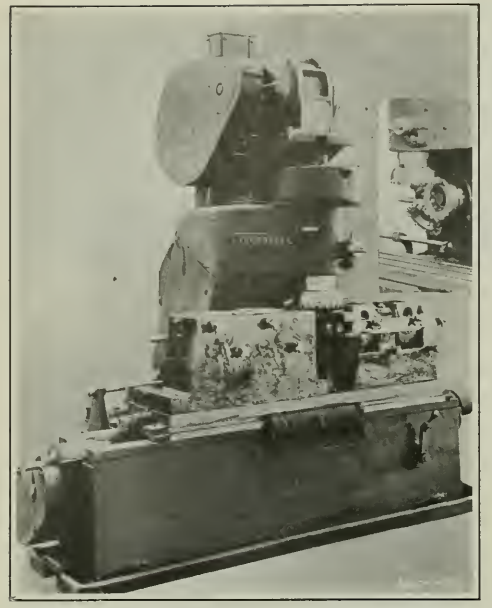


Fig. 7. Ingersoll Reciprocating Continuous Milling Machine designed and equipped for milling Two Types of Transmission Cases

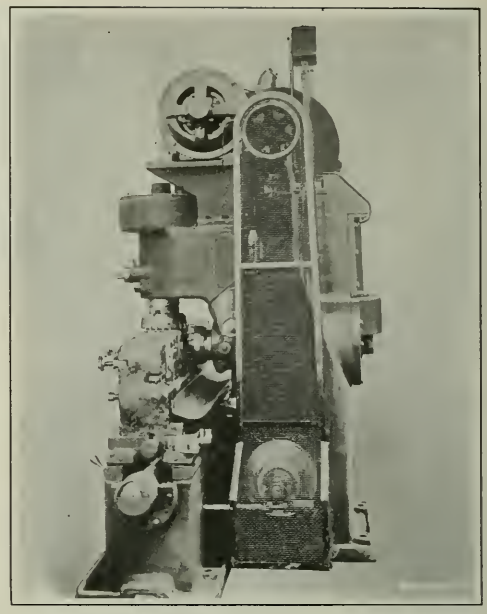


Fig. 8. End View of Machine shown in Fig. 7, illustrating how Work is held for simultaneously milling Two Surfaces

and this movement continues until the work held by the fixture at the opposite end of the table is brought up to the cutters. When this piece of work has been advanced to the proper point, the fast traverse is automatically disengaged and the 4½ inches per minute rate of feed once more becomes operative. It is important to note that while milling the work held in one fixture, the table is feeding in the opposite direction from that in which it moves while milling work held in the other fixture. While the milling operation is proceeding on one piece, the operator is employed in removing the milled casting from the fixture at the opposite end of the table and setting up a fresh blank in its place; and after the machine has reversed to start milling this casting, the operator at once proceeds to remove the milled piece from the other end of the table and set up a casting in that fixture. As a result, both the machine and its operator are kept constantly employed, and losses resulting from non-productive time of machines and labor are reduced to a minimum.

In Fig. 1 there is shown a machine of this type, which has a capacity of 30 by 28 inches by 5 feet. It will be apparent that this machine has two spindles which are furnished with an 8-inch cutter on the horizontal spindle and a 14-inch cutter on the vertical spindle. There is an adjustment of 6 inches for each spindle quill. Reference to the accompanying illustrations will make it apparent that the work-holding fixture has been designed with a view to allowing the maximum rapidity to be attained in setting up blanks and removing finished pieces of work. At the right-hand end, as illustrated in Fig. 1, the casting rests in a cradle that embraces the circumference of the flange; and at the center of the fixture there is a vertical column or wall that carries two pilots on its opposite sides, these pilots being of sufficient size to enter the bore in the work, as shown at the left-hand end in Fig. 1. Each pilot locates a piece of work in the fixture, and the casting is held back against a vertical locating face by means of the three-legged spider *A* that is furnished with a pivoted latch *B*, so that it is merely necessary to loosen the nut *C* through half a turn and then swing back the latch, after which the spider may be lifted over the nut. A clearer idea of the construction of the work-holding fixture on this machine will be gathered from Fig. 2; and at *A* and *B* in Fig. 3, the shaded areas indicate the surface that is milled on these machines. The rate of production obtained on this milling job is 150 pieces in an eight-hour day.

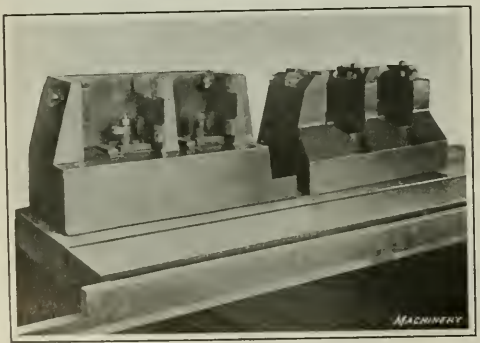


Fig. 9. Close-up View of Fixtures of the Type which are shown in Place on the Machine illustrated in Figs. 7 and 8

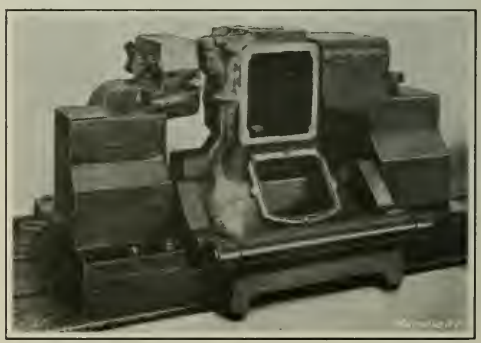


Fig. 10. Close-up View of Fixture used for holding Transmission Cases for the milling of which the Three-spindle Machine is used

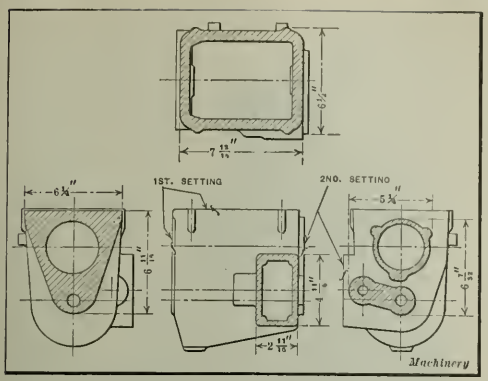


Fig. 11. Transmission Case on which Four Surfaces have to be milled, Two Faces being milled at Right Angles at Each of Two Successive Operations

Milling Flange and Manifold Surfaces on Cylinder Blocks

Figs. 4 and 5 show a reciprocating milling machine for use in machining four surfaces on motor car cylinder block castings, two settings of the work and two operations being required for completing the work on each piece. By comparing Figs. 1 and 4, the reader will gain a comprehensive idea of the way in which special machines are built to suit the requirements of individual jobs, with the incorporation of standard Ingersoll principles of design in all machines of a given type. Superficially, there is very little resemblance between the two millers which are at present under discussion, but actually they are both reciprocating milling machines, with two fixtures mounted at opposite ends of the table and the mechanism arranged to move the table back and forth, so that the cutters may first mill two surfaces on one casting and then start work on another casting, after reversal of the machine, so that the operator may busy himself unloading and reloading the idle fixture, while work is proceeding on a casting held in the second fixture, in the manner which has already been described. On this machine the work is of such a character that it can be handled at rather higher speed than was possible in the case of tractor transmission housings. The rate of feed employed for milling cylinder blocks is 6¼ inches per minute, and the rapid power traverse of the table is accomplished at a rate of 10.6 feet per minute. A 10-inch inserted-tooth cutter is carried by each spindle. The capacity of this machine is up to 20 by 17 inches by 6 feet. Adjustment of the cutters is obtained through the standard Ingersoll quill mechanism, each spindle having an adjustment of 4 inches.

There are two pairs of surfaces to be milled on these castings, and two cutters on the machine provide for completing this work by first milling two surfaces and then resetting the cylinder block in a fixture at the opposite end of the machine for milling the second pair of faces. It will be apparent from Fig. 4 that the fixtures at opposite ends of the table are of different design, the reason for this being explained by the fact that different operations are performed on the work held in them. The first operation is to mill the flange face of the casting and the manifold surface, for which purpose the fixture shown in Fig. 4 at the left-hand end of the machine is used, the casting being strapped down in this fixture on locating pads which afford an approximate setting of the work by engaging the rough cast faces. This casting is then reset in the fixture at the opposite end of the table, with the milled faces used as locating points, so that an accurate setting is obtained, thus enabling the cylinder-head contact and the carbureter pad, which are milled at the second setting, to be brought exactly at right angles to the previously milled faces. Fig. 5 shows a close-up view of the cutters and work set up for performing the first operation; and in Fig. 6 the shaded areas at *A* and *B* are those finished at the first setting of the work, while *C* and *D* are the surfaces milled at the second setting.

Milling Operations on Two Types of Transmission Cases

In Figs. 7 and 8 there is shown a type of miller known as a reciprocating continuous milling machine which is employed for machining two different types of transmission cases, and so far as general exterior appearance is concerned, this machine is quite similar to the equipment for milling cylinder blocks which is illustrated in Fig. 4. Also, it is furnished with the same arrangement of slow feed and rapid power traverse, although the rates are somewhat different, being 4½ inches per minute and 11.8 feet per minute, respectively. One of the transmission cases milled on this machine has simply two surfaces to be finished at right angles to each other, and for handling this job there is a 9-inch inserted-tooth cutter on the vertical spindle and an 8-inch cutter on the horizontal spindle. The second type of transmission case, for the milling of which this machine is designed, has the two surfaces at right angles, in addition to which there is an angular face; and to provide for milling such work, the machine is equipped with a third spindle mounted at an angle so that an 8-inch cutter can be set up for finishing the inclined face of the work. There is a 4-inch adjustment for the quill of each of the three spindles. This machine has a capacity of 14 by 20 inches by 4 feet.

Of course, it will be apparent that for handling the two different types of work for the milling of which this machine is adapted, fixtures of different designs must be provided. The best idea of the fixtures employed for milling the simpler of these two castings, which has faces to be machined at right angles, will be derived by referring to Figs. 8 and 9 which show the work set up for milling, and rear views of the empty fixtures, respectively. On this job, one pair of faces is milled with the work held at one end of the table, after which the casting is reset in a fixture at the opposite end of the table for milling two additional faces, which completes the operation. Fig. 11 shows four views of the work and illustrates the surfaces to be milled. The rate of production is 150 milled transmission cases in a nine-hour day, which includes the performance of two milling operations on each case.

Fig. 10 shows a rear view of a fixture used for milling the type of transmission cases on which there are three surfaces to be machined, and in Fig. 12 there are illustrated three views of the transmission case with the milled sur-

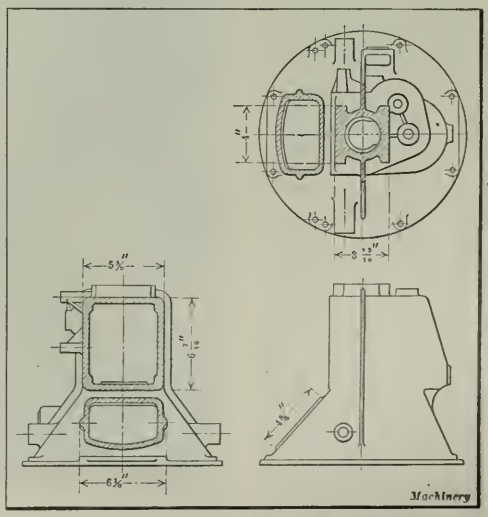


Fig. 12. Transmission Case on which Three Surfaces are milled simultaneously

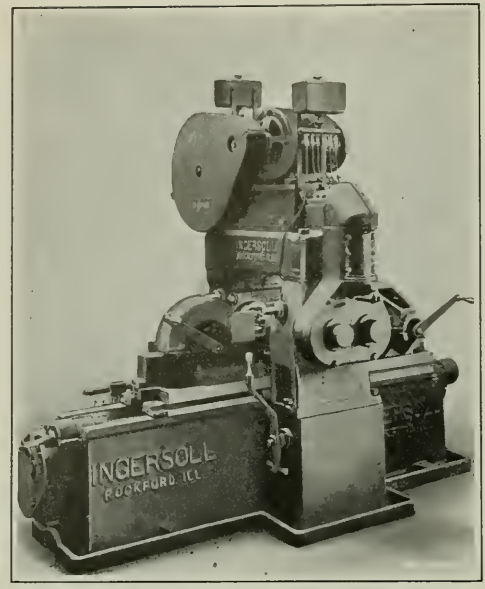


Fig. 13. Ingersoll Four-spindle Reciprocating Type of Continuous Milling Machine, built and equipped for machining Two Surfaces on Transmission Case Covers

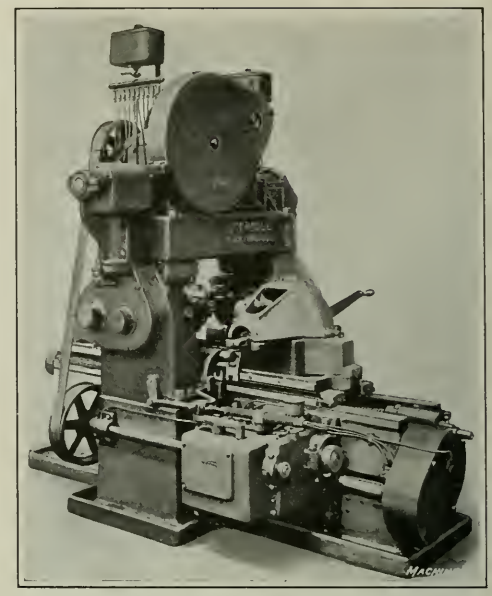


Fig. 14. Opposite Side of Ingersoll Four-spindle Reciprocating Type of Continuous Milling Machine. This Illustration shows the Second Surface to be milled

faces shown in cross-section. For this job only one setting of the work is required, and so the fixtures at the opposite ends of the milling machine table are of identical design.

Milling Two Surfaces on Transmission Case Covers

In Figs. 13, 14, and 15 there is shown another reciprocating type of continuous milling machine, which serves as a further example of how different the superficial appearance of these machines may be, although they are actually of the same type. This machine was designed and built for use in milling two surfaces on transmission case covers, and it will be seen that there are four spindles which carry inserted-tooth cutters, two of which operate on the casting held in a fixture at one end of the table, while the other two cutters operate on work held by a fixture at the opposite end of the table. This form of machine construction was necessitated by the shape of the work that has a shoulder, on the ends of which there are faces to be milled. The overhanging portion of the work would interfere with the cutters in traversing the table, unless the space between the housing of the machine was substantially widened. This would not only add to the cost of building the miller, but would also make it take up a greater amount of floor space. As a result, it was considered a more economical proposition to use the four-spindle design. On this machine a feed of 6¼ inches per minute is employed, while the rapid table traverse is at a rate of 10.6 feet per minute. The cutters are 4 inches in diameter, and each spindle quill has an adjustment of 2 inches. The capacity of the machine is 14 by 14 inches by 5 feet. In Fig. 16, the shaded areas show the surfaces that are milled at opposite ends of the work.

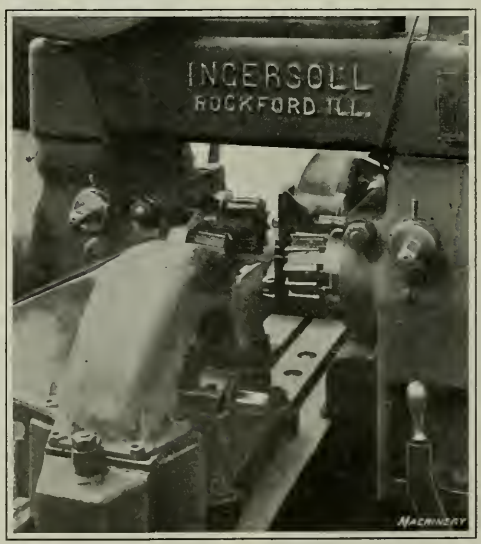


Fig. 15. Close-up View of Cutters and Work on Ingersoll Four-spindle Reciprocating Type of Continuous Milling Machine shown in Figs. 13 and 14

Milling Timing Gear Case Covers on Semi-automatic Machines

In Figs. 17 and 18 there is shown a semi-automatic milling machine which was built for use in the performance of two successive operations on timing gear case covers, but in this instance the method of procedure in handling the work is essentially different from that which was employed in the case of cylinder blocks and transmission cases. Here, instead of employing a single machine for performing two successive operations, two separate machines are used on which the first and second operations are performed. On the first machine, all of the cutters are 5 inches in diameter; and on the machine for performing the second operation there are 5-inch cutters on the horizontal spindles and 7-inch cutters on the vertical spindles. A 2-inch adjustment is provided for all of the spindle quills. The rate of feed employed is 6¼ inches per minute, while the rapid traverse back to the starting position takes place at the rate of 10.6 feet per minute. The capacity of the machine is 14 by 12 inches by 4 feet.

In their general form these machines are rather similar to the well-known Ingersoll planer type millers, but they

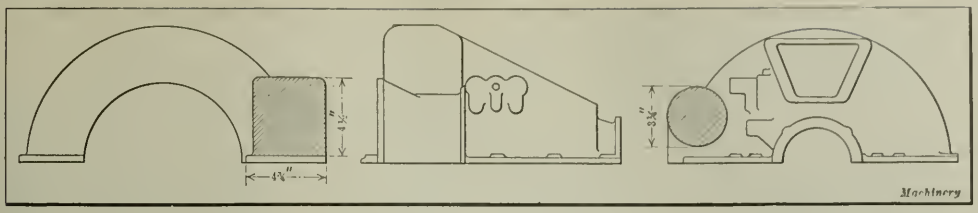


Fig. 16. Transmission Case Cover to be milled. In this Illustration the Cross-sectioned Areas show the Surfaces to be machined

are intended for the quantity production of small work, and to meet the requirements of this special service, several modifications of design were found necessary. Most important among these is the arrangement of the feed mechanism for controlling the table movements, and this can best be explained by telling how the operator proceeds to load and unload the fixtures that are furnished on the table. While the table is still at rest the operator loads the first fixture, after which he throws in a feed-lever that starts the table carrying the work under the cutters at a rate of 6¼ inches per minute. Directly the operator has engaged the feed movement he proceeds to load the balance of the fixtures as rapidly as possible, the design of the clamping mechanism having been worked out in such a way that no trouble is experienced in loading the fixtures more rapidly than the table carries them under the cutters. After the operator has loaded the last fixture of the string (it will be seen that there are two rows of fixtures running parallel along opposite sides of the table), he goes to the opposite side of the arch and unloads milled castings which have passed out from under the arch.

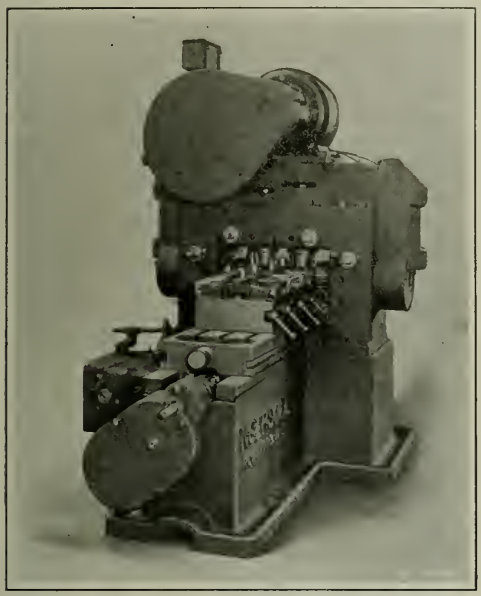


Fig. 17. Ingersoll Semi-automatic Milling Machine, for performing Two Operations on the Covers for Timing Gear Cases

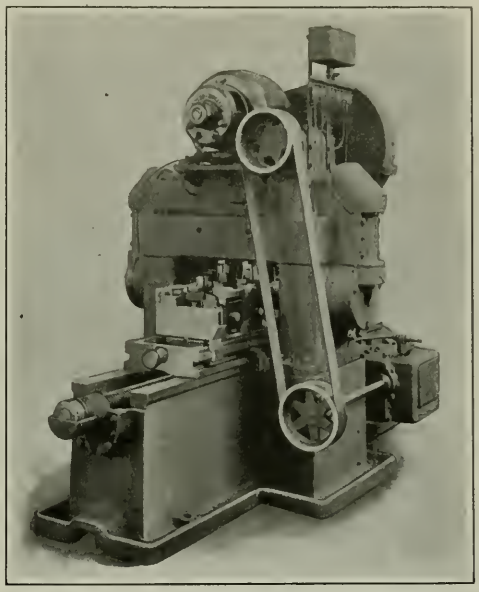


Fig. 18. Opposite Side of Machine illustrated in Fig. 17. At this Point in the Table Travel, the Operator starts unloading Castings

When the cutter has cleared the last piece of work, a stop is engaged to automatically throw out the 6¼-inch power feed and engage a rapid traverse movement which takes place at a rate of 10.6 feet per minute. This quickly carries the balance of the pieces of work out from under the arch, after which a second stop disengages the fast table movement, leaving the table at rest. The operator now proceeds to remove the balance of the pieces of work from the fixtures, after which he throws in a return lever to start the table traveling back to the initial position at a rate of 10.6 feet per minute. When the table reaches the starting position, it stops automatically. The cycle is then repeated by the operator putting two castings in fixtures at opposite sides of the table and reengaging the forward feed movement, after which he proceeds to reload

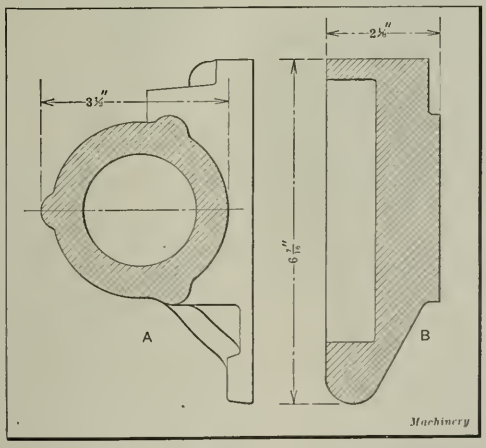


Fig. 19. Two Views of the Timing Gear Covers, where Cross-sectioned Areas show Surfaces to be milled

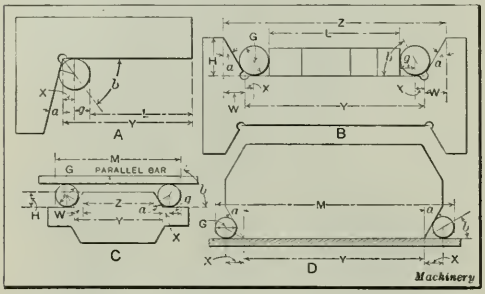
the balance of the fixtures and go through the other movements of the cycle that have just been described. It will be seen that on each of the timing gear case covers that are milled on this machine, there are two surfaces to be milled at the first operation, and that four spindles are provided to enable these two surfaces on each casting in the two rows that are carried at opposite sides of the table to be simultaneously milled as they are carried under the arch of the machine. After the work has been completed on this machine, the castings are sent to a second miller on which another milling operation is employed. Fig. 19 shows the two shaded areas *A* and *B* that are milled on the machine shown in Figs. 17 and 18.

* * *

USE OF WIRES FOR INSPECTING SPECIAL GAGES

By V. E. AYRE

When inspecting a gage such as shown by diagram *A*, the distance *Y* from the intersection of the two gaging surfaces to the top of the gage may be checked in the following manner: Measure the angle *a* by the use of a sine bar; then clamp the gage to an angle-plate, with the surface of



Types of Special Gages in the Inspection of which Measuring Wires are employed

which *Y* is the length, in a vertical position. Place a wire of radius *g* tangent to the finished surfaces of the gage and hold it in position by means of a rubber band. Measure the distance *L* from the top of the wire to the top of the gage, and from these measurements determine the distance *Y* by an evolution of the following formula:

$$Y = L + g + X$$
$$X = g \cot b$$

But *b* equals ½ (90 degrees + *a*); therefore

$$Y = L + g + g \cot \tfrac{1}{2} (90 \text{ degrees} + a)$$
$$= L + g [1 + \cot \tfrac{1}{2} (90 \text{ degrees} + a)]$$

A gage of the type shown at *B* may be inspected by the use of two wires of known diameter. To find the distance *Y* from intersection to intersection, first check the angles *a* by means of a sine bar. The distance *L* between the wires may be determined by the use of size blocks, being careful that the wires make proper contact with the finished surfaces; or, this distance may be determined by clamping the gage to an angle-plate, the surface of which *Y* is the length being held in a vertical position, and the wires being held in place by means of rubber bands. Then determine *L* by transferring the measurements taken over the wires to the stacks of size blocks. From these measurements and wires of diameter *G* and radius *g*, solve for *Y* as follows:

$$Y = L + 2g + 2X$$
$$X = g \cot b$$

But *b* equals ½ (90 degrees + *a*); therefore

$$X = g \cot \tfrac{1}{2} (90 \text{ degrees} + a)$$
$$2X = 2g \cot \tfrac{1}{2} (90 \text{ degrees} + a)$$
$$= G \cot \tfrac{1}{2} (90 \text{ degrees} + a)$$

Then

$$Y = L + G + G \cot \tfrac{1}{2} (90 \text{ degrees} + a)$$
$$= L + G [1 + \cot \tfrac{1}{2} (90 \text{ degrees} + a)]$$
$$W = H \tan a$$

Therefore,

$$Z = Y + 2H \tan a$$

The check *D* for the gage shown at *B* is also inspected by the use of wires. Measure angles *a* by means of a sine bar. Clamp the check to a surface plate and take a micrometer reading *M* over the wires of diameter *G*, as shown. From the above measurements calculate *Y* by employing the formula $d = m - C$, for obtaining the diameters of tapered plugs from measurements taken over two wires, as deducted in the February number of MACHINERY, page 541. Referring to the diagram, angle *b* equals ½ (90 degrees — *a*)

$$Y = M - G [1 + \cot \tfrac{1}{2} (90 \text{ degrees} - a)]$$

in which the values *Y*, *M* and the correction $G [1 + \cot \tfrac{1}{2} (90 \text{ degrees} - a)]$ correspond, respectively, to the values *d*, *m* and *C* in the formula for tapered plugs.

Referring to the special gage shown at *C*, first check angle *a* by the use of a sine bar. Measure depth *H* and take a micrometer reading *M*, over two wires of diameter *G* placed as shown in the diagram. To insure contact of the wires with the finished surfaces of the gage while taking the measurement *M*, the wires should be held down by exerting a slight pressure on a parallel bar placed against the tops of the wires. As a further precaution, use a very light pressure on the micrometer spindle, as an excessive pressure will raise the wires and result in an inaccurate reading. Then calculate *Y* and *Z*.

$$Y = M - 2X - 2g$$
$$b = \tfrac{1}{2} (90 \text{ degrees} + a)$$
$$2X = 2g \cot \tfrac{1}{2} (90 \text{ degrees} + a)$$

Therefore

$$Y = M - G - G \cot \tfrac{1}{2} (90 \text{ degrees} + a)$$
$$= M - G [1 + \cot \tfrac{1}{2} (90 \text{ degrees} + a)]$$
$$Z = Y - 2W$$
$$W = H \tan a$$

Consequently

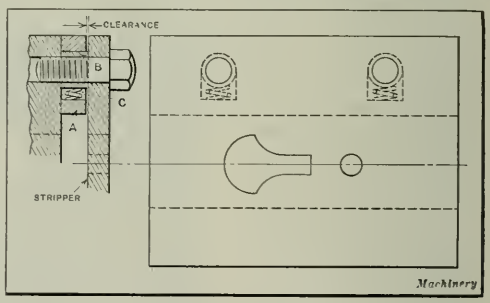
$$Z = Y - 2H \tan a$$

* * *

SPRING GUIDE FOR BLANKING DIES

By WILLIAM C. BETZ

In connection with combination blanking and piercing dies, it is frequently desirable to provide a self-adjusting stock guide to compensate for variation in the width of the stock.



Construction of Compensating Spring Guide for Blanking and Piercing Dies

To this end, the spring guide shown in the accompanying illustration was designed. The holes in the guide strip *A* through which the screws pass that secure the stripper to the die-block, are bored over size, so as to permit the bushing *B* to be inserted. All the holes on one side of the die are treated similarly, and are elongated to permit a small coil spring *C* to be inserted. The bushings are longer than the thickness of the guide strip, so that the strip will not be bound tightly between the die-block and the stripper, thus permitting any variation in the width of the stock to be compensated for by the yielding construction of the guide strip.

Industrial Conditions in Scandinavia

By G. A. LINDSTEDT, President, A. B. Galco, Ltd., Stockholm, Sweden

THE industrial conditions in the Scandinavian countries are still abnormal, as the time that has elapsed since the war has been too short to permit of a complete readjustment. Furthermore, many new problems have come up, especially in regard to labor. Some raw materials are difficult to obtain, but on the whole, the industries do not suffer for lack of either coal or raw material, although the prices for these essentials are still very high. There is no scarcity of food, such as during the war, but prices are about as high in these countries as in the United States.

In the present article, Mr. Lindstedt, who has just visited the United States for a few weeks, gives a review of the general industrial conditions in Sweden, particularly as they affect the machine tool trade. He points out that the German machine tool industry is now so disorganized that no competition is offered from that source. On the other hand, Scandinavian manufacturers last year stocked up with German machine tools offered at low prices and will not be in the market for any large quantities of standard machine tools for some time to come; but there is a market for semi-automatic and automatic machinery as well as high-grade grinding and milling machines.

German Machine Tools in Sweden

The trade of machine tools in the Scandinavian countries is far from brisk. Last summer and fall a great many German machine tools were sold at very low prices, as pointed out in the writer's article in the December number of MACHINERY; but at present, practically no German tools are sold. This is due partly to the increased price of German machine tools, which are now but slightly cheaper than those offered by America or England, and partly to the unstable conditions in Germany, which make it impossible for the German machine tool builders to keep promises in regard to deliveries. In cases where orders were placed last fall, buyers have received several notifications of increases in price, and the delivery dates have been put off from time to time. The result has been that the whole Scandinavian industry has become tired of dealing with the German machine tool builders and now will not buy anything at all from this source. The belief that Germany would largely supply Scandinavia with machine tools for the future has thus proved unfounded.

General Situation in the Scandinavian Machine Tool Trade

The foregoing statements refer particularly to Sweden, but are applicable to Norway and Denmark as well. So are also the statements following, relating to the general conditions in the machine tool trade in the Scandinavian countries. There is no likelihood of any large amounts of standard types of machine tools being sold there for some time to come, because many of the factories bought German machine tools at the low prices at which they were offered last year in such quantities that they are now kept in stock for future use. Some are also stocked up with machine tools that were built in Sweden during the war, and one large concern, for example, has a whole storehouse that is full of machine tools which have never been used and which are being kept in stock with a view to meeting future requirements. Some of the larger firms, in fact, have stocked up so heavily with machine tools that they are now offering them for sale in the open market.

The result of this is that only certain classes of American machine tools are likely to find a market in the Scandinavian countries for the next year or two. Machines that can still be sold are automatic machines of various types, especially multiple-spindle drilling machines, automatic turret lathes, the better grade of grinding machines, and special automatic machinery adapted to specific industries. There is no doubt that there is a great field for machines of these types in all the Scandinavian countries, and especially in Sweden, provided the manufacturers there can be educated to appreciate the importance of installing modern equipment to increase production, so that the effects of the high wages and the shorter working hours now in force may be overcome.

General Industrial Conditions

In some industries business is brisk, especially in those engaged in making ball bearings, dairy machinery, and oil engines; the shipbuilding industry is also active. The manufacturers making agricultural machinery have found business quiet, but it has improved considerably during the last few months. The shops building locomotives and railway cars are working with a limited force. Orders are not being placed by the railroads to fill these plants to capacity because of the finances of the roads. The wages of the trainmen and other railroad employes have been increased to a very great extent, fuel prices are abnormal, and the increased fares and rates that have been put into effect are not sufficient to make up for the increased costs; hence, the roads have to try to effect a saving on equipment.

It is difficult to start new enterprises, because investors have become used to exceptional returns during the war period and many seem to prefer speculative undertakings promising exceptional returns to sound, normal enterprises. Others, again, are over-conservative and refuse to invest in anything at all, fearing the present instability of conditions. Nevertheless, some of the forward-looking men in the Swedish machine industries are planning to enter new lines of manufacture and to build up international trade. In one case, for example, one of the largest munitions plants is reorganizing to build an extensive line of forging machinery and also to enter the world's hardware market.

Labor Conditions

The eight-hour day has been established by law in all the Swedish industries. Compared with former Swedish conditions, wages are exceptionally high—from three to four times as high as ten years ago. In Stockholm a good toolmaker receives from 60 to 65 cents an hour, based on normal exchange; a machinist receives about 50 cents an hour. In the smaller towns and in the country districts, toolmakers get from 45 to 50 cents an hour, and machinists from 35 to 40 cents an hour. Unskilled labor employed in the outdoor trades is getting much higher wages than machinists and toolmakers, and for that reason it is difficult to retain the men in the machine shops.

General Conclusions

Summarizing what has been said, especially as to its effect on the sale of American machine tools in Sweden, it may be stated that for the next few years there will be little sale for standard machine tools, such as lathes, planers, drilling machines, and plain milling machines. There will be a fair trade in universal milling machines and grinding machines, and if dealers are able to convince Swedish manufacturers of the necessity of installing modern labor-saving machinery, there will be a large trade in semi-automatic and automatic machinery, and especially in machinery for special purposes in the hardware and similar trades.

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A DREAM OF UTOPIA

No capable business man would attempt to conduct an immense and diversified business without employing highly trained and well paid specialists to manage the different departments. The business of this nation is probably the greatest and most complex in the world, but many if not most of the men responsible for its operation are of mediocre ability, not capable of efficiently managing a manufacturing business of more than ordinary size and character. When by a twist of luck a capable executive finds himself occupying a government job, as many did during the war, he is quickly surrounded by the stone walls of custom and finds his most enthusiastic efforts opposed by official inertia.

What a wonderful thing it would be for this country of ours if capable executives were given real control of the government's work and of the men under them, as is done in successful manufacturing corporations—the only test being results!

We look over some of the great enterprises that have come up from almost nothing in the field with which we are most familiar; we review our wonderful mechanical progress in the last twenty years—always striving for the reduction of cost or its equivalent—increased output—and we say, let us work hard to secure the application of these principles to the operation of our national government—that antiquated, lumbering, hit-or-miss machine, the same in principle that it was twenty, thirty, forty years ago—but always costing the taxpayers more.

Then we see that our idea is not one which belongs in these practical columns; it is a dream of Utopia.

* * *

PERSEVERANCE WINS

How many failures in business are due to lack of perseverance? Men conceive ideas, follow them out for a time, and when immediate success is not apparent, give them up to try something else which may be inferior to their first conception. The quality of perseverance is one that has sustained many men through apparent failure to success, and in engineering there are numerous examples of this—Eli Whitney, John Ericsson, Elias Howe, DeLaval, Elihu Thomson, the Wright brothers, and Henry Ford. In 1881 a humorous editorial appeared in a scientific journal about a young man named Thomas Edison who had made certain improvements in a machine that he called an electric motor and which he thought some day could be used to drive machinery of all kinds. One of the leading financiers of New York more than forty years ago is said to have directed Alexander Graham Bell to a toy store as the proper place for the sale of his telephone. Fortunately such men are not easily discouraged, for if they had not persisted in perfecting their inventions and in making others realize their value, many of the wonders of our present-day civilization might not yet be known.

Recently we were shown a crude and simple tool developed by a mechanic of the inventive and persevering type some seven years ago, which did not look like the basis for a substantial business. Other mechanics who saw it at the time were unable to visualize its possibilities, but from the crude idea represented by the original tool, one of the most highly refined precision gages has been developed, and it is probable that a large business will be built up from that apparently insignificant idea.

The young man of today needs to cultivate perseverance. There is too great a tendency to float from job to job, to consider nothing very seriously, to believe that a fortune can be made at a single stroke, and that success can be achieved by brilliancy and personality rather than by persistent effort. While personality is a great help to success, it will accomplish little unless coupled with that perseverance of effort which overcomes difficulty, disappointment, and even failure. These stand between almost every man and success.

* * *

THE AMERICANIZATION MOVEMENT

The workmen in large plants usually comprise two groups or classes which must be differentiated to some extent in order that proper methods may be adopted in dealing with them. There are the native-born workers and those born in foreign countries who have come to the United States intending either to return after a few years, or to make permanent homes here. It is of great importance that all foreigners of a desirable type should be made to feel at home in America, so that, if they originally intended to return to their native country, that intention may be changed as soon as possible. They should be encouraged to become citizens, and means should be adopted to make it worth while for them to acquire American viewpoints and modes of living. If this is accomplished, they will be governed during periods of industrial unrest, by the same conservative ideas that generally influence the native-born American workman, and if they have come to appreciate and believe in American ideals, they will more carefully consider the arguments of radical agitators. Meanwhile, all industry is passing through a transition period. Methods of management which have produced seemingly satisfactory results in the past will undoubtedly be so modified during the next decade as to bring conservative workingmen into a closer and more harmonious relation with the management of our industrial organizations.

It is believed by many who have been closely in touch with industrial management during the past few years that the present movement toward the Americanization of the foreign-born and the trend toward greater cooperation between the management and the workers, will ultimately stabilize conditions in American industries, produce a more homogeneous body of workers, and increase the prosperity and happiness of all through the increased production that naturally will result from improved industrial relations.

Why the Metric System Must Not be Made Compulsory

By FRED A. GEIER, President, Cincinnati Milling Machine Co., Cincinnati, Ohio

In the present article, Fred A. Geier, one of the best known men in the American machine tool industry, gives some very definite reasons why the metric system must not be made compulsory in the United States. He points to the confusion and loss that would result and to the heavy burden that would be placed upon the industries—upon the management and workman alike—without any gain whatsoever resulting from the change from our present system. In conclusion, he states that the industries must receive first consideration in this matter, because they will be most seriously affected, and he further emphasizes that at this time everything should be done to keep the wheels of industry running smoothly and to encourage production. Mr. Geier makes it clear that a compulsory metric law would cause confusion and have exactly the opposite effect.

EFFORTS to put a compulsory metric law through Congress have recurred at intervals for a good many years, and each time Congress or the Committee on Weights and Measures has, after careful consideration, refused to take such action. It must be assumed that there were good reasons for this, but at no time were there such good reasons for not passing such a law as at present. The whole world is looking to us for production, and it is inconceivable that Congress should seriously consider any action that would further curtail production—and this would be the first result of a compulsory metric law.

Confusion and Expense Would be the Result of Adoption of Metric System

The confusion and loss which it would entail would fall especially heavy on the industries. It would require the duplication of the entire present equipment of tools, jigs, fixtures, micrometers, measuring instruments, gages, drills, taps, etc. This is exceedingly expensive equipment and can not be changed over to suit the metric system. This is a fact which is either not understood or is deliberately ignored by the advocates of compulsory metric legislation. They apparently do not know that all manufacturing is done according to adopted standards, and the standards used in metric countries which grew out of that system of measurement are different from those used in countries employing the English or inch system. Merely changing the dimensions on English drawings to metric dimensions will not convert them to metric standards.

A simple example is the 1-inch diameter milling machine arbor. The nearest standard used in metric countries is 27 millimeters and not 25.4 millimeters, which is the approximate metric equivalent of the inch. In the same way, out of the metric system has developed a metric or module system of gears, which will not interchange with our diametral pitch system. Not only is it not possible to make a gear manufactured to the inch standard run with a gear manufactured to the metric standard, but a set of metric gears cannot be put into a machine which previously used English or inch gears, because the center distances would not be correct. These are only two examples selected because of their simplicity, but they illustrate very fully that the two systems cannot be reconciled with each other.

Machinists' and Toolmakers' Present Tool Equipment Would be Useless

In addition to the direct expense to the industries referred to above, the proposed law will impose a more serious burden, a full share of which must be borne by the workers. They will be compelled to purchase very considerable additions to their present kit of tools, and they will be compelled to learn the new system. For a long time it would be necessary to use both systems and this would result in much confusion, loss in wages, and loss in production.

Compulsory Legislation Would Prove a Great Hardship to the Industries

It would seem that the existing law, making the metric system legal, should be sufficient. To make it compulsory and actually enforce the compulsion, would prove disastrous for many corporations, and extremely expensive for all, and I have found no one yet who could show where anything would be gained to the industries by a change from our present system of measurements to any other.

This is a matter in which the industries deserve first consideration, because they will be most seriously affected, and anything that affects them will in the same way affect the large proportion of the population which derives its livelihood from the industries. This is a time when everything should be done to keep the wheels of industry running smoothly, and I believe that it is the earnest desire of our Congress to do all that it can to encourage this condition. A compulsory metric law would have exactly the opposite effect.

* * *

STATUS OF PROPOSED METRIC LEGISLATION

According to the latest advices from Washington, it is probable that Congress will not take any action at this session in regard to the bills introduced for the purpose of making the metric system compulsory. It is not likely that these bills will be reported out of committee at this session; and hence, for the present, any danger of hasty and ill-advised legislation is past.

The agitation for the metric system on the part of the World Trade Club in San Francisco, nevertheless, is going on with the same vigor as in the past, and manufacturers and others who believe that conservative and thoughtful consideration of this matter is important should not permit themselves to think that the question will not be forced to the front at the next Congress, even though it may not be brought up at this. Statements of facts should be given the widest publicity, and it should be understood that the present controversy is not one concerning the merits of the metric system as compared with the English system, but purely a question of whether or not at the present time it would be advisable to make a change in the system of measurement used by the American industries. Most of the leading manufacturing and commercial organizations in the country have passed resolutions recording their opposition to any legislation for making the metric system compulsory.

The American Institute of Weights and Measures is endeavoring to counteract the influence of the World Trade Club in San Francisco. The latter has made use of many untrue statements in its propaganda, particularly by quoting statements from leading men out of their proper connection and by implying that individuals and firms are favorable to the metric system when they are not.

Fastening Machines to Concrete Floors and Foundations

By ARTHUR F. OWEN

MACHINE tools of light weight are generally fastened to concrete floors by the use either of standard expansion bolts as shown at *A* in Fig. 1 or by lag screws around which molten lead has been poured, as shown at *B*. The holes in a concrete floor for the style of mounting shown at *B* should be drilled somewhat larger in diameter near the bottom in order to prevent the lead core from loosening and thus necessitating frequent tightening of the bolts. At *C* is shown a wooden plug driven into a drilled hole in a concrete foundation by means of which the machine is fastened with ordinary lag screws. This method, however, is used more extensively in the erection of light apparatus such as electrical switch boxes, etc., rather than in the fastening of machine tools, where the service demanded of a foundation bolt is much more severe.

Where the machine is heavy or the vibration excessive, or where unusual rigidity is required, the method illustrated at *D* is generally used. As shown, a standard machine bolt and washer is set in concrete grouting. This method permits the use of a bolt of large diameter, and comparatively short length. All the methods shown in Fig. 1 are ordinarily used on old concrete floors. Where machinery is liable to be changed or transferred, the method shown at *A* or that at *B* is most desirable, as in both these cases no projecting bolts are left in the floor after the removal of a machine.

Drills for Cutting Holes in Concrete

The drills usually employed for cutting holes in concrete are shown in Fig. 2. *A* is a standard star drill, and the one most commonly used for this kind of work. Where the depth of the hole is limited, a collar adjusted by a set-screw is sometimes used to prevent drilling too deep. This method of gaging the depth of hole is especially advantageous when drilling into floor slabs in multiple-story concrete buildings where the floors are necessarily thin, and where, in the event of the hole going through, a constant source of trouble would result from the leakage of oil or other liquids. At *B* is shown a drill constructed along the lines of an ordinary cold-chisel. If this drill is used carefully, and not driven with too great a pressure, a clean hole can be cut through a concrete floor or wall. Of course some breakage or raggedness around the hole where it breaks through is unavoidable, but this may be reduced to a minimum by substituting the drill shown at *A* when the hole is nearly cut through, and striking lightly, while constantly turning the drill in the hole.

Setting Bolts in New Foundations

In new foundations where a larger variety of bolts is available for use, it is the general practice to use permanently set bolts, that is, bolts bonded into the concrete of the floor or foundation. Simplicity and low cost are the determining factors in this work. At *A*, Fig. 3, is shown a common type of foundation bolt, which in all probability is the cheapest bolt to use in this construction. It consists of a bar of cold-rolled steel of suitable diameter, threaded on one end, and nicked or cut with a chisel on the end which is to be imbedded in the concrete. These nicks or lips are sufficient to withstand all ordinary strains when the bolt is properly set, and when the concrete is well puddled around it. At *B* is shown a bolt which is extensively used for engine erection, general construction, etc. It is quickly and cheaply made, and is unexcelled for strength and simplicity. This bolt is also made of cold-rolled steel, as a good thread can be easily cut on this material. The lower end is heated and bent at right angles to the bolt as shown. At *C* is shown

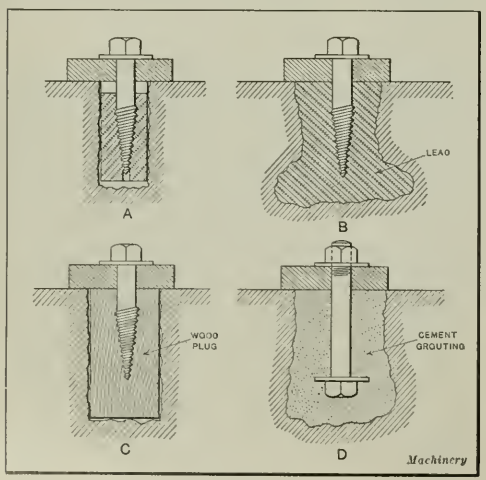


Fig. 1. Common Methods of fastening Light Machine Tools to Concrete Floors

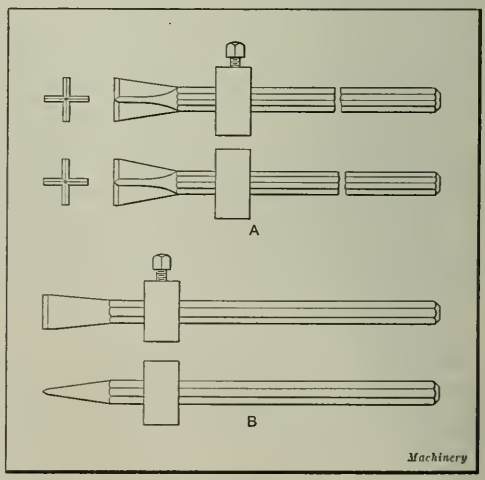


Fig. 2. Two Types of Drills employed to drill Holes in Concrete Floors and Foundations

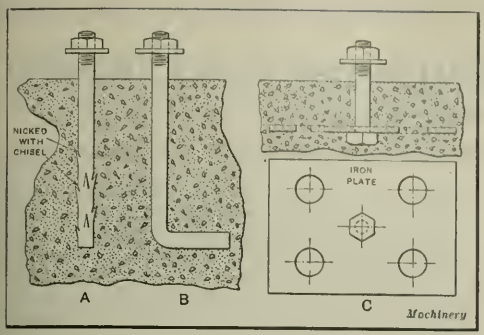


Fig. 3. (A) and (B) Commonly Used Types of Bolts which are set in Concrete Floors or Foundations when Concrete is in Plastic State. (C) Construction when Short Bolts are used

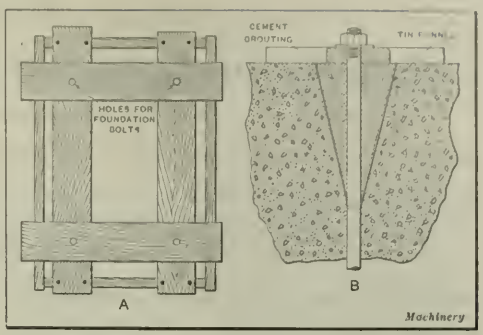


Fig. 4. (A) Templet for locating Bolts while filling Concrete Mold. (B) Method of setting Bolt which permits it to be bent after Concrete solidifies

the method of setting a foundation bolt where the depth to which it can be imbedded in the concrete is limited, due to pipes or other equipment imbedded beneath its proposed location. It is simply a standard machine bolt, with a plate of ¼-inch iron used as a washer. The size of this plate should be at least 4 by 5 inches when imbedded in one inch of concrete, and should be provided with holes at least 1 inch in diameter, through which the concrete may bond when it is puddled. This method gives a strong fastening and the liability of the concrete cracking over the plate is greatly reduced.

Locating Bolts in Correct Position

In setting foundation bolts, a simple templet made of scrap wood, as shown in Fig. 4 at *A* is frequently used. The bolt centers are laid out and drilled to the bolt size, and the templet is nailed to the form of the foundation. The thickness of the templet must be taken into consideration when setting up the nuts on the foundation bolts, so that the proper length of threaded bolt will extend above the finished surface of the foundation. On extra heavy work, where it is either impossible or impracticable to use a templet, the bolt centers may be laid out while the concrete is still soft, and the bolts pushed or driven into place. When employing this method it is advisable to use funnels or sleeves on the bolts as shown at *B*, Fig. 4. These funnels are made of tin or any available scrap sheet metal. They permit bending the bolts to the proper center distances after the concrete has set, and are more than worth the extra expense of making, where the machine to be erected is large and heavy and the lay-out complicated. After the concrete is set, the funnels are removed, the bolts adjusted to proper centers, and the machine lowered to its final position. The space left around the bolt by the funnel is then filled in with cement grouting.

Grouting, as generally used, consists of equal parts of Portland cement and coarse sand, mixed to the consistency of paste, or in other words, made liquid enough to be easily poured with the assurance that it will fill all the voids around the bolts. A very good aggregate, or ratio of ingredients, to use for small foundations is: one part Portland cement; two parts sand; and four parts screened gravel. This differs from the standard 1:2:4 concrete, only as regards the size of the gravel. By screening the gravel through a ½-inch mesh screen, the concrete may be poured considerably wetter.

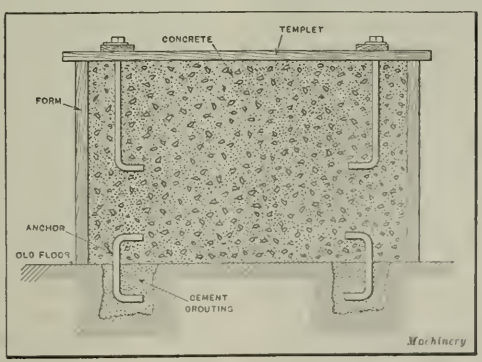


Fig. 5. Method of anchoring Concrete Foundation to Concrete Floor

and the necessity for finishing the foundation by plastering is almost always eliminated. If a smooth, neat finish is necessary, it may be readily obtained by brushing the concrete with a stiff wire brush, wet with water, while the concrete is still in a semi-plastic or "green" state.

When building a foundation for a motor, or similar machine, upon a floor already laid, means must be provided for bonding the foundation with the floor. While it is usually more satisfactory to break a hole in the floor, and excavate to a depth determined by the weight of the machine and the nature of the under soil, it sometimes happens, owing to piping beneath the proposed foundation or to the machine being placed on an upper floor of the building, that a foundation must be built on top of the floor already laid. These foundations may be erected as shown in Fig. 5. Bolts are first grouted into the floor, and the form for the foundation is then placed over them. After the bolts for holding the machine are set, the concrete may be poured. After pouring, the concrete must be either well puddled, or tamped so as to completely fill all the spaces between the bolts. This type of foundation was used by the writer on two different foundations for high-speed machinery with great success.

* * *

MATERIAL HANDLING MACHINERY MANUFACTURERS ASSOCIATION'S NEW OFFICERS

The Material Handling Machinery Manufacturers Association, 35 W. 39th St., New York, at a recent meeting elected the following officers for the coming year: President, Charles F. Lang, president of the Lakewood Engineering Co., Cleveland, Ohio; vice-president, Rumsey W. Scott, of the Otis Elevator Co., New York City; treasurer, Lucian C. Brown, general sales agent of the Elwell-Parker Electric Co., New York City; secretary and manager, Zenas W. Carter. At this meeting the retiring president, Calvin Tomkins, was elected to honorary membership as an expression of appreciation for his excellent work as first president of the association. E. F. Carey, president of the Haskell-Barker Mfg. Co., was also elected an honorary member in recognition of his activity in initiating the organization of the association at the close of the war. The following companies were elected to active membership: Whiting Foundry & Equipment Co., Harvey, Ill.; Motors Terminal Co., Cleveland, Ohio; and C. W. Hunt Co., West New Brighton, N.Y.

Cooperation between Employer and Employe

By WILLIAM A. ROCKENFIELD, Assistant General Manager, Baldwin Chain & Mfg. Co., Worcester, Mass.

THE spirit or morale in any factory is generally a reflection of the attitude of the management toward the employes, and after all is said, the answer to the question "How do your men feel toward you?" will be found in the correct answer to the question, "How do you feel toward them?" If the attitude of the management toward the employes is just and right from a moral standpoint, even though not at times conforming with the men's viewpoint, they will understand the sincerity of purpose in due time and will show their appreciation by loyal effort. The true attitude of the management will manifest itself regardless of any diplomacy, because ultimately this attitude will dominate the policies of the company.

Recently I read that as a mark of respect for an employer who had passed away, the workmen in his plant, without any urging or outside influence, turned out the biggest day's production in the history of the plant—the most effective way in which they felt that they could show their respect. To my mind this action corroborates the slogan adopted by one company: "Men are square," to which I would add, if allowed, "if treated fair"; and in this statement I think lies the whole solution of our present industrial problems.

Fairness the Most Important of all Managerial Qualifications

A manager's best asset is a reputation for being fair. If the employes recognize that he has this quality, they will make allowance for many other personal shortcomings or idiosyncrasies. Let us remember that the employes study the manager just the same as he studies them, and they have the advantage of the many viewpoints that come with added numbers. The manager is always in the spotlight, whereas each individual employe is not; and generally speaking, the employes have a more definite knowledge of the personality, the strength, and the weaknesses of the manager than he has of each of them individually. Any manager, therefore, can profit by bearing in mind that the acid test applied to him by his employes is the question most generally asked by the workmen either directly or indirectly—"Is he on the level?"; and the answer to that question indicates whether or not he can manage a force of men so as to gain their efficient cooperation.

The Necessity for Organizing Ability

Next in importance to the respect of the men working for him, comes the manager's ability to organize the business. The best test of his organizing ability is an affirmative answer to the question "Will the business run without him?" When a business can be conducted with at least a reasonable degree of efficiency in the absence of the manager, it is proof that he has gained the cooperation of the employes and at the same time has developed that initiative in the organization without which it could not run independently. Any plant, to work efficiently, must have a clearly defined scheme of operation and delegated responsibilities. In a machine shop or plant, there should be, for example, a definite engineering department responsible for new designs and the working out of new ideas. The best results will be obtained, however, when this department works in thorough cooperation with the manufacturing departments. The foremen and toolmakers know something about mechanics also, and should be called into conference in order to obtain their views on new designs. Other department heads should also be given an opportunity to express their opinions before a final decision is made.

Regardless of the excellence of any suggestion or any new departure, it is impossible to obtain the best results from the inauguration of new methods if the thorough cooperation of everybody concerned has not been assured beforehand, and this cooperation can be obtained only by preliminary discussions before the final decision has been reached. Such discussions also contribute to the interest of each individual in his work and lifts the routine manufacturing work somewhat out of the monotony of repetition work. The value of the cooperation that is gained by giving a man a voice in the things for which he is later expected to take the responsibility of operating or building, cannot be measured in dollars and cents. It is a psychological asset which cannot possibly be bought with money.

The Value of Conferences

Conferences are excellent things for stimulating cooperation, but past experience indicates that when composed of more than four or five men at a time, they produce little of real value except arguments, and the presentation of good ideas is often prevented in a large conference because there are few men, especially among those engaged in mechanical work, who are not self-conscious in a big audience. When it becomes necessary to have a matter considered by a large number of men, it is best to call different groups at different times, and in that way bring out the ideas of each group, after which these ideas can be welded together and, if necessary, presented by a brief, comprehensive statement to the whole body of men assembled at one time.

The Importance of Listening to Suggestions

The manager must never be too busy to listen to suggestions. If the suggestion comes from an office employe or from one who is used to writing reports or otherwise capable of making a written statement, it is a good policy to request the person making the suggestion to write it out in the same manner as he would tell it, in order that it may be given more careful consideration. When a man has to write out a suggestion, there is an automatic sifting of ideas, and this is an excellent test of its value. Furthermore, the written suggestion will give a good idea of the carefulness of thought that has been given to it by the man submitting it. It insures that the man himself will understand what he suggests. Also, the written suggestion sometimes supplies its own answer and leads to other suggestions.

After the suggestion has been received and the manager has said that he will think it over, it is important not to let the question die, even though the answer to the suggestion must be contrary to the wishes of the man who proposes it. It is better to meet the issue squarely, and while "yes" and "no" are the two hardest words to say, in the long run they create the most favorable impressions. The ordinary shop man is sensible enough to know that everything cannot be settled offhand, and that big things generally move slowly, but he wants to see recognition taken of obvious things and some effort made that will ultimately lead to a proper adjustment. Big grievances are generally the result of small, petty grievances for which no proper outlet has been provided. Some means should be at hand so that every man can get satisfaction even in the case of a small grievance. The manager, in order to obtain thorough cooperation and efficiency from his men, must be accessible—approachable—and must be willing and able to settle grievances even though they seem small and insignificant to him.

Graphical Method of Designing Broaches

By GEORGE C. HANNEMAN

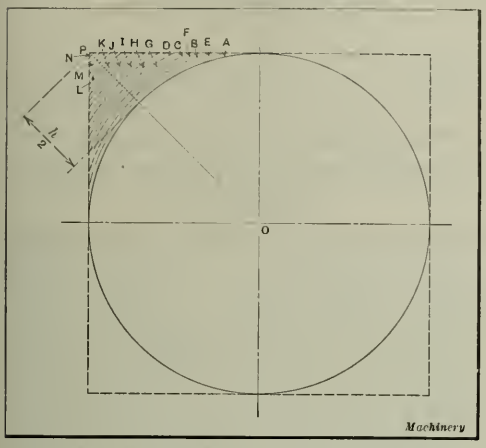


Fig. 1. Method of determining Size of Broach Teeth

IN designing pull-broaches, it is desirable to proportion the sizes of the teeth so that each tooth will remove an equal amount of stock from the part being broached and prevent the broach from being subjected to irregular stresses. This usually means that the depth of cut taken by each successive tooth should not increase by a constant amount over that of the preceding tooth, but should increase by a varying amount. For instance, when a square hole is broached from a round one, the width of each successive cut decreases, and in order to remove the same quantity of stock, the diameter or distance across the corners of each successive tooth must be increased in proportion. Thus if the first teeth of a broach take cuts 0.001 inch deep, the last teeth might be required to take cuts 0.010 inch deep in order to remove a like quantity of stock.

Figs. 1 and 2 illustrate a graphical method of determining the diameter or size of any tooth of a broach after the total amount of stock to be removed has been determined. The depth of a cut that any tooth can take, of course, depends upon the hardness and toughness of the material from which the work is made. This method is applicable to any type of broach. In order to show the manner of its application, assume that it is desired to find the dimensions of the teeth of a broach which is to cut a 0.750-inch square hole from a hole 0.750 inch in diameter. First draw these holes to a large scale of about 10 to 1, as shown in Fig. 1, in which the dotted square represents the hole to be broached and the full circle represents the original round hole. Next draw line *OP* from one corner of the square to center *O*. Let *h* equal the distance across the corners of the final hole minus the diameter of the original hole; then *h*/2 equals the height of the metal to be removed from one corner, when measured along line *OP*. Next divide *h*/2 into ten equal spaces by arcs *B*, *C*, *D*, etc., struck from center *O*. The area of the space between arcs *A* and *B* is obviously considerably larger than the area between arcs *B* and *C*, because the nearer the space is to the corner of the square, the smaller the area naturally becomes. This proves that if the successive teeth on a broach took cuts of the same depth, the amount of metal removed by each successive tooth would be considerably smaller than the amount removed by the preceding tooth. In fact, the first 10 per cent of the teeth would remove about 25 per cent of the stock which is not, of course, desirable. The next step is to draw arcs *E*, *F*, *G*, etc., midway between the arcs previously drawn. The lengths of the newly constructed arcs will be in the same proportion as the areas between the arcs *A*, *B*, *C*, etc.

Referring to Fig. 2, next draw a horizontal line *XY*, on which lay out spaces equal to one-half the lengths of the arcs *E*, *F*, *G*, etc., Fig. 1, to the same scale as the diagram in that illustration was constructed, and erect a vertical line between each space. At the left-hand end of line *XY*, erect a vertical line equal in length to the value *h* when laid out to a convenient scale, also of about 10 to 1. In the example given, *h* can be found by multiplying the diameter of the round hole by 0.414; thus $h = 0.414 \times 0.750 = 0.3105$. Therefore, line *h* should be drawn $10 \times 0.3105 = 3.105$ inches long. Next divide this line into ten equal spaces and erect horizontal lines to the right until they intersect with the vertical lines previously drawn, after which construct a curved line through each point of intersection. The value of each horizontal line should be marked at the left end. The tooth line *UV* should then be drawn the same length as the diagram and should be equally divided according to the number of teeth that the broach is to have. In the example given, assuming that the broach is to have forty teeth, this line would be spaced as illustrated.

The method of finding the correct size of any tooth of a broach is as follows: Locate the point on the tooth line corresponding to the tooth in question, then from a point on the base line of the diagram directly above the point of the tooth line, erect a vertical line until it intersects with the curve, then from this intersection project a line to line *h*, and add the value obtained there to the diameter of the original hole. Thus in the example given, the amount to be added to the diameter of the round hole to find the diameter of the twelfth tooth is approximately 0.043 inch so that this dimension would be $0.750 + 0.043 = 0.793$ inch. Similarly, the diameter of the twentieth tooth would equal $0.750 + 0.080 = 0.830$ inch. An examination of the diagram will show that if a broach is designed in this manner, 25 per cent of the stock to be removed will be removed by the first 25 per cent of the teeth, instead of by the first 10 per cent as in the case previously referred to. The use of a slide-rule

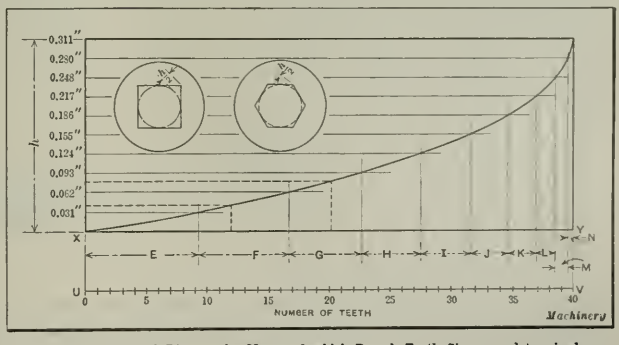


Fig. 2. Developed Diagram by Means of which Broach Teeth Sizes are determined

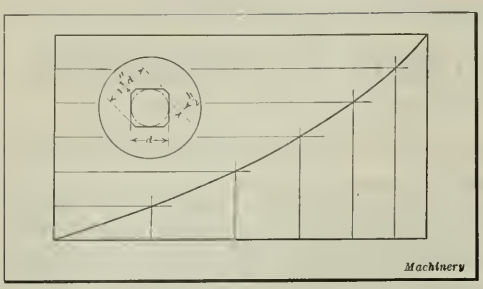


Fig. 3. Type of Curve that is developed for finding Sizes of Teeth for Square Broaches having Rounded Corners

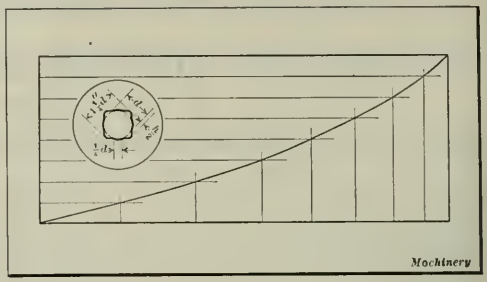


Fig. 4. Curve for Square Broaches with Rounded Corners when Diameter of Hole is Larger than Width of Final Square

will greatly facilitate the determination of the dimensions for the various teeth.

Curves similar to the one shown in Fig. 2 will be developed for all broaches of a square or hexagonal shape such as shown within the circles in the diagram. Fig. 3 shows the curve that will be developed for a square broach with rounded corners. In the case illustrated, $h/2$ was divided into six equal spaces and so the chart was constructed accordingly. Fig. 4 shows the curve for a square broach also having rounded corners, but with the original round hole somewhat larger in diameter than the width of the final square hole. In this case $h/2$ was divided into eight equal spaces.

In cases where the hole broached is simply enlarged without altering the shape, as in the examples shown at *A*, Fig. 5, the depth of the cut decreases slightly with each successive tooth. The curve developed for broaches of this type is almost a straight line, the same being true for broaches used on holes of the type shown at *B*. However, for accurate work and especially when the work is very thick in comparison with the diameter of the hole, a curve should be developed in connection with the design of the broach. When keyways or splines are broached in the hole, as shown at *C*, a true straight line will be developed on the diagram instead of a curved line.

The method described can also be adapted to the design of push-broaches, but then the diagram should be so constructed that the first teeth do not remove as much stock as the last teeth. This is because the length of the broach in compression, or the distance between the engaged teeth and the end of the broach attached to the machine, decreases as the broach is forced through the hole, and as this distance becomes smaller, greater loads can be carried by the broach with less danger of flexure. This correction can be readily made by irregularly spacing arcs *B*, *C*, *D*, etc., in Fig. 1, making the spaces nearest to the center narrower than the others. By a thorough understanding of the method described, a designer is enabled to properly proportion a broach for machining holes of any shape. As broaches are comparatively expensive, it is well to design them so that equal stresses are placed on each tooth, thus increasing their life.

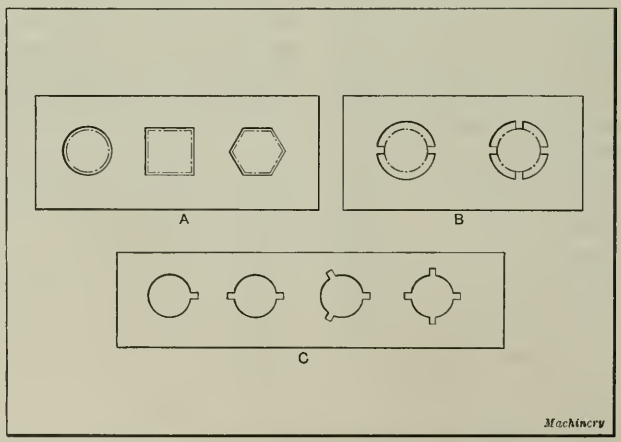


Fig. 5. (A) and (B) Holes for which the Developed Broach Curve will be nearly a Straight Line. (C) Holes for which a True Straight Line will be developed

TRANSPARENT CASE FOR PROTECTING JOB TICKETS

The common method in most shops is to have a job or routing ticket accompany the work during its travel through the various departments so that its identification can be readily accomplished or so that the operations to be performed in a certain department can be easily understood. However, unless these tickets are protected in some manner from grease, dirt, soiled hands of workmen, etc., they soon become illegible and their usefulness is impaired, if not ended. In order to prevent this from occurring, it is the practice in some shops to place the ticket in a flexible case having a transparent front that is water-, grease-, and stain-proof. Thus the ticket is prevented from becoming soiled and the markings can always be plainly seen.

Cases for this purpose are on the market, but they can also be easily made. The transparent cover in the front of the case should consist of a sheet of thin isinglass, celluloid, or material of a similar nature. The back of the case should be made of a leather substitute or rubber-coated cloth. The back is folded over the transparent front on three sides and stitched to it, the fourth side being left open to provide for placing the ticket in the case. A small eyelet is placed in the back to afford means of attaching the case to the work. When it is necessary to view both sides of the ticket and it is not desirable to remove it from the case for this purpose, both sides of the case can be made of the transparent material, the other material only being used to protect the edges of the transparent sheets. In automobile factories and other establishments where much leather substitute and transparent material are used, the ticket cases can be made out of scrap. When the material must be purchased especially for the purpose, however, it is better to use a leather substitute having a pyroxylin coating than to use a rubber-coated cloth, because the latter is not as good an oil-resisting material.

* * *

During the nineteen months that the United States was in the war, 50,000 American soldiers were killed in Europe. According to *Safety News and Comment*, during the same time 126,000 people were killed by accidents in the United States.

Machining Tractor Camshafts

Description of Equipment for the Milling, Centering, Turning and Facing Operations

By RALPH E. FLANDERS
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THE various operations required in the machining of four-cylinder tractor camshaft forgings are described in the following article, which also contains a description of the tooling equipments used in several of the operations. These camshafts are of the type that is standard on practically all four-cylinder gasoline engines, whether used on automobiles, trucks, or tractors, or in the marine field. Because the grinding of work of this sort has been brought to a high degree of efficiency, the most interesting operations in the machining of the camshafts are those in which the various turning and facing cuts are taken. These operations are performed on Fay automatic lathes, which permit a large number of automatically operated tools to take cuts on the work at the same time. This feature makes possible a high rate of production, which would be impossible on lathes of the ordinary type, due to the large number of short facing and turning cuts that tend toward a low output. The output of engine lathes is also considerably limited by the physical endurance of the operator. The various operations on each camshaft will be dealt with in the order in which they are performed.

Milling the Camshaft Forgings to Length

The first operation consists of milling the ends of the camshafts to length. The work is mounted on a milling machine as shown at *A* in Fig. 1 for the performance of this operation. The camshaft *D* is held in a fixture mounted on the milling machine table, being clamped in V-blocks at each end by clamps *E*. The camshaft is properly located in the fixture by means of the locating piece *F*, which is placed at the center of the fixture and locates the work by means of its central bearing surface. The ends of the work are milled by the two milling cutters *G* which are mounted on the arbor of the machine.

If the production required it, arrangements could be made so that another camshaft forging could be placed on the opposite side of the arbor. In this manner a finished forging could be removed and replaced by an unfinished one, while a forging on the opposite side of the arbor was being machined. This arrangement would permit the production to be approximately doubled.

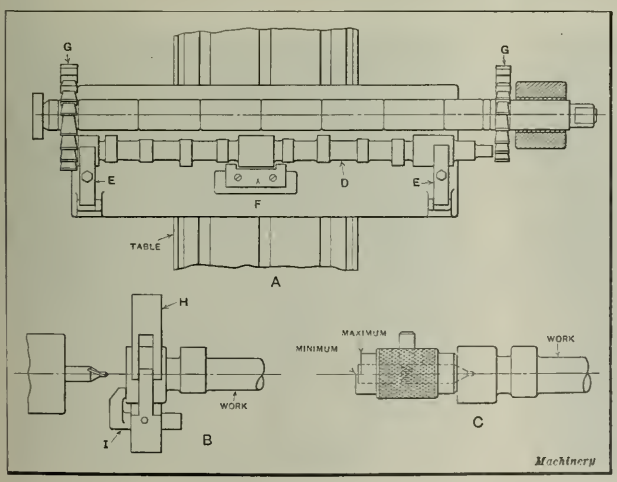


Fig. 1. (A) Method of mounting Camshaft on Machine to mill the Ends to Length. (B) Manner of locating Work for Centering Operation. (C) Limit Gage used in inspecting the Centers

Centering the Forging Ends and Turning and Grinding the Large Bearing Surfaces

In the second operation on the camshaft, the ends are centered to a standard depth. This operation is performed on a centering machine, the work being held in the machine by means of jaws *H*, which may be seen in the view at *B*, Fig. 1. Stop *I* is provided to accurately locate the end of the work longitudinally in relation to the spindle of the machine. The depth to which the tool is fed into the work is regulated by means of a stop-collar on the spindle. The center depths are kept within limits so that when the work is mounted on the automatic lathes and grinding machines in the succeeding operations, the various shoulders will be machined accurately. In the view at *C* is shown a limit gage of the flush type, which is used for inspecting the depths of the two centers.

The three large bearing surfaces of the camshaft are rough-turned in the third operation, which is performed on an engine lathe. These surfaces are then ground within a tolerance of 0.005 inch in the fourth

operation, which is performed on a grinding machine. By machining these surfaces at this time, they can be used as driving and back-resting surfaces in performing the succeeding lathe and grinding operations.

Turning and Facing Operations on Fay Automatic Lathes

The camshaft is mounted in a Fay automatic lathe for the performance of the fifth operation, which consists of turning the surfaces between the cam lobes on one end of the camshaft, facing the shoulders of the cam lobes, and turning and facing several surfaces at the other end. A lay-out of the tool equipment provided on the machine for this operation is shown in Fig. 2. The work is mounted between the headstock and tailstock centers, and is supported at the central bearing surface by means of steadyrest *A*. It will be noted that eighteen tools are contained in this equipment, all of which operate at one time. The rear tool-holders *B* and *C* swivel forward on the bars which support them, in the direction indicated by the arrow at the rear of the machine, thus bringing the tools into the cutting positions. The tools in carriage *D* take rough-turning cuts on the surfaces at the extreme right end of the work, the carriage being fed longitudinally toward the left as indicated by the arrow. The tools in carriage *E* turn three of the surfaces between the cam lobes on the left end. This carriage is first fed toward the center of the machine until the proper depth of cut is reached, then it is fed toward the left until all of the surfaces have been machined, after which it is withdrawn from contact with the work. The arrow below this carriage shows the direction of the several feeding movements, all of which are automatic. The carriages and tool-holders return to their original positions when the part has been machined, after which the machine is automatically stopped. Fig. 4 shows a view of the machine used in performing this operation.

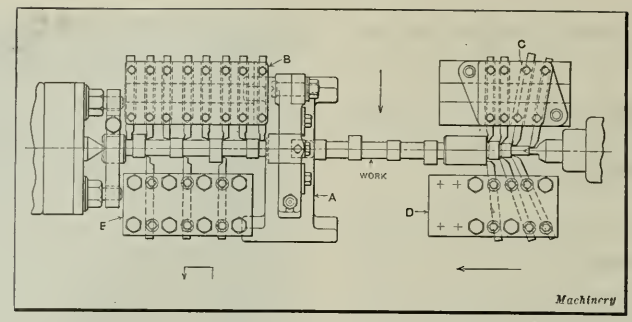


Fig. 2. Tooling Equipment provided on Fay Automatic Lathe for performing the Turning and Facing Operations

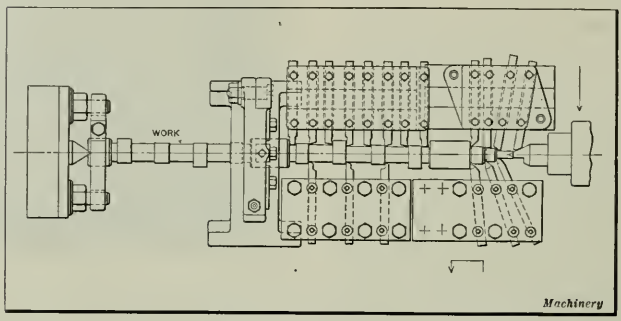


Fig. 3. Lay-out of Tools required on Automatic Lathe for performing the Final Turning and Facing Operations

The sixth operation consists of turning the surfaces between the cam lobes on the right end of the camshaft, facing the shoulders of these cam lobes, and finish-turning and beveling the same surfaces at the extreme right end that were rough-machined in the preceding operation. This operation is performed on another Fay automatic lathe, which is provided with the tooling equipment illustrated in Fig. 3. Eighteen tools are also provided for machining the various surfaces finished in this operation. The work is mounted on the machine in the same manner that is employed in the fifth operation. The rear tool-holders swivel forward in the manner previously described, and the front carriages are first fed toward the center of the machine until the proper depth of cut is reached, after which they are fed longitudinally toward the left until the various sur-

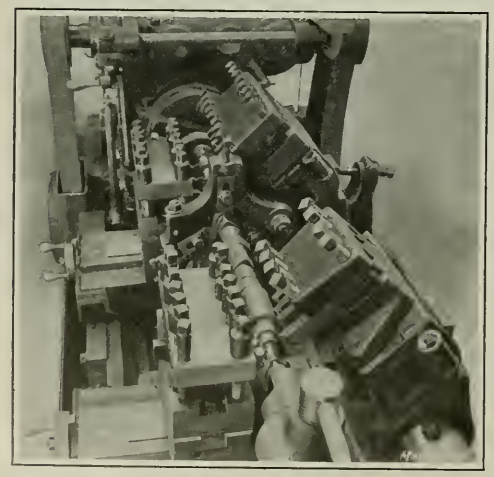


Fig. 4. Fay Automatic Lathe provided with Tool Lay-out shown in Fig. 2

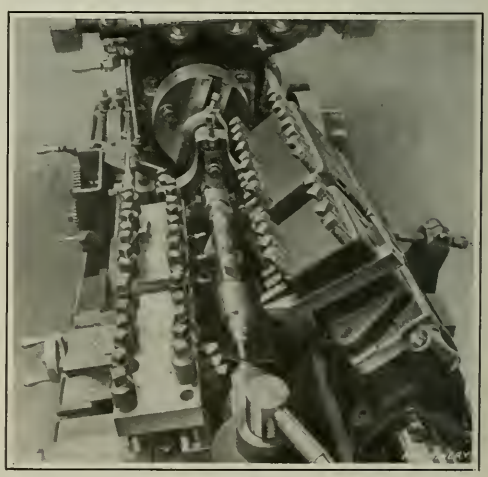


Fig. 5. Fay Automatic Lathe provided with the Tool Lay-out shown in Fig. 3

faces are turned to the proper length, when they are withdrawn from contact with the work. The arrows indicate the direction of the various movements which is similar to those of carriage *E* in Fig. 2. The setup of these tools on the machine is clearly shown in Fig. 5. The machines used in the fifth and sixth operations are placed beside each other as shown in Fig. 6, so that the work can be mounted on the second machine almost immediately after it is removed from the first machine, thus eliminating unnecessary transportation of the camshafts.

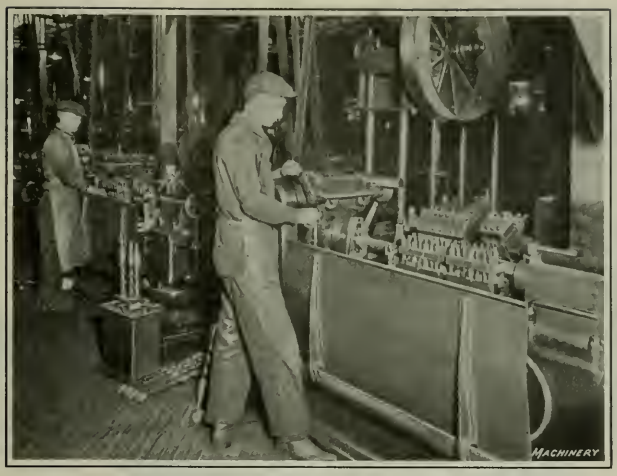


Fig. 6. View showing Method of placing the Two Automatic Lathes to eliminate Unnecessary Transportation of Work

The final operations on the camshaft consist of keyseating, oil-grooving, and cylindrical and cam grinding operations. Standard methods and machines are employed in the performance of these operations, and for this reason it is not deemed essential to give a detailed description of them here.

The order of operations here illustrated is subject to change when shop practice requires it. For instance, when selective hardening of the cams is required, the machines are often set up to face all the shoulders on the first turning operation, after which the shaft goes to the carburizing furnace. On its return, and before hardening, the second Fay lathe takes all the turning cuts, removing the carburized metal from between the cams.

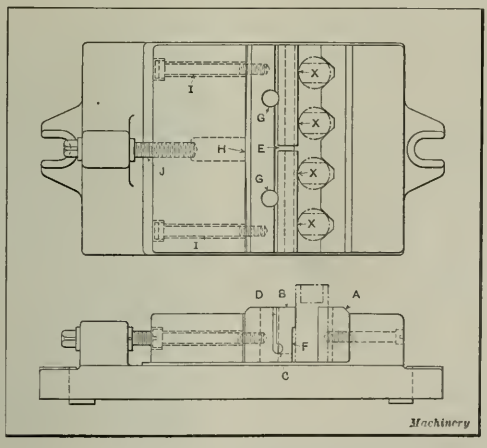
The photographs reproduced in this article were taken in the Fordson tractor plant, by courtesy of Henry Ford & Son.

* * *

VISE USED IN STRADDLE-MILLING FOUR PIECES OF WORK

By F. SERVER

An ingeniously constructed vise used in straddle-milling a flat on each side of four round pins is shown in the accompanying illustration. All of these parts are gripped by one movable jaw, which is machined in such a manner that two of its sections are permitted to give slightly so as to securely hold the two pieces that are gripped by each of these sections. The fixed or locating jaw *A* is provided with four V-grooves in which the pieces of work are placed as indicated by the dot-and-dash line. The movable jaw *B* is a piece of tool steel which was machined as illustrated and then spring-tempered. Hole *C* is drilled through this movable jaw, while slot *D* is also machined its entire length. Slot *E* is milled at the center of the jaw from the front edge to slot *D*. By machining this jaw in the manner described, two very flexible sections are obtained along the front edge which will give slightly when pressure is brought to bear on them. These sections are relieved as shown at *F* so that only the upper portions are in contact with the cylindrical surfaces of the work. A pin *G* is driven into the jaw at the back of each flexible section as shown, and the back of the jaw is relieved on each side, so that it bears against the movable slide only at point *H*. The holes provided for bolts *I* are sufficiently large to permit these bolts to float slightly and allow the movable jaw *B* to rock about point *H*.



Vise with One Movable Jaw having Flexible Sections that permit the gripping of Four Pieces of Work

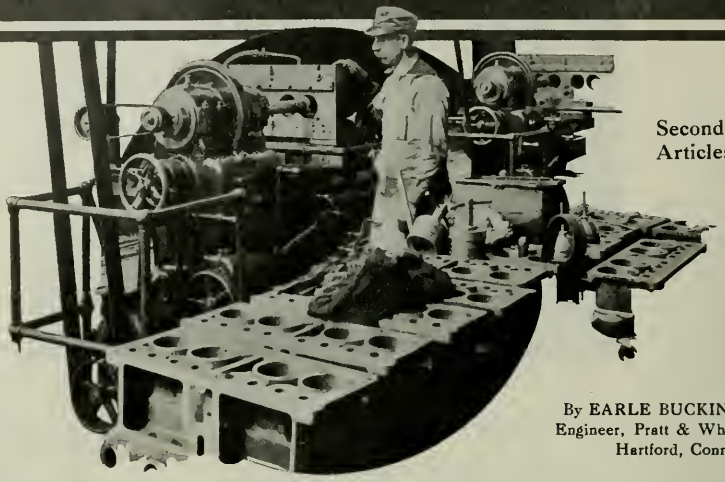
When the slide and jaw are brought forward by revolving screw *J*, points *X* on the jaw come in contact with the work. When this occurs the flexible sections of the jaw pivot around pins *G* sufficiently to adjust themselves to suit any slight differences between the diameters of any two pieces of work. If two of the pieces on either side of the vise are both slightly smaller in diameter than the two on the other side, the entire jaw will turn a suitable amount about point *H* because of the relieved back surface of the jaw previously mentioned. It is obvious that through the use of this vise the work is gripped equally and securely; of course, this construction would not do for holding rough work, as the variations in the size of the different pieces of work would be too great. However, for finished work sufficient spring can be obtained in the flexible sections to compensate for any slight variations in the diameter or thickness.

* * *

Attention has been called, within the last year and a half, to a new kind of fuel, called colloidal fuel. This fuel consists of a mixture of powdered coal and fuel oil, certain processes being used in mixing for keeping the powdered coal in suspension in the oil so that the coal does not settle to the bottom of the tank supplying the furnaces with fuel. The main advantage of colloidal fuel seems to lie in the fact that the process would increase the effective supply of available fuel oil by 40 or 50 per cent. Colloidal fuel appears to have the same advantages as are obtained in burning fuel oil alone. Sufficient information, however, is not yet available on this subject to make it possible to draw definite conclusions as to the future of this new fuel, but investigations are being made, and it is probable that in the future a new valuable fuel will be added.

Equipment for Interchangeable Manufacturing

Jigs Used in Machining an Automobile Transmission Case, and Other Examples Illustrating Principles that should be Applied in Designing Manufacturing Equipment



Second of Three Articles

By EARLE BUCKINGHAM
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IN order to make clear the application of some of the principles stated in the first installment published in the April number of MACHINERY, examples of properly designed jigs and fixtures are presented in this article. The methods of locating and securing the work on each jig or fixture are described in detail, and one or more illustrations of each jig or fixture are given, so that a clear conception of the principles underlying the design of these equipment parts will be readily obtained.

Special Equipment for Machining Automobile Transmission Cases

For the first example, part of the special equipment required to manufacture the transmission case shown in Figs. 1 and 2 will be considered. As over forty operations in all are required to machine this case, space will not permit a detailed discussion of each, but as many are either practically duplicate or are handled in well-known conventional ways, only the most instructive operations will be dealt with. The drawings shown in Figs. 1 and 2 are not complete, many dimensions and projections which do not affect the operations to be discussed having been purposely omitted. The first operation is to snag and chip the casting. This is a bench job and requires no special equipment. The second operation is to drill the main bearing hole *A*, Fig. 2, as shown in the operation drawing, Fig. 5.

Operation drawings of this sort are of great value to the tool designer and also to the shop foreman and machine operator. Only the information required for a single operation appears on each drawing, thus making it handy for reference in the shop and also preventing any possibility of using a wrong dimension. They may be drawn to a much smaller scale than the component drawings and still contain information that cannot always be placed on the component drawing without danger of misuse. In practice, they are readily made. Small drawings of each projection of the work are made, and then the section or projection required

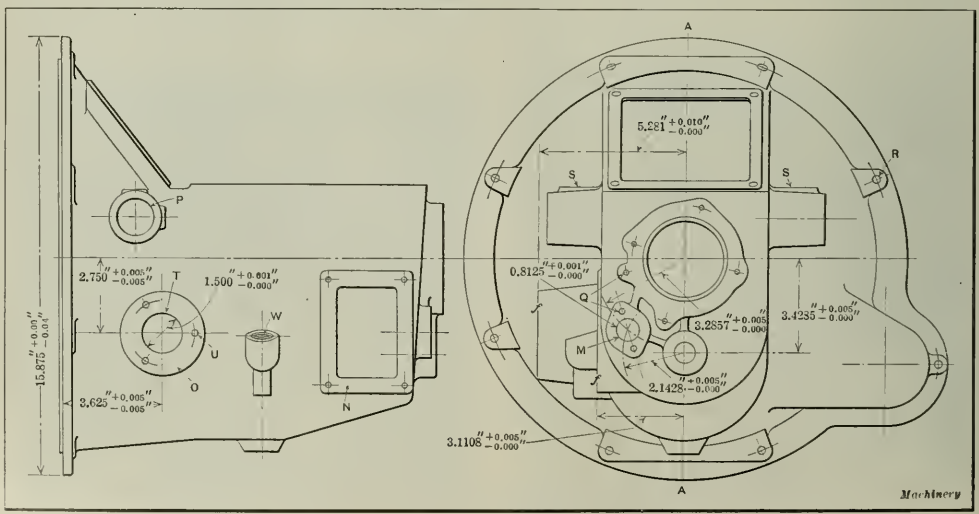


Fig. 1. Drawing of Automobile Transmission Case which requires Forty Machining Operations

for any particular operation drawing is traced and the required dimensions and notes added. Free-hand tracings are often sufficient. No great amount of detail need be shown in these drawings. All that is required is enough to indicate the machined surface in question, the required register or locating surfaces, and the clamping points. On operations where little or no special equipment is required, no operation drawings are necessary. When these operation drawings are developed in conjunction with the operation lists described in the article previously referred to, a further advantage is gained. The work of designing the tools and fixtures can be readily and safely distributed among several designers, either in the same organization or in independent shops. When time is essential in commencing production, this factor becomes of great importance.

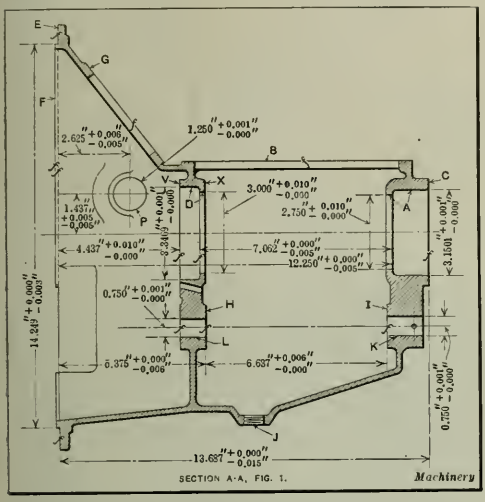


Fig. 2. Sectional View of Transmission Case

Jigs for Drilling Holes in Transmission Case

The first machining operation is important in several ways. As the surface machined at this time becomes the register point for many of the succeeding operations, it is necessary that the casting be carefully centralized in the jig, which is shown in Figs. 3 and 4. A study of these illustrations and the operation drawing shown in Fig. 5, will make clear the general construction of the jig. The locating

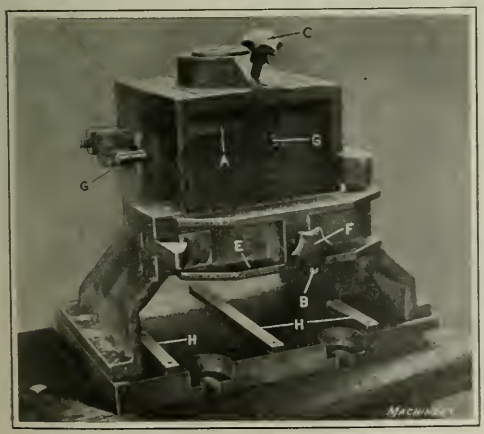


Fig. 3. Front View of Jig for drilling Main Bearing Hole in Small End

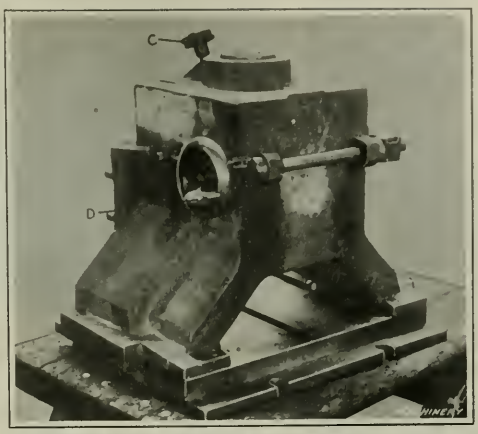


Fig. 4. Rear View of Jig, showing Mechanism for operating Equalizing Clamps

points and clamps are lettered alike on these three illustrations.

The operation of this jig is as follows: Leaf *E*, Fig. 3, being open, the transmission case is slid along the locating rails *H* until the shifter housing face *B*, Fig. 2, comes in contact with bar *A*, Fig. 3, and the locating lugs come in contact with the buttons *B*. This locates the case in one plane and also squares it up. Clamp-screw *C* operates on an angle against the fillet on boss *C*, Fig. 2, and holds the case down on rails *H* and also against bar *A*. Handwheel *D* operates the equalizing clamps *G* which both locate and clamp the case in another plane. The leaf *E* is then closed and the clamp-screw *F* which it carries is used to complete the rigid clamping of the case. Thus, the case is located and clamped in three planes. This transmission case is a relatively large

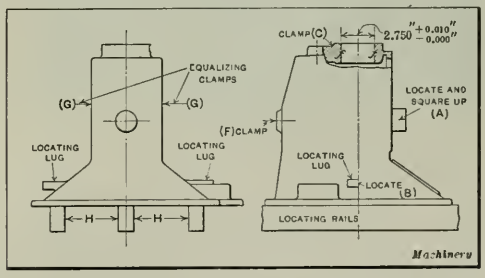


Fig. 5. Operation Drawing for drilling Main Bearing Hole in Small End

piece. Therefore, the design of jigs and fixtures to clamp it with only one or two motions of the operator's hands would be a complicated and difficult task unless some type of hydraulic or pneumatic clamping mechanism were employed. This has been successfully accomplished in a simple and effective manner, but is not yet common practice. An example of such a jig will be presented later.

A drawing of the jig just described is shown in Fig. 6. It will be seen that stop *A* is pivoted to allow for inequalities in the casting. The equalizing clamps *G* are operated by levers which are actuated by nuts, one threaded right-hand, and the other left-hand. These nuts are operated by means of similar threads on the handwheel spindle. It will be noted that this jig is rugged and simple, that all functional locations and parts are accessible, and also that the chip clearances are liberal, thus making a fixture that is readily cleaned and operated. It is also one that requires little attention in service.

The third operation consists of drilling and rough-counter-

boring the main bearing hole *D*, Fig. 2, and facing and turning flange *E* and boss *F*. This is done in a large Potter & Johnston lathe. An attachment to the spindle of the machine which runs in a cat-head at its outer end, locates the case on an arbor through the hole drilled in the preceding operation and from the back of the flange. The case is also aligned and clamped around the outside of the flange. Two locating lugs cast on the bell of the case assist in locating and driving the work. These two locating lugs are removed after the machining is completed. The face of flange *E* and the center line of the main bearing holes *A* and *D* now become the primary locating points for most of the succeeding operations.

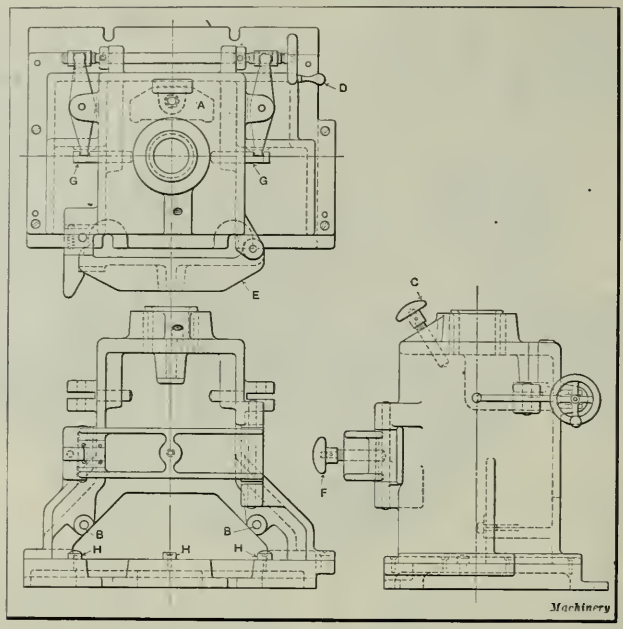


Fig. 6. Assembly Drawing of Jig illustrated in Figs. 3 and 4

Jigs and Tools Used in Various Operations

The fourth operation is performed on a boring mill and consists of facing the case to length and rough-counterboring hole *A*, Fig. 2. The operation drawing for this operation is shown in Fig. 7. The case is located in the jig shown in Fig. 9, by flange *E* and boss *F*, Fig. 2, and also on an arbor which passes through the main bearing hole *D*. This arbor is hollow to receive the pilot on the boring-bar, thus helping to align it. The case is squared up by two studs *A*, Fig. 9, which bear on the shifter housing face *B*, Fig. 2, and is supported centrally and clamped by two clamp-screws *B*, Fig. 9. The bearing in the end of the jig is large enough to permit the boring-bar *C* to enter with the cutting tools assembled.

The boring-bar for this operation is shown in Fig. 12. Pilot *A* enters the hollow arbor on the jig. Surface *B* carries a reaming tool which corrects the alignment of hole *A*, Fig. 2. Slot *C* carries a combined boring and facing tool which faces surface *C*, Fig. 2, and so machines the case to length, and rough-counterbores hole *A*, Fig. 2. This makes a self-registering tool for the depth of the counterbore. It will be noted that this depth of counterbore is given in a different way on the operation drawing from the way it is shown on the component drawing. This is only a roughing operation, and it will be noted that stock is left for finishing. A later operation will bring the dimensions for this surface in accordance with the component drawing. Surface *D* on the tool, Fig. 12, runs in the large bearing in the fixture, while the lock-nut *E* is adjustable and acts as a stop for regulating the position of the facing tool. A little study will show that this arrangement will maintain the length of the case in accordance with the component drawing. The face of the flange is located against fixed points on the fixture. The face of the shoulder of the large bushing *D* is held in a fixed position in relation to the lo-

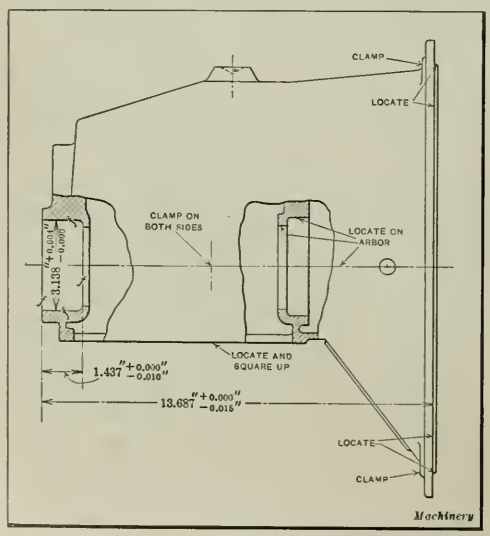


Fig. 7. Operation Drawing for counterboring the Main Bearing Hole in the Small End and facing the Boss

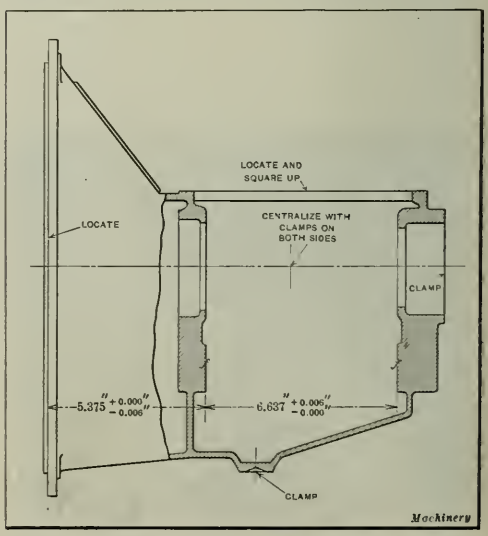


Fig. 8. Operation Drawing showing Methods of locating and clamping Work for Seventh Operation

cating blocks on the fixture. Therefore, it makes a reliable registering point for a tool which must maintain a specified relation to these locating blocks.

The fifth operation is to mill the shifter housing face *B*, Fig. 2, and the clutch hand-hole face *G*. This is a straight milling operation performed on a large planer type milling machine which machines a large number of castings at one time. The sixth operation consists of hand-reaming the counterbores of holes *A* and *D*, Fig. 2, both for diameter and depth. The stand shown in Fig. 10 is provided to hold the case and to pilot the tools while hand-reaming. The case is placed on the arbor shown at the left to ream counterbore *A*, Fig. 2, with the face of flange *E* resting on the locating blocks. The pin *A*, Fig. 10, enters a hollow lug at the large end of the case to prevent it from rotating. The end of the arbor acts as a stop for the reaming tool, thus maintaining the conditions called for on the component drawing. The case is then inverted and placed on the arbor shown at the right in Fig. 10 to ream counterbore *D*, Fig. 2. The block *B* rests against the shifter housing face *B*, Fig. 2, to prevent rotation of the case. The bottom of the counterbore finished on the other arbor rests on shoulder *C*, while the end of the arbor acts as a stop for the reamer, thus maintaining the location of the bottom of this counterbore in accordance with the information given on the component drawing.

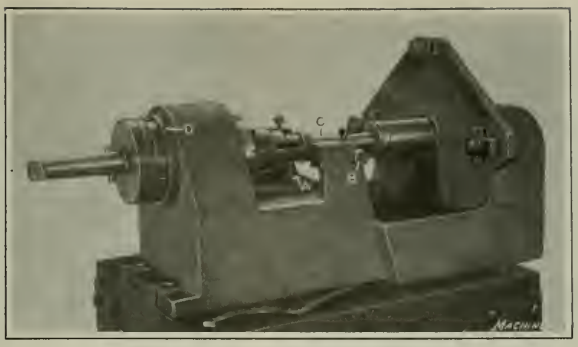


Fig. 9. Jig and Boring-bar used in machining Case to Length and counterboring Main Bearing Hole in Small End

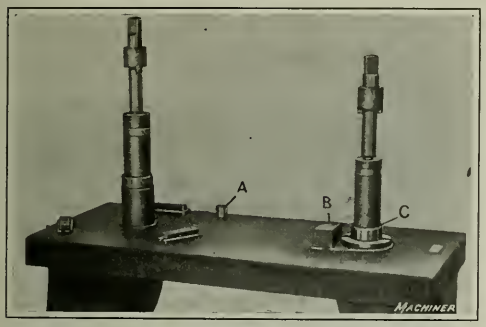


Fig. 10. Fixture employed in reaming Both Main Bearing Holes of the Transmission Case

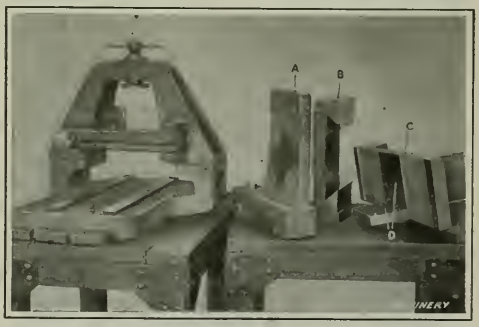


Fig. 11. Fixture used in Milling Operation on Case, and Parts for supporting Auxiliary Cutter-head

Operations Performed on Vertical Milling and Profiling Machines

The seventh operation consists of milling surfaces *H* and *I*, Fig. 2, and the corresponding surfaces around the idler shaft hole *M*, Fig. 1. This operation is performed on a vertical milling machine equipped with an auxiliary cutter-head to reach down into the case. The operation drawing for this job is shown in Fig. 8. The fixture used for this operation is shown at the left in Fig. 11. The case is located in one plane on the flange, squared up and located in the second plane on the shifter cover face *B*, Fig. 2, and located in the third plane by being centralized on the body. The center line of holes *A* and *D*, Fig. 2, is not used as a locating point for this operation, because of two reasons: First, the requirements of the surface milled in this operation are that they be parallel to the flange and that they be maintained at the specified distance from the flange and from each other. Therefore, the location of the case in relation to the main bearing holes is unimportant. The second reason is that the use of an arbor in this fixture would greatly increase the amount of time required to load and unload the work. The case is clamped on surface *J*, Fig. 2, by the leaf and on surface *C* by the clamp-screw.

The construction of the auxiliary cutter-head is shown in Fig. 13. The driving spindle *E* fits into the spindle of the vertical milling machine and drives the cutters *F* and *G* through a train of gears. The drawing of this cutter-head should be self-explanatory. The cutter-head is supported by a bridge composed of pieces *A*, *B*, and *C*, shown at the right Fig. 11, which is clamped to the milling machine, as shown in Fig. 16. Support *B* is clamped at the proper height on the dovetail of the machine column. Support *A* is clamped to the dovetail on the knee of the machine, while bridge *C* is supported on the tops of the two supports. The auxiliary cutter-head is then fastened on surfaces *D*. Vertical adjustment is provided for the outer end of the bridge which rests on *A*, while none is required at the other end.

The knee of the milling machine is adjustable up and down to control the position of the cuts, and as support *B* holds a fixed position in relation to the machine while *A* moves with the knee, it is necessary to provide the adjustment for the outer end at *A*. The fixture, Fig. 11, is attached to the table and fed, with the table, to the cutters. Attention is called to the fact that the loading side of the fixture is on the side farthest from the cutters. This arrangement enables the

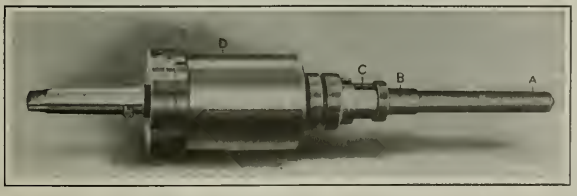


Fig. 12. Boring-bar disassembled from the Jig illustrated in Fig. 9

feed of the table to be kept to a minimum.

The eighth operation consists of milling the outside boss around the idler shaft hole *M*, Fig. 1, on the small end of the case. Ordinarily, this operation would be performed on a vertical milling machine, or with a facing tool on a drilling machine. In this particular case, however, profiling machines were available, while vertical milling machines were not. Furthermore, this cut is a relatively light one, which a profiling machine can handle satisfactorily, and so this type of machine is used. This indicates to a certain degree how the design of the equipment is determined by the machine tools available. The fixture for this operation is shown to the right in Fig. 14. The case is located on the face of flange *E*, Fig. 2, and by boss *F*, and is clamped on the back of the flange. This is an instance where a pneumatic or hydraulic clamping device could be used to great advantage and save fully half the setting-up time.

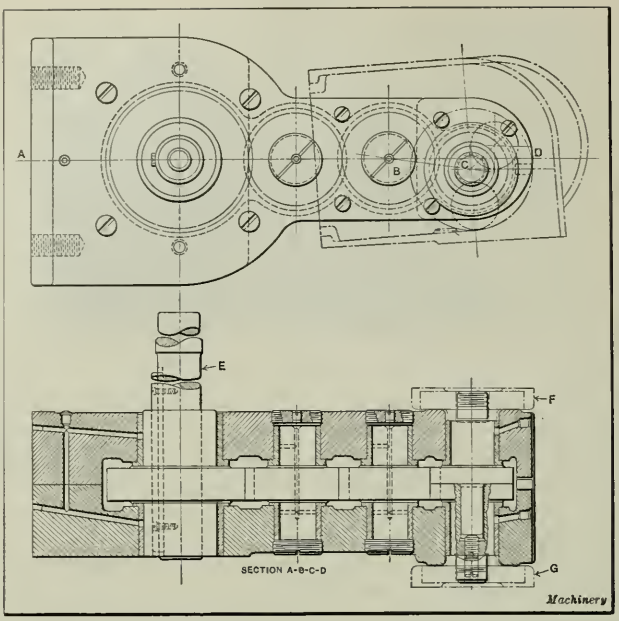


Fig. 13. Auxiliary Cutting Head used in milling Surfaces on Inside of Case

The fixture not only consists of a work-holding device, but also acts as the stand for the working gage. Lug *A* is used for registering the position of the cutters and also for registering the flat step-gage *D* which is used to test the finished height of the boss. Because the maximum distance between the table of the profiling machine and its cutter-spindles was not great enough, raising blocks *C* were provided to lift the heads of the machine sufficiently to permit the transmission case to be machined. Bracket *B* was also required to support the end of the operating handle shaft in its raised position.

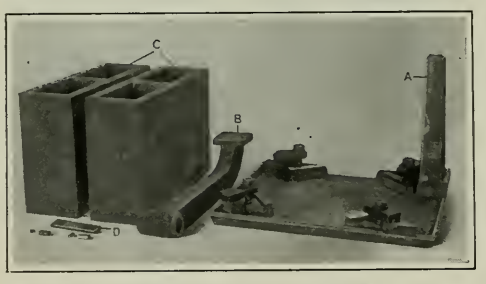


Fig. 14. Equipment provided to adapt a Profiling Machine for a Milling Operation on the Case

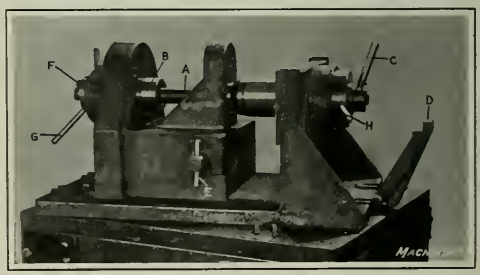


Fig. 15. Work-holding Fixture for Drilling and Reaming Operations on Radial Drilling Machine

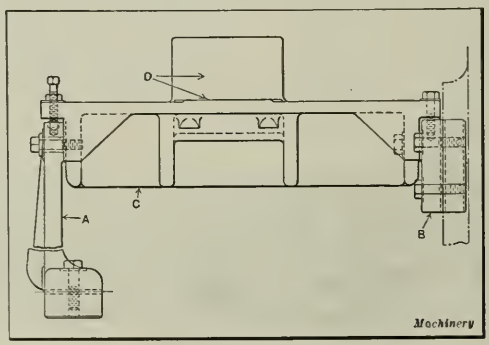


Fig. 16. Assembled View of Parts clamped on Milling Machine to support the Auxiliary Cutting Head

Drilling, Reaming, and Milling Operations

The ninth and tenth operations, respectively, consist of drilling and reaming the countershaft holes *K* and *L*, Fig. 2. Both of these operations are performed on horizontal radial drilling machines, and the work-holding fixtures employed in each case are practically identical in design. The jig for the tenth operation is shown in Fig. 15. The case is located on the face of flange *E*, Fig. 2, and on arbors through the main bearing holes *A* and *D*, and is squared up by two equalizing plungers which bear on surface *B*. The case is clamped by the end of the hollow arbor *B*, Fig. 15, which is drawn back against the bottom of the counterbore *A*, Fig. 2. Arbor *A*, Fig. 15, which passes through *B* contains a groove which receives leaf *F*. Thus, when arbor *A* is drawn up by the clamping nut *C*, this leaf is drawn up against the end of arbor *B*, clamping the case between the face of the flange and the bottom of the counterbore previously referred to. When leaf *F* is swung aside, arbor *A* is withdrawn. Bracket *D* is provided to support the end of the arbor *A* in its loading position. Handles *G* and *H* are used to wring the arbors into the case, as these arbors are a very close fit in the counterbores which are held to a tolerance of 0.001 inch. Handle *E* operates the equalizing plungers which bear against surface *B*, Fig. 2, and square up the case. The eleventh operation consists of drilling and reaming the idler shaft hole *M*, Fig. 1. A very similar jig is used in this operation, the principal difference being that the case is

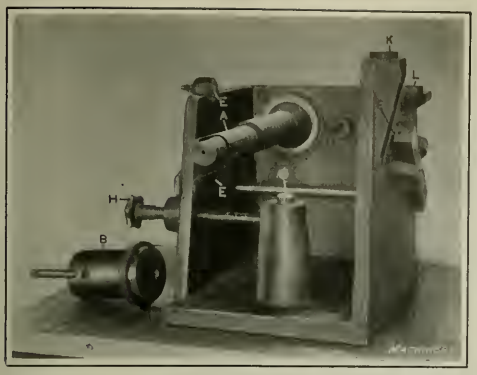


Fig. 17. Another Fixture provided for a Milling Operation on a Profiling Machine

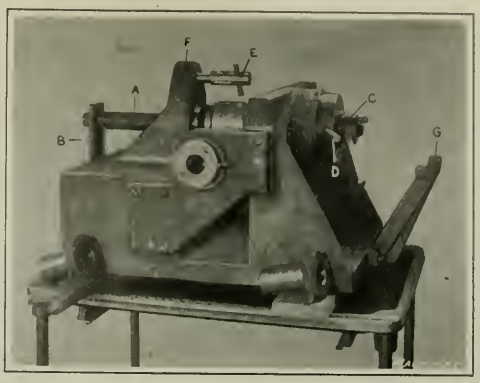


Fig. 18. Jig employed in Drilling and Reaming Operations on a Boring Mill

squared up by a plug in countershaft hole *K*, Fig. 2, instead of by equalizing plungers acting against surface *B*.

The twelfth and thirteenth operations, respectively, consist of milling the surfaces of the tire pump face *N* and pedal support boss *O*, Fig. 1. Both of these operations are performed on a profiling machine, and the same fixture is used. This fixture is shown in Fig. 17. The case is located on holes *A* and *D*, Fig. 2, by arbor *A*, Fig. 17, and hollow plug *B*, and on surface *C*, Fig. 2, by shoulder *C*. It is squared up by the pin *D* projecting into hole *K*, Fig. 2. Two screws *E* are adjusted to suit surface *B*, Fig. 2, to support the case against the clamping device *F*, Fig. 17. The spring plunger *G* is locked by the clamp-screw *H* and supports the case against the thrust of the cutters. Arbor *A* has a bayonet cam-slot which engages a stud in the hollow plug *B*, clamping the case between the bottom of counterbore *D* and surface *C*, Fig. 2. Stud *K* is the register point for the tool when milling the pedal support boss, while stud *L* is the register point for the tool when milling the tire pump face. Due to the position of this fixture on the machine, all of the operating handles must be on the front or on the sides. This is the reason for the extensions to the two clamps which are carried through the side of the fixture.

In the fourteenth operation, the clutch shaft hole *P*, Figs. 1 and 2, is drilled and reamed. This operation is performed on a boring mill. The jig, with slip bushings for the reamers, is shown in Fig. 18. The case is located by the usual register points, on the main bearing bore and counterbore *D*, Fig. 2, and on the flange *E*. It is squared up by the countershaft hole *L*, and clamped from the small end against the face of the flange. A groove at the end of arbor *A*, Fig. 18, receives leaf *B*. Clamp-nut *C* draws the arbor back, thus clamping the case between surface *C*, Fig. 2, and the face of the flange. Leaf *B* is swung aside when unloading, thus permitting arbor *A* to be withdrawn. Bracket *G* supports the shoulder of the large arbor in its withdrawn position. Handle *D* is provided to assist in wringing the large arbor into the case. Lug *F* enters the case through the opening in the shifter housing face *B*, Fig. 2. Plug *E*. Fig. 18, wrings into the countershaft hole *L* and into the lug *F* to align the case.

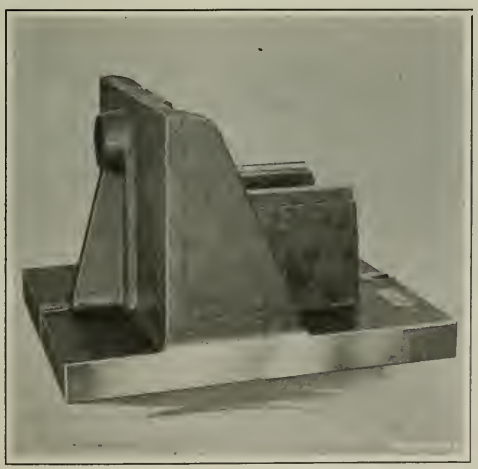


Fig. 19. Simple Stand provided for supporting Case during Operations on Drain Plug Hole

The fifteenth operation is performed on a drilling machine, and consists of drilling, tapping, and counterboring drain plug hole *J*, Fig. 2, and facing the surface of its bore. The exact location of this drain plug hole is of no importance. A conical spot is cast in the boss which is used to locate and center the drill point. The simple stand shown in Fig. 19, unprovided with bushings or clamps, supports the case on the drilling machine table. Further elaboration of this simple design would not improve its effectiveness in any way. The drilling machine is fitted with a quick-change collet to permit the operator to change the drill, tap and facing tools rapidly.

The jigs used in performing the remaining operations on the automobile transmission case will be described in the concluding installment of this article in the June number of MACHINERY.

* * *

NON-SHATTERING GLASS

The *Scientific American* describes a new triplex non-shattering glass which will resist shock. The glass is made by placing a thin sheet of xylonite between two sheets of glass and causing them to adhere by a special process under heat and pressure. The glass is transparent, non-shatterable, sound-proof, air-tight, and water-tight even when badly cracked. A test is described which illustrates the capacity of this glass to resist shock. A number of panels of the glass varying from ½ to 1 inch in thickness were subjected, one at a time, to the fire of a 45-caliber automatic pistol at ranges varying from 1 to 15 feet. The bullet penetrated only about 1/32 inch and was torn to shreds. Thinner panels, when subjected to this test, showed that some of the glass became detached from the reverse side, but in the case of thicker panels the reverse surface crumbled at the center and fell out in powdered form, but did not fly. This glass is particularly adaptable for use in safety goggles for workmen in steel mills and other industrial plants. It can be substituted in every case where common glass is ordinarily used, one of its valuable features being that it is burglar-proof. It resists all but the most violent blows, is immune to the bank robber's gun, and cannot be cut with a diamond.

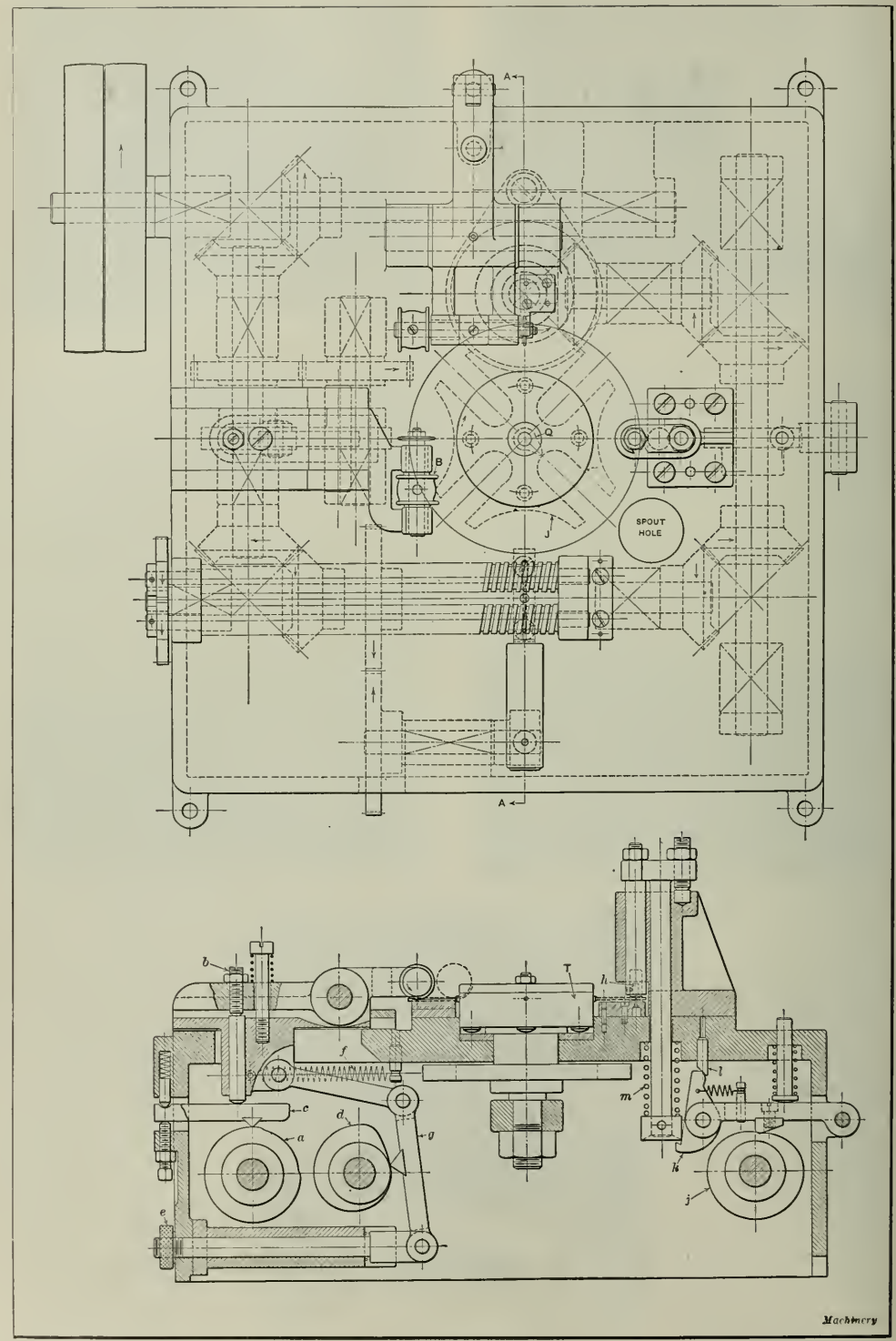


Fig. 1. Plan View and Longitudinal Cross-section of Special Machine employed in the Manufacture of Sewing Machine Needles

Manufacture of Sewing Machine Needles

By CARLOS RUIZ

THE methods of manufacturing sewing machine needles have not, to the writer's knowledge, been described in the technical press. It is the purpose of this article to outline briefly the general procedure in the manufacture of sewing machine needles, and to furnish a description of an interesting turret machine used in connection with the performance of the fourth, fifth, and sixth operations. There are fifteen operations required in the manufacture of a medium size sewing machine needle, each machining operation being shown diagrammatically in Fig. 3. This operation sheet represents the practice employed by large needle manufacturing concerns; from an inspection of the illustration it will be seen that the first and second operations consist of cutting off the stock, and beveling one end. The third operation is performed singly on a standard swaging machine equipped with an automatic feed. The fourth, fifth, and sixth operations are performed on the machine illustrated in Figs. 1 and 2, which will be described later. The next three operations, that is, the seventh, eighth, and ninth, are performed on a pointing machine of standard design. Following the pointing operations, the shank is milled flat, and the hole is burred, these operations being performed on hand-operated machines. The eleventh operation is slow and expensive, as the operator is required to thread each needle individually. It is probable that the eye could be profiled instead, if a suitable machine were available for this purpose. The four final operations consist of hardening, polishing, straightening, and inspecting.

The machine illustrated in Figs. 1 and 2 is a slight modification of the one actually used in the manufacture of the needles, but the principles of the design are the same. Fig. 1 shows a plan view and a longitudinal cross-section of the machine taken through the turret, while Fig. 2 shows another cross-sectional view on line *A-A* of Fig. 1. Under normal conditions a machine of this type and construction is capable of producing fifteen needles per minute. The time required to finish a needle is governed by the amount of time consumed in the performance of the fourth operation, since this operation consists of milling the long thread groove, and requires more time than the others; consequently the cutter-head *B*, in which the cutter is carried, should be timed so as to recede during the time that the turret *T* is indexing. The construction of the machine and its operation should be quite apparent from the illustrations, and for that reason a complete description will not be given.

Referring to the cross-sectional view, Fig. 2, cam *C* is employed to actuate the plunger *D*, which operates in an oil chamber, and this hydraulic pressure actuates plunger *E*, and advances the needle into position in the turret. Referring again to the plan view in Fig. 1, attention is directed to the two worm screws which are employed to advance the needle blanks from left to right into position in line with plunger *E*, Fig. 2. The cam *F* is employed to operate the plunger or index-pin *G*, through the medium of depressor *H* by means of which the turret is locked in position. The turret post or spindle *I* is stationary, being held rigidly as shown, and the turret is revolved on it through the action of an intermittent gear or Geneva wheel *J*, which also serves as an indexing plate. The outline of this Geneva wheel is shown dotted in Fig. 1.

A driver plate *K*, Fig. 2, driven by the bevel gears *L*, carries a trundle *k* for the purpose of transmitting the intermittent motion to the turret. There are four plungers employed to clamp the needles in their respective stations in

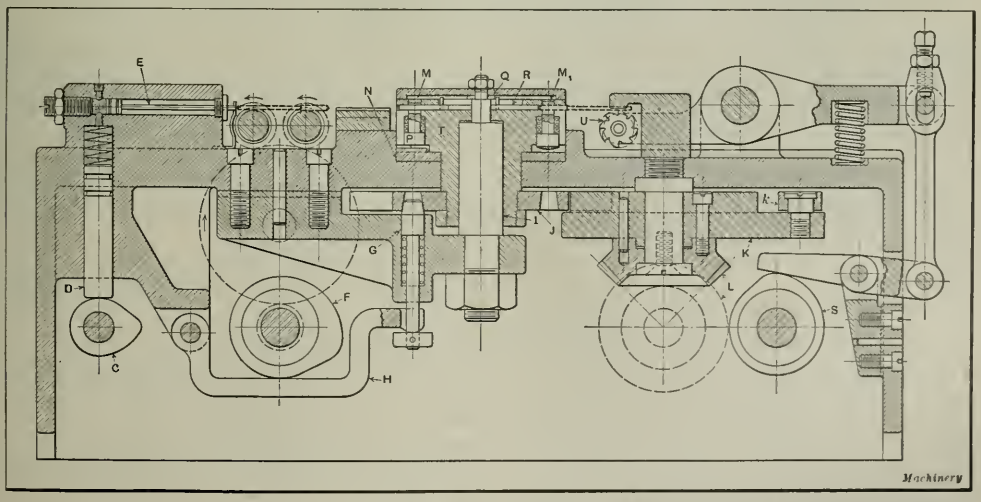


Fig. 2. Partial Cross-sectional View of the Machine illustrated in Fig. 1, showing Turret Mechanism and Cutter-head Traverse Arrangement

the turret, two of which M and M_1, are shown in the illustration; these plungers are operated by a lug P carried on the stationary flat cam N. One of these plungers is shown raised by the lug, while the other has dropped down and holds the needle in the turret. The stationary knock-out cam or ejector Q operates plunger R, and after the piercing operation, ejects the needles into a spout which delivers them to a suitable receptacle. The position of this ejector and its relation to the location of the spout is indicated in Fig. 1. Cam S is provided for the purpose of sinking cutter U during the operation of milling the short thread groove, there being no longitudinal movement of the cutter-head relative to the needle, suitable adjustment for controlling the depth of cut being provided. V-blocks are employed to support the work during the performance of the several operations.

The sectional view shown in Fig. 1 illustrates the arrangement of the mechanism employed to traverse the cutter-head during the performance of the fourth operation, and also the mechanism used to operate the piercing punch employed in the sixth operation. Cam a is employed to feed the cutter to the depth of the groove, as determined by adjusting screw b, through the medium of the rocker arm c. When the cutter is at work, this member c should have its top surface parallel to the slide, for which a suitable means of adjustment is provided. At the completion of the traverse of the cutter, cam a permits the arm to be forced down and the cutter to be raised so as to clear the work on the reverse stroke of the cutter-head. The function of cam d is to feed the cutter-head longitudinally, the knurled nut being employed to adjust the length of traverse of the head. The reverse traverse of the head is actuated by the coil spring f, which keeps the lug of lever g in contact with the cam during this movement.

Spring pressure rather than cam pressure is employed to actuate the movement of the piercing punch. The reason for this is that a cam travels too slowly to be employed in this case, and it has been found by experiment that a spring blow does not have the tendency to bend the punch as much as would occur under gradual pressure. The punch h is released by the cam j which trips the pawl k, releasing the spring m as the upper end of the pawl contacts with the pin l. No further explanation of the mechanism need be given, as the general arrangement and the functions of the device should be readily understood from the illustration.

ELIMINATE THE NAME "HAND SCREW MACHINE"

The name "screw machine" is no longer appropriate when applied to the modern turret lathe. This type of machine is seldom used for the making of screws, as automatic screw machines of various types serve this purpose better when large quantities are involved. The field of the modern turret lathe is as universal at the present time as is that of the engine lathe. Ten years ago bar work was the main product handled on what was then known as a hand screw machine; but today there is more chucking work performed on the turret lathe than bar work. Furthermore, the modern turret lathe is designed and constructed to handle heavy castings and forgings and is provided with sufficient power for machining tough forgings and alloy steel parts. For use merely in making screws, the present power provided in turret lathes would be entirely superfluous.

While there is a natural reluctance to change a trade name so long used, the Warner & Swasey Co., Cleveland, Ohio, has started a campaign for discontinuing the name "screw machine" as applied to the modern turret lathe. This company believes that the mechanical world prefers to call a machine by a name which describes the field for which it is intended —a name that it has acquired by evolution into a larger field, rather than by a name designating the field occupied years ago. The hand screw machine of yesterday is the turret lathe of today, and the Warner & Swasey Co. is urging all users and manufacturers to aid in the campaign for dropping the term "screw machine" applied to turret lathes.

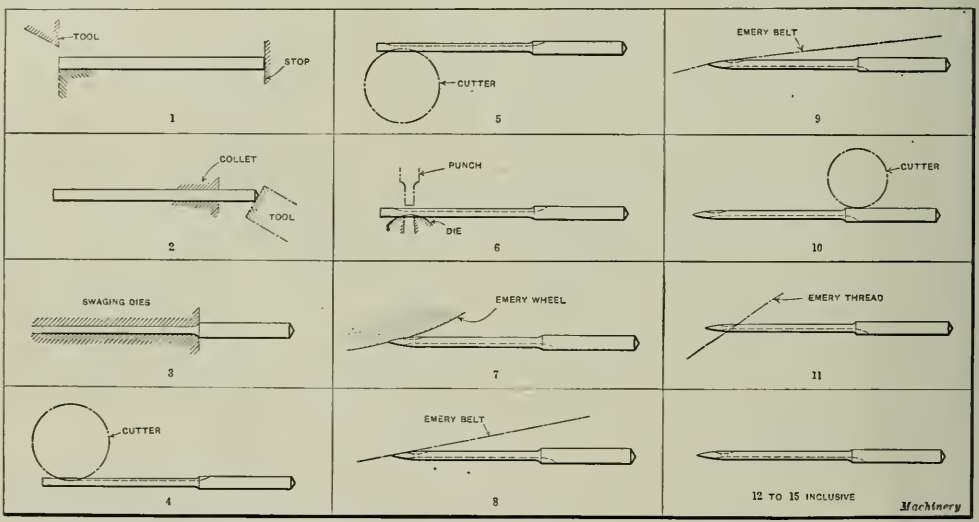


Fig. 3. Operation Sheet. (1) Cut off. (2) Bevel End. (3) Swage. (4) Mill Long Slot. (5) Mill Short Slot. (6) Pierce Eye. (7), (8), and (9) Rough, semi-finish, and finish-grind Point. (10) Slab-mill Shank. (11) Burr Eye. (12) Harden. (13) Polish. (14) Straighten. (15) Inspect

* * *

The war, in causing a tremendous increase in our exports, has brought about a considerable concentration of the channels of trade. In millions of dollars, the increase from 1913 to 1918 was from 2484 to 6149. In the earlier year five countries took nearly two-thirds of our exports, as follows: England, 541; Canada, 403; Germany, 352; France, 154; and Holland, 122. The United States sent nothing to Germany in 1918, and only eleven million dollars worth of goods to Holland. In place of these two countries Italy and Japan appeared among the five leading countries to which we sent almost three-fourths of our exports in 1918. The values were: England, 1953; France, 931; Canada, 887; Italy, 492; and Japan, 274.

Fuels, Burners and Quenching Mediums for Heat-Treatment

Advantages and Disadvantages of Different Kinds of Fuel, Types of Burners, and Description of Results Obtained by Various Quenching Baths

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Fig. 1. Typical Carburizing Furnace in which Coal is used for Fuel

THERE are three different fuels used in the heat-treatment of steel, namely, oil, gas, and coal. Each furnace maker claims particular advantages for the fuel that his furnaces are designed for. Fig. 1 shows a carburizing furnace in which coal is used for fuel. The cost of operating a furnace varies in different localities on account of the different prices of the fuel and the cost of labor to handle it, and so the location of the hardening shop sometimes affects the kind of fuel used. Coal is often cheaper than other fuels in localities adjacent to the coal fields, but this saving may be overbalanced by the cost of stokers and smoke screens necessary in cities. Oil can be used if the underwriter laws are not too severe and there is available space for storage and pumps. If the above conditions prevent the use of oil and coal, it is necessary to use gas. The size of the shop, the number of furnaces, and the amount of hardening to be done are also factors. A shop located in a city block, hardening tools and a few pots of carburized work with one or two furnaces, should use gas as a fuel. The advantages and disadvantages of each individual fuel are listed in the following:

ADVANTAGES AND DISADVANTAGES OF COAL AS A FUEL FOR HEAT-TREATING STEEL

Advantages	Disadvantages
Cost less than oil or gas in many localities.	Original furnace cost is greater than for oil or gas.
	Intense heat generated in the combustion chamber causes the lining to wear out.
Small amount of pumping equipment, an air or steam blast being all that is necessary.	Large floor space required to convert the coal into gas form.
	Clinker formation and trouble in removing.
	Handling of coal and ashes.
Small amount of power required, only enough being needed to run the blower, or stoker if automatically fed.	Storage space for coal and ashes.
	Labor required in tending furnaces.
	Smoke nuisance.
	High stacks required.
	Soot and dirt.
Equipment is usually of a rugged and heavy construction, and there are few mechanical parts to cause trouble or delay.	Not advantageous for small shops, variable production, or within certain types of buildings.
	Slow in bringing to heat.

ADVANTAGES AND DISADVANTAGES OF OIL AS A FUEL FOR HEAT-TREATING STEEL

Advantages	Disadvantages
Original cost of furnace low, compared with coal.	Cost of pump equipment.
Requires less floor space than coal.	Fuel lenks due to faulty piping.
Adaptability to all classes of work.	
Close heat control and quick response to added fuel.	Underwriter insurance risks.
Simple construction of equipment and ease of making repairs.	More space required for fuel storage than for gas.
Little labor required for attendance.	
Low storage space required for fuel, compared with coal.	Cost more than for other fuels in some localities.
Cleanliness, compared with coal.	
Not so bigh a temperature in the combustion chamber as is experienced with coal.	More mechanical parts to get out of order in pumping equipment and burners than on coal or gas equipment.
No smoke.	
Small stacks required in comparison with coal, in some cases none.	Backfires caused by careless lighting.

ADVANTAGES AND DISADVANTAGES OF GAS AS A FUEL FOR HEAT-TREATING STEEL

Advantages	Disadvantages
Original cost of furnace low compared to coal.	Usual high cost.
Requires less floor space than coal.	
Adaptability to all classes of work.	Danger of undetected leaks.
Close heat control and quick response to added fuel.	
Simple construction and ease of making repairs.	Larger areas in piping required than for oil, due to the usual low pressures.
Little or no attendance required.	
No storage space necessary.	
Cleaner than oil or coal.	
Not so bigh a temperature experienced in the combustion chambers as with coal.	Freezing of the gas lines in winter.
No smoke.	
Elimination of stacks.	Inconstancy of supply pressure and quality of gas.

Oil seems to be the best fuel for the purpose, and the majority of hardening shops use oil. Pulverized coal has not yet been made practical for the small hardening shop, but large plants are trying it out. It will probably be a success in large shops, as the fuel economy is important, because the cost of pulverizing is reduced on account of the large quantities used. Producer gas, if manufactured by the concern using it, has the advantages and disadvantages of both coal and gas. The disadvantages of gas at the furnace are increased if the producer gas is delivered hot to the furnace through flues which must be protected from fire. If producer gas is first cooled, there must be three times as much delivered to the furnace to give the same heat as city gas. Preheating of the air is sometimes done by using the waste flue gases. This may be accomplished by having the air pipes pass through the waste gas flues before they go to the burner. Another way is to have two chambers for waste flue gases filled with checkerwork or loose pieces of brick. If one of these is heated by the waste flue gases and its gases are then passed through the other, air may be drawn from the first chamber until the checkerwork has cooled, after which the process is reversed. Preheating of the air gives greater fuel efficiency, but it is seldom done in small shops.

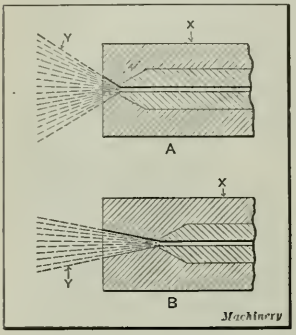


Fig. 2. Nozzle Regulators on Oil Burners for adjusting Cone of Atomized Oil

Coal Burners

In coal burning furnaces, the brick pit or coal box in which the coal is burned to gas, is called the "burner." The only exception to this is when the coal is pulverized and fed into the furnace in a powdered state by an air blast. This type of burner, however, has not been developed to a commercial extent for the hardening shop. The combustion gases, which are similar to the gases formed by a producer gas plant, are carried up over a wall of the pit, called the "bridge wall," and are brought to the flues of the furnace proper by a stack or forced draft. After leaving the bridge wall, the gases continue their burning or combustion, which is called "secondary combustion." In the older types of coal furnaces, the bridge wall was the side of the heating chamber, but with this arrangement economy and regulation were not good. Secondary combustion, if any, took place in the heating chamber or in the waste gas flues, and the full heating value of the coal was not obtained. All coal pits are fitted with a grate, under which an air blast or steam jet, or both, are placed to obtain forced draft. It is advisable to use steam, as it prevents, to a considerable degree, the clinkering of the coal during combustion. Automatic and semi-automatic stokers are sometimes used to feed the coal to the furnace at a more or less uniform rate, which lessens smoke and clinkerage. The following is a rough estimate: 1 square foot of fire pit area will serve 10 to 14 square feet of hearth area.

Types of Oil Burners

There are two main types of oil burners—high- and low-pressure. A high-pressure burner is one in which the oil is received by the burner at a pressure of about 30 pounds per square inch so that it will atomize or gasify when escaping through a nozzle and will carry air for combustion with it, the principle being similar to that of an injector nozzle. Usually this type of burner is supplied with air at a pressure of a few ounces per square inch in order to help the atomization of the oil and to regulate the oil vapor cone for different conditions of wall thickness. The prevailing type of burner is the low-pressure burner. With this type, the oil is used at a pressure of only about 2 pounds per square inch, and so will not spring leaks in the piping system as readily as when used at a higher pressure. In this case, atomization of the oil depends on the air which is supplied to the burner at from 1 to 5 pounds pressure per square inch.

Most burners of both types are fitted with a nozzle regulator for adjusting the cone of the atomized oil as shown at *A* and *B* in Fig. 2. The nozzle regulator is indicated at *X*, and the cone of atomized oil at *Y*. The regulator shown at *A* is suitable for thin-wall furnaces, while the one shown at *B* is adaptable to furnaces having thick walls. An inexpensive homemade low-pressure burner that operated very satisfactorily is shown at *A* in Fig. 3. This size will heat a hearth of 8 square feet to a temperature of 1500 degrees F. Larger sizes can be made with proportionate parts. Nozzle *C* tapers to a diameter of 3/16 inch at one end while the other end is welded to pipe *D*. Oil should be forced through pipe *D* at a pressure of from 1 to 2 pounds per square inch, while air at a pressure of from 1 to 5 pounds per square inch should be forced through nipple *E*. For adjusting the cone of the atomized oil, the nipple *F* should be made to screw easily into tee *G* and cap *H* on nipple *F*.

The clogging of oil burners is a trouble that is always present, and is caused by the following conditions: Impurities in the oil, such as grit; the use of too heavy oils, such as the Texas oils which gum; or gases coming back out of the furnace after it is shut off, which deposit soot on the nozzles. The clogging caused by grit in the oil may be lessened by placing strainers on the oil line, while the clogging caused by gases from the furnace may be lessened by closing off the burner opening into the furnace when the furnace is shut off.

The oil burner is placed outside the furnace, as shown at *B* in Fig. 3, and is fitted with valves for regulating the air and oil. The opening in the furnace walls should be slightly greater than the cone of atomization. The hole in the wall is generally from 5 to 7 inches square on the inside of the wall and from 2 to 3 inches square on the outside. To light an oil burner, a burning oiled rag is usually held beneath the outlet end and the oil and air turned on, the torch being held in place until the baffle brick glows or is hot enough to maintain the flame from the burner. Back-fires may at first result, and the operator should take care that he is not burned.

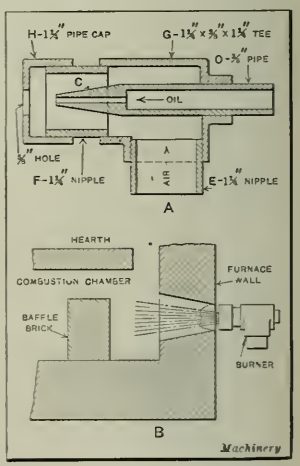


Fig. 3. Detail of Low-pressure Oil Burner, and Method of placing at Furnace

Construction of Gas Burners

Gas burners are constructed similarly to oil burners, and there are also two types, high- and low-pressure. The gas does not need to be atomized, but requires instead to be mixed with air, and the nozzles are therefore larger. The low-pressure burner is the type most commonly used, and a detail of such a burner is shown at *A* in Fig. 4. The method of placing this burner in the wall is illustrated at *B*. The dimension *X* on the detail of the burner should correspond to approximately the thickness of the furnace wall. The reason for placing the end of the burner in a counterbored hole is to prevent it from being heated by the combustion

chamber gases and pre-igniting the gas mixture as it comes through the nozzle. This would cause heat in the burner proper and not in the furnace, and would be accompanied by sharp reports. The air and gas pipes must be supplied with valves for regulation.

In the high-pressure type of burner, the gas pressure is increased by the nozzle injector before the gas is mixed with air. Table 1 gives the dimensions of high-pressure burners of various capacities. An air blower has lately been developed in which the gas enters and is mixed with the air to the proper proportion. This blower is piped directly to the furnace, and assures the proper mixture for all the burners, saves piping, fittings, etc., and is otherwise satisfactory. It is well to use a number of gas burners in one furnace, rather than only a few as is the case in an oil furnace. There is no established rule governing the number of burners to be used, but for a furnace 60 inches long by 40 inches wide, there should be four or six burners on each side. In an oil-fired furnace of the same size, one, two, or three burners would be satisfactory. When purchasing new burners, the claims of salesmen should be proved by measuring the fuel consumption for certain lengths of time.

Quenching Mediums

The most commonly used quenching mediums are water and oil. Some concerns use brine and acid solutions, while others use alkaline solutions, the reason for using different mediums being to fulfill the requirements of hardness, and to reduce warpage. Water is the most used quenching medium, its use only being restricted on account of its tendency to warp delicate work. The colder the water used in quenching, the harder the work will be. Water at the boiling point (212 degrees F.) is supposed to have the quenching properties of oil, while the addition of alkalies which raise the boiling point will undoubtedly give such a result. The cost of adding alkali to the water and the cost of maintaining the water at a fairly constant temperature often makes a water bath more expensive than an oil quenching medium. Water as a rule, is plentiful and cheap, and no pump or cooling device is necessary, as is the case with oil.

Oil Quenching Baths

Oil is used extensively as a quenching medium, since it gives the best proportions of hardness, toughness, and warp-

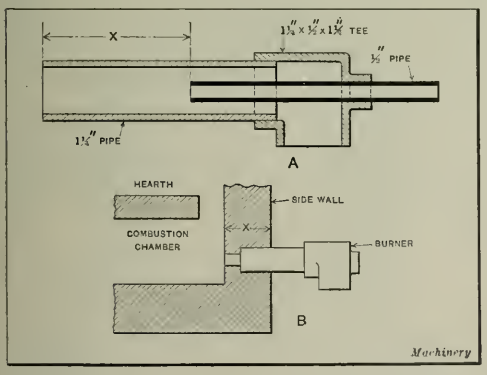
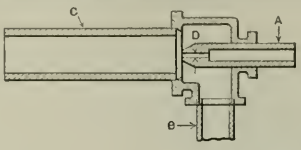


Fig. 4. Low-pressure Gas Burner, and Method of inserting End in Furnace Wall

age for standard steels. In the past, such oils as fish oil, linseed oil, etc., were considered the only kinds in which steel could be quenched, this belief being handed down from the time when the cost of these products was low. At present the cost of these oils is excessive, and after considering the odor of fish oil and the edge of gum about the top of the quenching tank when cottonseed oil is used, it is a wonder that these oils retained their popularity as long as they did. Their only advantage is a high flash point.

Fish and cottonseed oils were supplanted to a great extent prior to the war by special compounded oils of the soluble type. The soluble properties enable the oil to make an emulsion with water, which constitutes a slight advantage, because if water gets into the oil it combines with it to form a medium which cools the work slightly faster than oil alone. In non-soluble oils, the water does not emulsify with the oil, but goes to the bottom of the quenching tank, and as the hot steel passes through the oil to the water it receives unequal hardening strains, which have a decided

TABLE 1. DIMENSIONS OF HIGH-PRESSURE GAS BURNERS OF VARIOUS CAPACITIES



Capacity of Burner, Cubic Feet per Hour	Size of Pipe			Diameter of Nozzle Opening
	A	B	C	D
28	⅜	½	½	1/16
56	½	¾	¾	1/8
93	¾	1	1	3/16
115	1	1¼	1¼	¼
225	1-1¼	1¼-1½	1¼-1½	5/16

Machinery

tendency to crack the work. However, there should be no reason for getting water in the oil in a well designed plant. Claims are made that greater quantities of steel can be quenched per gallon of soluble oil than with other oils, and that the former have high "refrigerating" qualities. The so-called "refrigerating" qualities are really the capacity of the oil to remove the heat from the steel rapidly and then radiate its own heat to the atmosphere. These properties are even better in a light-bodied oil that will circulate itself by a thermo-syphon action. The quantity of steel that can be quenched per gallon of oil depends on the fluidity of the oil, that is, its draining qualities, because the lighter the body of the oil, the better it drains from the work and the smaller the waste.

Further claims are made that the physical properties of the quenched steel do not vary to an appreciable degree when soluble oils are used up to temperatures of from 200 to 250 degrees F. These claims are in the main true, but this can also be said of other oils. However, there is no occasion for allowing the oil to reach such high temperatures as to cause discomfort to the men through burns, etc. Aside from these properties, soluble oils have perhaps no advantages over any other oil as far as the hardening of the work is concerned.

Properties of Good Quenching Oils

A good quenching oil should possess a flash and fire point sufficiently high to be safe under the conditions used, and 350 degrees F. should be about the minimum point. Its viscosity should be such as to allow it to drain readily from the work and circulate itself freely by a thermo-syphon action. The specific heat of the oil regulates the hardness and toughness of the quenched steel, and the greater the specific heat is, the harder the steel will be. Viscosity must also be considered in this respect to some extent. Specific heats of quenching oils vary from 0.20 to 0.75, the specific heats of fish, animal, and vegetable oils usually being from 0.2 to 0.4, and of soluble and mineral oils, from 0.5 to 0.7. The oil should not contain water, should not gum in use, should not be of a disagreeable odor, or become rancid, or have a skin-drying effect on the bodies of the workmen. A great many concerns use paraffin and mineral oils for quenching, while a few use crude fuel oils.

The following is a resumé of a recent test on various oils. The method of testing was to heat a steel cylinder weighing 3510 grams (about 7¾ pounds) and having a specific heat of 0.1165 to a temperature of 1400 degrees F. in a lead pot maintained at a temperature of 1500 degrees F. Each bath contained 10 liters (about 2½ gallons) of the oil being tested. A thermo-couple was placed in the center of the steel cylinder to obtain accurate readings of the cylinder temperature at all times. The temperature of the oil was taken with a thermometer before and after the cylinder was quenched. The number of seconds required to cool the steel from 1400 to 800 degrees F. and from 1400 to 500 degrees F. were also recorded. From this data the specific heats of the different oils were obtained by means of the following formula:

$$C_1 = \frac{CW\,(T - T_1)}{W_1\,(T_1 - T_2)}$$

in which

C = specific heat of steel cylinder;
C_1 = specific heat of oil;
W = weight of cylinder;
W_1 = weight of oil bath;
T = temperature of hot cylinder;
T_1 = temperature of oil after cylinder was cooled to 500 degrees F.;
T_2 = original temperature of oil.

consequence, the use of alkaline solutions gives the least amount of hardness possible to the work when quenching in a liquid to the cold stage. The loss in hardness is compensated for by the toughness obtained and the elimination of the tendency to warp. When the hot steel is plunged into the bath, the "shock" or rapidity of cooling is so lessened that the case of the steel does not set with such hardness that the strains, etc., in the main bulk cannot bend it to a position of strain equilibrium. The alkali quench is adaptable to treating steel parts such as axles, etc., when certain physical properties are desired. In casehardening, alkaline solutions are well adapted for quenching for core refinement on delicate parts that would warp excessively if quenched in a faster cooling medium. Alkaline solutions are not generally used for the reason that with the different grades of steels that can be obtained, a grade can almost always be selected that will give the desired physical properties by quenching in oil or water.

Other Quenching Baths

Brine and acid baths are used in cases where extremely hard work is desired. This quench cools the work very rapidly, but results in a great warpage and cracking of the work. Many hardeners have devised other fast-quenching baths, the formulas of which they carefully guard, that often are adapted for particular classes of work. The following is a formula for such a bath, which has been used for many years: Dissolve in 40 gallons of water, 1 quart of sulphuric acid; 4 pecks of salt; 1 pound of yellow prussiate of potassium; 1 pound of powdered alum; and 2 pounds of saltpeter. As previously mentioned, because almost any physical properties desired can be obtained by quenching a certain grade of steel in oil or water, brine and acid baths are also used but little.

By quenching in molten metals such as lead, the hardness of the work decreases at a slow rate as the steel cools from the red to the black stage and the work is tempered at the temperature of the lead. By quenching in a mercury bath, extreme hardness of the work will be obtained, but this is only practical on very small parts.

TABLE 2. PROPERTIES OF VARIOUS OILS USED IN TEST

Different Kinds of Oils	Flash Point, Degrees F.		Viscosity, Seconds		Rise of Oil Temperature During Quench, Degrees F.	Average Quenching Time in Seconds		Specific Heat
	Before Test	After Test	Before Test	After Test		From 1400 to 500 Deg. F.	From 1400 to 800 Deg. F.	
Fish	400	400	112	112	131	142	70	0.4057
Raw linseed	400	520	134	129	125	165	81	0.4118
Mineral	395	398	140	109	126	172	96	0.4410
Mineral No. 1	360	355	101	105	126	182	86	0.4273
Mineral hardening	328	330	70	73	126	167	78	0.4551
Soluble	370	370	119	125	128	174	86	0.4354
Engine	390	390	230	230	129	191	96	0.4120

Machinery

In Table 2 are given various properties of the different oils tested. The flash points given in this table were obtained by means of the "open" test. The viscosity of the oils was obtained by means of a Saybolt viscometer, and the values are given in terms of that instrument.

The condition of the various oils after being held at a temperature of 240 degrees F. for sixty hours was as follows: Fish, thick, lumpy, and very bad; raw linseed, dark and as thick as a light grease; mineral, dark and quite thick; mineral No. 1 and mineral hardening, a little dark and some sediment but not thick; soluble, dark with a heavy sediment, but not thick; and engine, very dark, thick and lumpy.

Mixtures of oil and water are sometimes used in different proportions to give a greater hardness than oil alone, and less hardness than water, but this can only be done with soluble oils or oils that will emulsify with water. The following is an instance where such a solution was used. The experience of a concern making permanent magneto magnets was that when the magnets were quenched in water they became cracked and warped. An oil bath was then used and although it caused no such trouble, it did not give the desired hardness. A quenching bath consisting of three parts of water to one part of oil was finally mixed, with which satisfactory results were obtained.

Alkaline Quenching Mediums

The materials employed in preparing alkaline quenching solutions are lye, soda ash, soap, etc., and these are used in various amounts according to the final results desired. These solutions cool the steel through the critical range or from the hardening temperature to the black stage at a slower rate than oil, which governs the hardness of the steel. In

* * *

REMOVING BROKEN TAPS FROM CASTINGS

One of the many uses to which an electric arc welding outfit may be put is the removal of broken taps from holes in castings. The method employed is very simple, and has been quite extensively used. It consists simply of building metal on the shank of the broken tap within the hole, up to or above the level of the work. Care must be exercised in this building-up operation, to prevent the deposited metal from coming in contact with the threads in the tapped hole. After the shank has been built up in this manner, the head of a bolt or a nut is tacked to the built-up shank and then the tap may be readily backed out in the regular manner. A considerable amount of time and labor may be saved by this method, and by the exercise of caution the thread will not be injured.

Design of Sub-Presses

Description of Cylinder and Pillar Types, Ways of Mounting, and Method of Making Pillar-type Sub-presses

By D. H. CHASON

THE sub-press as an adjunct to the power press has not been as extensively employed, in the writer's opinion, as it should be. It can be used for plain, progressive and compound blanking, piercing, forming, bending, drawing, swaging, shaving, and, in fact, for the variety of work that is generally done on power presses. The prime reason for its restricted use may be the initial cost, especially where the cylinder type of sub-press is used. However, on investigation it will be found that a properly made sub-press will considerably increase the life of the punch and die. The extra cost will soon be made up in the time saved in setting up, and in reducing the amount of grinding necessary to keep the punch and die in proper condition.

In some respects a power press is the most abused machine in the shop. This may not be intentional but is probably due to a lack of appreciation and knowledge of the proper design of the means of locating and holding the punch and die. Many a good press is condemned through the use of poorly designed and constructed means of locating and holding the punch and die. This is particularly true of the sub-press, and may in a measure account for its restricted use.

Types of Sub-presses

Sub-presses are made in two types—the cylinder type, Fig. 1, and the pillar type, Fig. 2. The cylinder type is the older and more expensive one to make and maintain, and while there may be some advantages in its design for certain classes of work it has been generally superseded by the pillar type. One of the advantages claimed for the cylinder type is that of adjustability for wear. This advantage, however, is more imaginary than real. If the wear on the plunger has not been uniform, adjusting the lining bushing may not bring the punch and die in proper alignment again, thus causing damage to them, if indeed it does not ruin them. Several cases of this kind have been noticed. Another advantage that may be claimed is that of compactness, but it is this very compactness that restricts the die space.

Pillar sub-presses are less expensive and are more simple to make than those of the cylinder type. They have the distinct advantage of more die space. It may be claimed that the pillar type of sub-press lacks adjustability for wear. If properly made, there will be no cause for this claim. The sub-press in itself may be ever so well made, but if the means of fastening the upper and lower members is not correct the excellence of the sub-press or the power press goes for naught.

Methods of Mounting Sub-presses

The general practice has been to fasten the upper member of a sub-press rigidly to the ram and the lower member rigidly to the bed of the press. When the plunger of a

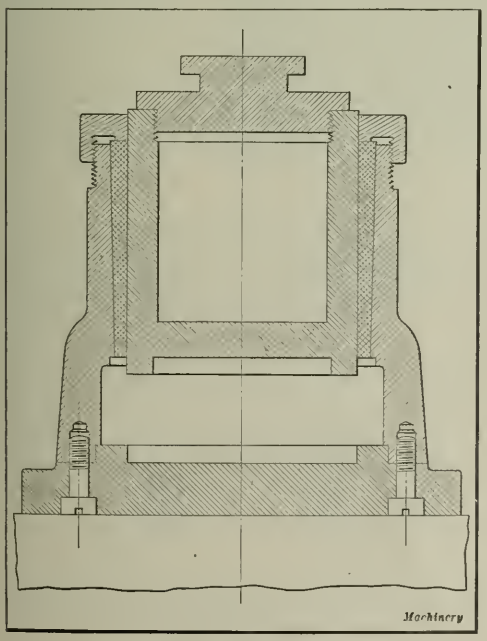


Fig. 1. Cylinder Type of Sub-press

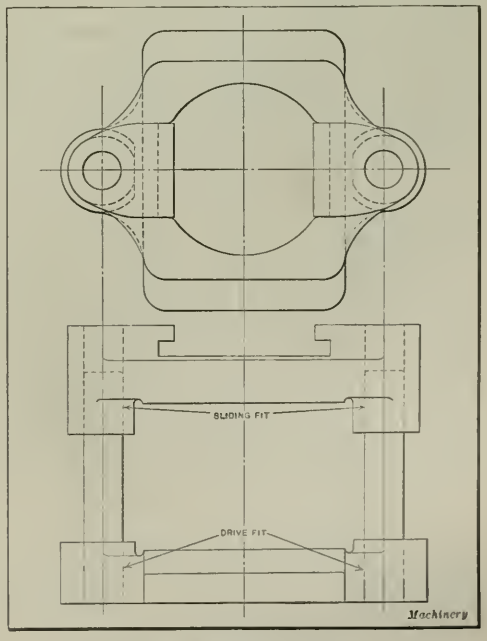


Fig. 2. Pillar Type of Sub-press

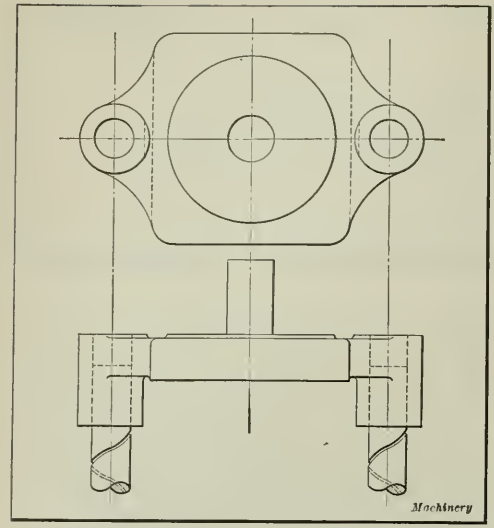


Fig. 3. Upper Member of Sub-press having Usual Type of Shank or Plug Connection

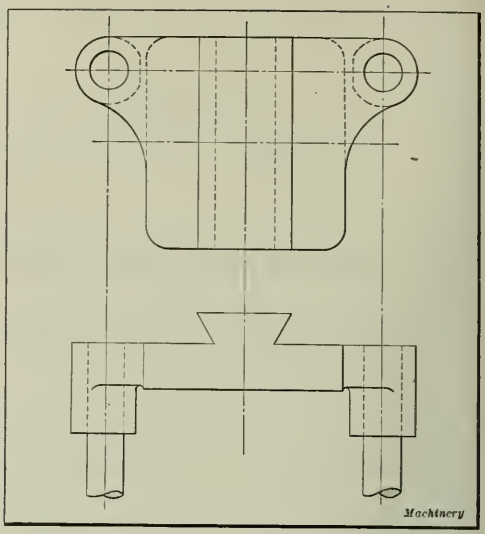


Fig. 4. Offset Type of Upper Member which is dovetailed to Press Ram

cylinder-type or the upper member of a pillar-type sub-press is rigidly connected to the ram of a power press it cannot be termed a true sub-press. The prime reason and sole function of the pillars on a pillar-type sub-press, or the bearing around a cylinder of the cylinder-type sub-press is to do the guiding. If, however, the upper member is connected rigidly to the ram of the power press the function of the pillars is impaired or entirely destroyed. It may be argued that with a rigid connection between the ram of the press and the upper member of the sub-press the ram assists the pillars to do the guiding, but this is the case only where the ram and the upper member are absolutely in alignment—a condition that is difficult to attain and still more difficult to maintain.

In a number of presses where the rigid connection was used, it was noted that the pillar holes were worn elongated from the continuous cramping action on the pillar. In some cases where a shank or plug connection was used, the shank was sheared off. On the other hand, in a pillar-type sub-press with an adapter that had 1/32 inch or more play, or in other words, a floating connection, it was found that the pillar holes were 0.001 inch larger than the pillars, and this was an instance in which the press was in almost continuous operation for ten years. Therefore it would appear to be the best practice to employ a floating connection and use the pillars solely for the purpose they are intended for, namely *to do the guiding.*

Of the pillar-type sub-presses there are several varieties, distinguished mainly by the location of the pillars in relation to the punch and die and the means of connecting the upper member to the ram. Fig. 3 shows the usual type of shank or plug connection for the upper member. Fig. 4 shows the dovetail type. Another method of connecting is to bolt the upper member to the ram without any means of locating. These three types illustrate the usual practice for making a rigid connection.

Figs. 2 and 5 show pillar-type sub-presses using a floating connection between the ram and the upper member. In locating the pillars in relation to the punch and die, the best practice is to have the punch and die center in line with the

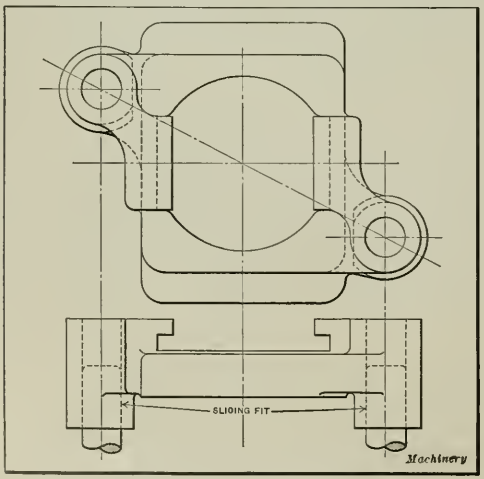


Fig. 5. Sub-press in which Dies are readily Accessible

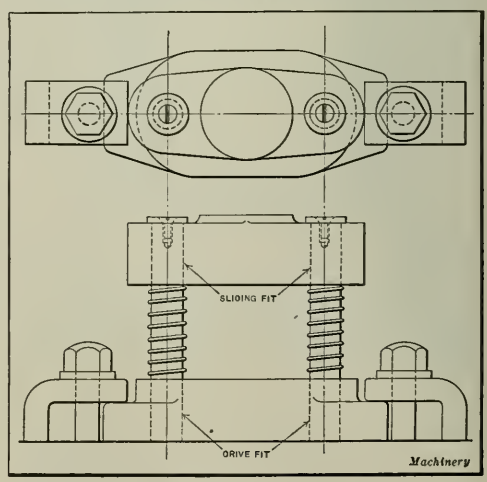


Fig. 6. Sub-press adapted for very Small Work

pillars, as shown in Figs. 2, 3, and 5. This construction will obviate the tendency of the upper member to tilt or cramp on the pillars. An offset in the pillars as shown in Fig. 4 should be avoided whenever possible. The only apparent reasons for offsetting the pillars in this way is to give the stock clearance when feeding, in blanking operations, and to make the die more accessible. By constructing the sub-press as shown in Fig. 5, these advantages are retained and the pillar and punch and die centers are still kept in line. Fig. 6 shows a type of sub-press that has proved efficient for very small work. There is no connection except that of contact with the ram, the springs raising the upper member. Of course, its range is somewhat limited, no drawing or stripping being possible.

In many factories where the equipment consists of old style power presses, there is not enough space between the bed and the ram for a sub-press. In that case a sufficient amount can be planed off from the bed and the ram to make room for the sub-press, or clearance holes can be drilled in the ram for the pillars if necessary.

Making a Pillar-type Sub-press

For the upper and lower members of a pillar-type sub-press, a good grade of charcoal iron should be used. After rough-machining, allow it to season and then machine the faces parallel to within limits of 0.0005 inch. The pillar holes should not be cored, as better results are obtained by drilling from the solid. For the pillars use machine steel. After turning, pack-harden, rough-grind, and season. Finish-grind and lap to a sliding fit in the upper member and grind to a driving fit in the lower member of the sub-press. To avoid reversing the pillar in the grinding machine, drill a hole in the end of the pillar as shown in the right-hand view Fig. 7. This should engage a pin in the faceplate or driving pulley of the grinding machine. By using this method, the pillar can be ground with one setting and thus avoid making the two bearings eccentric.

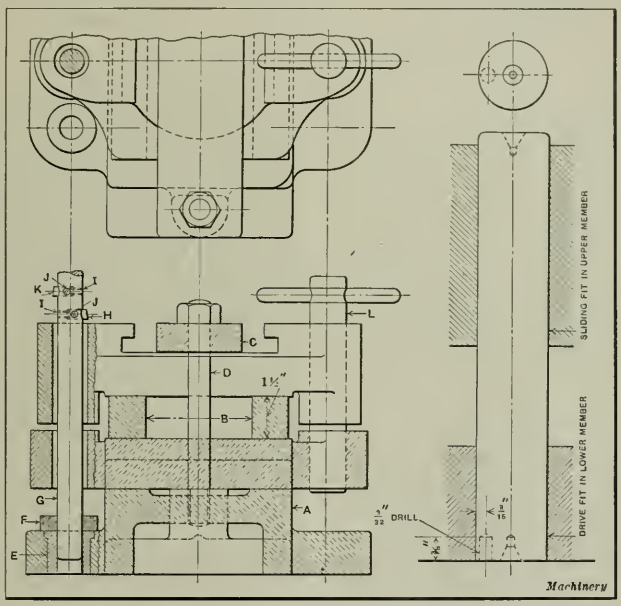


Fig. 7. Drilling Machine Fixture for machining Pillar Holes in Sub-press, and Illustration of properly Designed Pillars

In some cases, two different size pillars are used in the same sub-press in order to prevent the improper setting of the punch and die in relation to each other. Where the same size pillars are used, some distinguishing mark should be placed on the upper and lower members, furnishing a guide for the proper assembling of the sub-press. These marks should not be small or in an inconspicuous place. A good practice is to number both members on the front where they can be easily seen. By using different numbers, the tendency to mix the members of different sub-presses will be avoided.

The use of oil-grooves on the pillars should be avoided. A grooved pillar makes a first-class lap, which tends to reduce the life of the bearing. This has been proved to be the case by actual experiment. The use of bushings or liners is not necessary, as the cast-iron bearings become glazed and will outlive any steel or bronze bushings. It is of course essential to have the holes smoothly reamed and the pillars smoothly ground and lapped. The corners on the upper end of the pillars should be well rounded as shown in the right-hand view in Fig. 7.

The care of a sub-press should not end with its use on the press. To place the sub-press on the floor under the press or in some other place where it can become covered with dirt is not conducive to its efficiency when it is used again. After use it should be cleaned and oiled and placed on a suitable rack, the size of which is of course governed by the number of sub-presses required. Each should have its own space; piling one on top of the other is poor practice.

A Drilling and Reaming Fixture for Sub-presses

Generally the upper and lower members of a sub-press are drilled, bored, and reamed on a boring machine. The left-hand view, Fig. 7, shows a drilling, boring, and reaming fixture that can be used on an upright drilling machine having power feed. The fixture consists of a base *A*, with clamp strap *C* and clamp screws *D*, and two parallels *B*. The tools consist of a center for locating, a small and a large sized drill, a hardened and ground boring-bar *G*, a hand reamer, and an aligning bar *L*.

The fixture is lined up by means of the boring-bar *G* in the pilot hole in base *A*, and then clamped to the drilling machine table. The holes are laid out on the upper side of the upper member, and both members are placed on the fixture, separated by parallels *B*, and set in their proper place by means of the center in the drilling machine spindle; they are clamped by clamp strap *C* and clamp screws *D*. The parts are next drilled to within 1/16 inch of the finished size, using a ¼- or ⅜-inch drill first and then a larger drill. The boring-bar *G* carrying the roughing tool *H* and the finishing tool *K* is then employed to rough-bore the parts to within 1/64 inch of the finish size. The tools are held as shown at *J*, and are adjustable by means of screw *I*. The lower end of the boring-bar is guided by hardened bushing *E*, the bearing of which is protected by felt washer *F*. After the rough-boring operation, the hole is hand-reamed, using the center in the drilling machine spindle as a guide. The aligning bar *L* is inserted in the finished hole in order to locate the other hole, and the procedure is then the same as before. The drilling machine table should be jacked underneath to insure rigidity.

* * *

The effect on the German iron industry of the loss of Alsace-Lorraine is indicated by the following figures: The pig iron production in Germany for the first nine months of 1917 was over 10,000,000 tons, and for the same period in 1918 nearly the same amount, but for the corresponding period in 1919 it fell to 4,720,000 tons.



Manufacture of Wrought Iron Pipe

A Description of the Various Steps in the Production of Wrought-iron Pipe, Beginning with the Puddling Process and Ending with the Inspection

By N. BOWLAND, A. M. Byers Co., Pittsburg, Pa.

THE annual production of welded pipe in this country has been in the vicinity of from 2,500,000 to 3,000,000 tons during recent years. About nine-tenths of this tonnage is steel pipe used in the production of oil and gas, and since the sizes employed in these industries are large, correspondingly big tonnages result. Steel pipe is also used for structural purposes, such as awning frames, fences, railings, etc., as well as for agricultural implements and numerous other appliances. On the other hand, if the amount of wrought-iron pipe used simply as a tube for conveying liquid should be compared with the use of steel pipe for the same purpose, it would no doubt be found that the wrought-iron pipe tonnage makes up nearly 50 per cent of the total tonnage used for permanent installations, especially where conditions of corrosion are encountered.

Pig Iron and the Puddling Process

The making of wrought-iron pipe starts with the reduction of iron ore into pig iron. A pipe manufacturer who owns his own blast furnace has the advantage of being able to mix the ores so as to produce the most uniform and the most suitable grade of pig iron for refining into wrought iron. With few exceptions, the puddling furnace and puddling practice have remained practically unchanged since the advent of the reverberatory furnace in 1784. An important improvement in this furnace was made in 1804, when an air- or water-cooled iron bottom was substituted for the sand bottom of the original furnace, and also in 1830 by the introduction of what is known as "pig boiling."

According to the practice followed in the mills of A. M. Byers Co., Pittsburg, Pa., a coal fire is first made in the fire chamber of the brick furnace, after which the puddler and his helper line the furnace bottom, sides, and bridge wall with moistened ore and mill scale. In the vernacular of the shop, this is known as "fettling." This lining eliminates the extensive losses of iron which took place when the sand bottom was used in the furnace, a loss which was fully half the total charge of the furnace. The furnace is next charged by hand with about 560 pounds of pig iron, which the puddler presently begins to turn over with a long iron bar until the iron melts down into the bath of slag which is being formed by the chemical union of iron, mill scale, and such impurities as are contained in the pig iron and the lining. This slag floats on top of the molten mass and protects the iron against losses from oxidation. Fig. 1 shows a typical puddling furnace, and in the foreground may be seen a pile of iron pigs.

The furnace heat is lowered somewhat as soon as the iron has melted, in order to prevent the removal of carbon before the sulphur and phosphorus are removed. These two im-



Fig. 1. Charging Pig Iron into Puddling Furnace

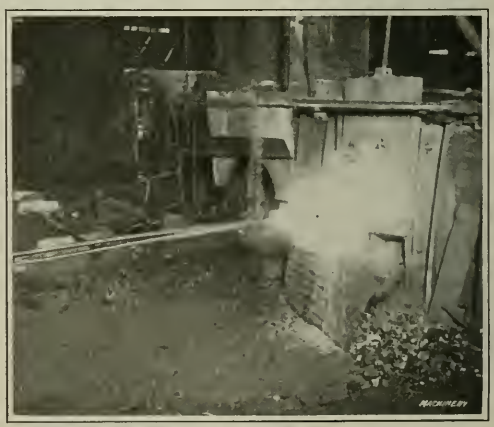


Fig. 2. Removing Puddled Ball of Metal from Furnace



Fig. 3. Puddled Ball of Iron entering Squeezer



Fig. 4. Hot Metal passing through Muck Rolls

purities combine largely with the slag. A small quantity of mill scale is next thrown into the furnace, and the temperature slightly raised. When the mass begins to boil, small blue flames shoot up through the slag which floats on top; these small flames are caused by the combination of carbon with the oxygen of the ore and mill scale, the resulting oxidized carbon escaping as a gas up the stack. During this operation, which is called "pig boiling," the puddler continuously stirs or rabbles the charge with a long iron bar, the object being to expose the mass uniformly to the action of the flames which are thrown down from the reverberatory furnace roof. Large quantities of the slag will flow out through a shallow depression in the foreplate, causing the melting temperature of the remaining mass to be gradually increased.

After the molten mass has boiled for ten or twenty minutes the iron begins to form into small pasty globules of pure iron each of which is surrounded by a film of liquid slag. These small globules gradually adhere to each other and form larger masses of plastic iron. The duties of the puddler at this stage become very arduous, because he must continuously turn these broken lumps over to complete the elimination of impurities, and at the same time must gradually form them into two or three larger balls. In Fig. 2, the operation of taking a puddled ball of iron from the furnace is shown. It will be seen that a pair of long tongs, suspended by a chain from an overhead rail, is employed for the purpose. The puddle furnaces are arranged in rows, set back to back, so that a battery of thirty or more furnaces may be served by a single squeezer.

The Squeezer and its Application

The squeezer to which the hot rolls of iron are taken from the puddling furnace consists of a horizontal corrugated drum which revolves eccentrically within a housing. A good idea of the design of the squeezer may be had by referring to Fig. 3 in which a ball of iron is shown as it is being deposited in the machine. Between the drum and the housing wall, which is open at one side, there is a channel which is large enough at one end to receive one of the puddled balls. This channel tapers in its passage around the drum so as to flatten the ball gradually into an elongated section of metal. When this flattened metal reappears after its revolution around the drum, it has been freed from much of its original slag. It is then quickly picked up and shot backward and forward between a set of "muck" rolls which adjoin the squeezer. In Fig. 4, the so-called "muck bar" is seen passing through the rolls, and a puddled ball is entering the squeezer. The muck bar is in a very crude state at this stage, not having received sufficient working, due to the smallness of the puddled ball; that is, the ball is so small that it is impossible to produce a satisfactory strip from it which would be immediately available for manufacture into pipe.



Fig. 5. Cutting the Muck Bars into Short Lengths and making them into Fagots



Fig. 6. Charging Fagots into Furnace for reheating from One to Two Hours



Fig. 7. Crane conveying Loads of Skelp Iron to Pipe Mill

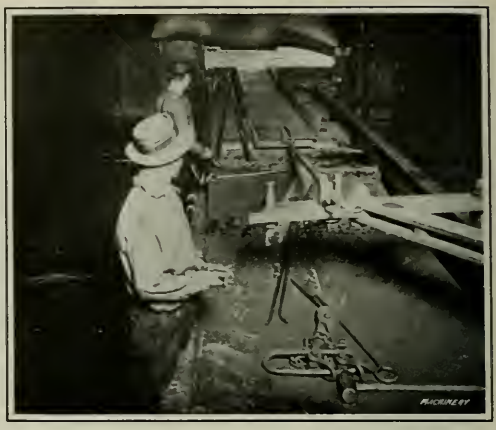


Fig. 8. Charging Skelp for Lap-weld Pipe into Bending Furnace

The muck bars are therefore laid out on the ground and sprayed with water. After they have been thus quickly cooled, the bars are picked up and sheared into lengths of 2 or 3 feet, these lengths being stacked up into rectangular piles, each of a size suitable for rolling into the desired size of "skelp," which is the name given to the long flat strips of iron from which the pipe is afterward made. The process of cutting the muck bar into short lengths is shown in Fig. 5. Each pile is weighed and sent to the heating furnace (Fig. 6) where it remains from one to two hours before it is taken out and rolled into finished skelp. This second rolling involves much more work than the first rolling operation, the work being similar to that frequently seen in a steel pipe mill.

The preceding operations embody the essential practices which are responsible for whatever differences may later be discovered in the physical and chemical characteristics of wrought-iron pipe, as distinguished from steel pipe.

The Transformation of Rolled Skelp into Welded Pipe

After the finished skelp has been cooled and sheared into lengths of about 18 feet, it is picked up by a crane, as shown in Fig. 7, and conveyed to the pipe mills. In welding the pipe, two separate processes are employed, the butt-weld process for the smaller sizes and the lap-weld process for the larger sizes. In welding the small pipe, the flat pieces of skelp are pulled through a die shaped like a bell with the top cut off, which causes them to be bent while hot into circular shape and welded in one operation. The bell, as the butt-weld die is called, is located at the exit of the skelp heating furnace, the skelp being pulled through by means of a pair of power-operated tongs. The larger skelp is charged into the bending furnace (Fig. 8) from which it emerges and is pulled through the bending die. The arrangement of the dies employed in both welding operations may be clearly seen by referring to Fig. 9, in the lower part of which the flat skelp is being pulled through the bell die, while in the upper part of the illustration the rollers employed in the lap-welding process for producing the larger sizes of pipe may be seen.

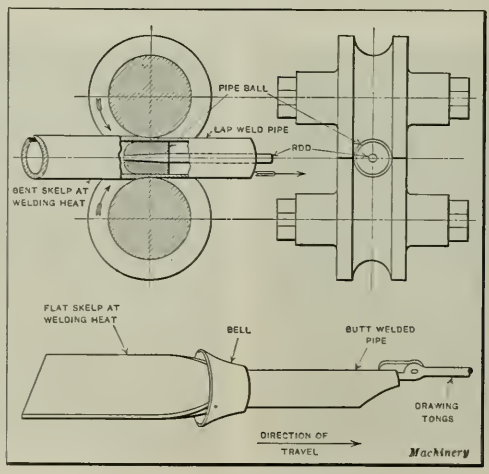


Fig. 9. Diagrammatical View showing Process of Lap- and Butt-welding Wrought-iron Pipe

Fig. 10 shows the bent skelp as it is being rolled laterally over to the adjoining heating furnace from which it emerges on the opposite end and is welded into pipe. This operation is shown in Fig. 11, in which the rolls which are shown diagrammatically in Fig. 9, may be quite clearly seen. These two rolls each have a semicircular groove so that between them, revolving face to face, there is a complete circular opening. A projectile-shaped ball attached to a long rod is held in the middle of this circular opening between the rolls over which the pipe is forced. This arrangement, as will be apparent from an inspection of Fig. 9, gives the pipe its true inside diameter and helps to confine the pressure exerted by the rolls from the exterior of the pipe, upon the overlapping edges of the bent skelp. The friction exerted by the rolls upon the pipe is sufficient to pull it over the ball. Each ball may be used several times, and when it becomes necessary, is detached and replaced with a new one. The pipe is next automatically conveyed through a series of three sets of rolls, known as the size, blister, and cross rolls. The cross rolls, as may be seen from Fig. 12, consist of two cylindrical roller members, mounted askew, by means of which the pipe is given a whirling corkscrew motion, the purpose of which is to strengthen the weld and to improve its surface and roundness.

Couplings, in the best modern practice are rolled and welded from short pieces of heavy skelp. A strong weld is of vital importance due to the high internal pressure to which a coupling is subjected when being screwed tightly on the pipe (see Fig. 13), and to the added working pressure of the fluids to be conveyed through it. Great accuracy is required in subsequently reaming and threading the couplings in order that perfect threads and a wall of even thickness may result. The fact that wrought iron is universally used for coupling manufacture even by the manufacturers of steel pipe is sufficient proof of the excellent welding and fabrication qualities of high-grade wrought iron.



Fig. 10. The Bent Skelp is rolled up to the Lap-weld Furnace



Fig. 11. Pipe from Lap-weld Furnace passing through Welding Rolls

Final Operations Including Straightening and Finishing

The straightening, inspection, and finishing operations can only be briefly outlined. After passing the cross-rolls, the pipe arrives on the traveling cooling rack where the ends of the pipe are cropped off, the operation being shown in Fig. 14. This brings the pipe into line with the straightening press, shown in Fig. 15, from which it passes to the inspection table where it receives a careful examination for inside and outside weld and surface defects. Inferior pipe is, of course, marked for rejection and the ends of the accepted pipe are marked to indicate the amount of crop. For the purpose of cutting off the crop ends of the larger pipe, special roller cutting machines are employed, the cutting tools of which consist of three rotary disks, two located at the bottom and one at the top. The length of pipe is next measured and weighed to determine the weight per foot, these operations being shown in Fig. 16. The practice in the Byers plant allows a maximum variation of 5 per cent above and 2½ per cent below standard weight, these being very strict requirements.

The next stage in the manufacture of wrought-iron pipe consists of threading the ends. This operation is illustrated in Fig. 17, from which it will be seen that the threading machines are so arranged that the opposite ends can be threaded without turning the pipe end for end. Other machines are provided for screwing on the couplings, for hydraulic testing, and for reweighing with the couplings attached. The pressures employed in the hydraulic test vary from 750 to 1000 pounds per square inch for standard weight pipe, and as high as 2000 pounds and over for extra heavy and double extra heavy pipe.

Galvanizing

The hot process of galvanizing is still the process most commonly employed in pipe mills. While there are a number of different coating processes which possess lower first cost, they have, in service tests made under corrosive conditions, generally proved less resistant than the hot galvanizing coating. This fact accounts for the survival of the hot galvanizing process. The black pipe on entering the galvanizing plant is picked up in large bundles by a crane and conveyed first to the pickling tank containing diluted sulphuric acid. After the sand, dirt, and grease have been cleaned off by this means, the acid is washed off in a tank of water.

The pipe is next conveyed to the hydrochloric acid bath and finally deposited over the drying oven, where the hydrochloric acid coating volatilizes, leaving a clean surface preparatory to entering the hot bath of spelter. The underlying strata of this coating has about the same microscopic appearance as the customary commercial sherardizing coating. From one-third to one-quarter of the galvanized coating thus consists of an iron-spelter alloy, having about the same composition and thickness as that obtained in sherardizing, the remaining two-thirds of the surface coating being pure

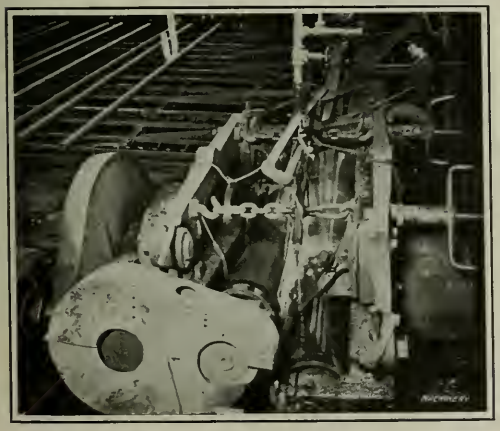


Fig. 12. Cross-rolls which give the Pipe a Whirling Motion

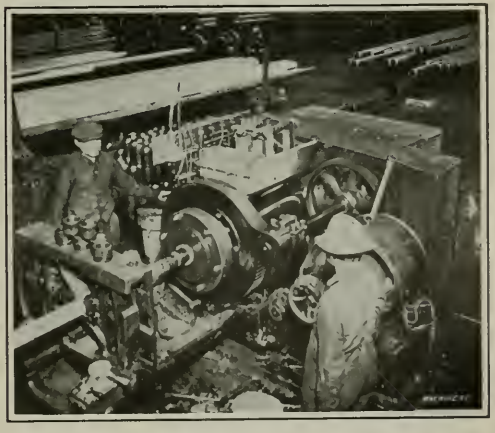


Fig. 13. Screwing Couplings in the Pipe

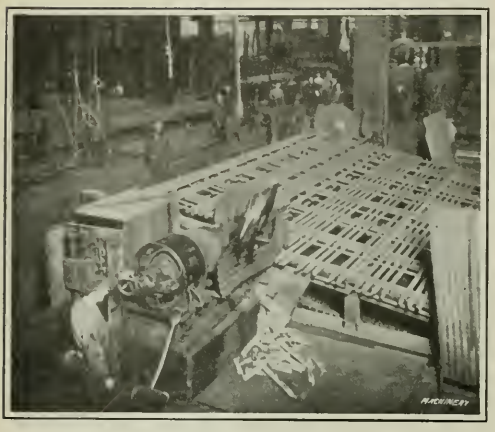


Fig. 14. Cropping off Ends of Pipe

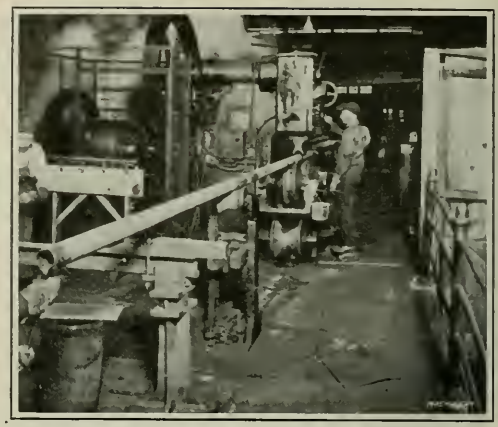


Fig. 15. Pipe passing through Straightening Rolls

spelter which has a greater rust resistance, toughness, and elasticity than the underlying alloy.

An elaborate series of chemical and physical tests is employed in the manufacture of pipe, which follow the product from the receipt of the raw material at the blast furnace to the final inspection on the shipping floor. On the rigidity of these tests and the care exercised in inspection, depends the average quality of the pipe.

Welding Characteristics of Wrought-iron Pipe

The efficiency of a weld depends on the effectiveness of the union of metal to metal. During heating, iron and steel become coated with scale, which on account of its viscosity at welding temperatures, does not squeeze out of the way at the edges to be welded. For welding steel, borax is used as a flux, but fluxes are not employed in welding wrought iron because its slag content makes it self-fluxing. This explains why the weld in wrought-iron pipe is more efficient than the weld in steel pipe.

Threading Qualities of Wrought-iron Pipe

The easy threading qualities of high-grade wrought-iron pipe are due to the fibrous character of the wrought iron, which causes the chips to break or crumble, reducing friction and preventing the chip space from clogging. A clean, accurate thread which is an essential in strong, leakproof joints is the result. There is also less tendency on the part of the threads to strip.

Resistance to Vibration

Figures for tensile strength, elastic limit, and elongation are no criterion of endurance under vibratory stresses or repeated shocks. The characteristic of steel becoming brittle and fracturing under such conditions is said to be due to fatigue, resulting in crystallization, but this characteristic does not apply in nearly as great a degree to wrought iron. The slag in wrought iron performs an important function in that it arrests the development of fissures. The comparison between steel and wrought iron is analogous to a solid bar as contrasted with a stranded cable. A small initial fracture in a solid bar may continue to grow under repeated stresses until failure occurs, whereas the cable may suffer rupture in an individual strand without noticeably affecting the strength of the cable as a whole. Wrought iron consists of a multitude of independent iron fibers by reason of the associated slag filaments.

According to the best standards of manufacture, many parts of locomotives and cars upon which the safety of life is vitally dependent, are specified to be made of wrought iron; also wrought-iron staybolts for locomotive boilers are required because they will best withstand the repeated stresses due to expansion and contraction.

Resistance to Corrosion

The electrolytic theory of corrosion is now generally accepted. According to this theory all corrosion proceeds by electrolytic action, caused either by small electric-conducting

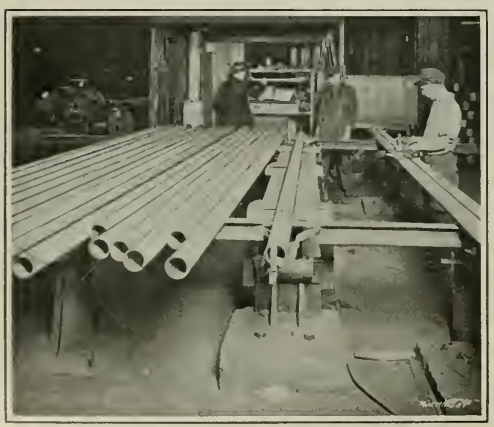


Fig. 16. Measuring and weighing to determine the Weight per Foot



Fig. 17. The Pipe may be threaded without turning it End for End

impurities that exist within the metal itself or by related causes. The purity of wrought iron, particularly as regards absence of sulphur and manganese, is an important factor in retarding corrosion and pitting. There is no reason to assume, therefore, that Bessemer steel, which is the most impure of all commercial steels in this respect, should not be more susceptible to corrosion than steels or irons of higher purity. By inference, pure wrought iron should be relatively more immune from attack. It is argued that if impurities cause corrosion, then the large amount of slag in wrought iron should cause it to corrode even more quickly than steel. The explanation of this is that slag is a glassy substance, is a poor conductor of electric current, and is itself practically non-corrodible.

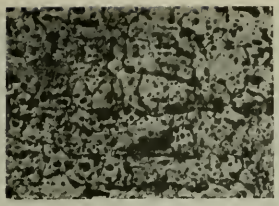


Fig. 18. Cross-section of Piece of Wrought Iron. Dark Areas are Ends of Slag Filaments and Light Areas are Iron

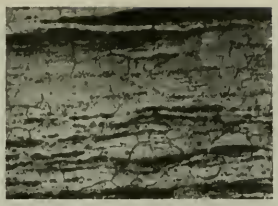


Fig. 19. Longitudinal Section of Piece of Wrought Iron; in this View also Dark Areas are Slag Filaments



Fig. 20. Bar of Wrought Iron etched in Acid to develop its Fibrous Character

However, purity as regards the sulphur, manganese and carbon content is only one factor entering into the question of corrosion, for it is well known that physical conditions, such as strains in the metal and particularly the rust itself, play most important parts in accelerating corrosion. It is therefore only possible to retard the progress of corrosion by physical obstructions from within the metal. No matter how pure steel may be, it does not offer this resistance, while wrought iron presents an infinite number of slag filaments as a barrier to the progress of corrosion and pitting.

* * *

INTERNAL AND EXTERNAL LENGTH GAGES

By D. R. GALLAGHER

A set of gages for measuring inside and outside dimensions may be cheaply made if the construction shown in the accompanying illustration is followed. If gages of this type are handled with care, very accurate results can be obtained. The internal gage *A* is made of wood, with two wood-screw gaging points, as was described in the September number of MACHINERY. The external gage *B* consists of a wooden body, which if the greatest amount of service is to be secured, should be made of hard wood. It should be about 1¼ inches thick for lengths greater than 4 feet, and other sizes in proportion. Two angle-pieces *C*, made of flat stock, are attached to the body as shown, being tapped for the adjusting screw *D*. The angle-pieces should be made of ⅜-inch stock, 1¼ inches wide, and secured to the wood body by two screws *H*. This allows the arms to be relocated so as to suit different gaging lengths when the adjustment provided by the screws *D* is not sufficient. One of the adjusting screws should be a thumb-screw as shown at *G*, because finger adjustment permits the operator to feel the amount of adjustment that is required.

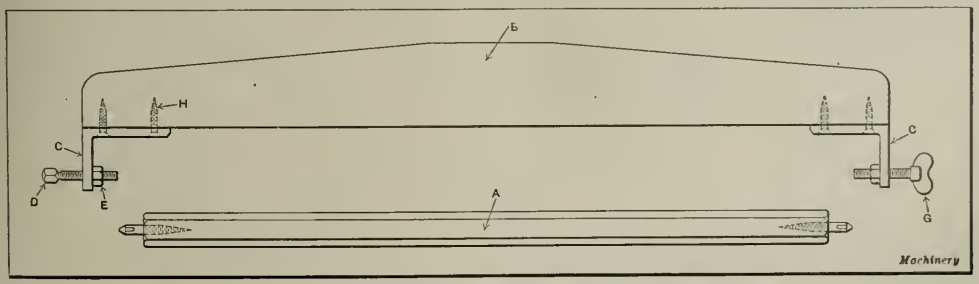
Gages of this type have been used on work up to 60 inches in diameter and the work held to very close limits. In measuring cylindrical work with gage *B*, the work should be held in a chuck, as the length of arms *C* will not permit reaching to the center. This makes it necessary to measure across the end of the work. In general, gages of this type adequately answer the purpose for which they are intended and are of especial value in cases where the work would not warrant making a more elaborate style.

* * *

SPRING MEETING OF A. S. M. E.

The spring meeting of the American Society of Mechanical Engineers will be held at St. Louis, Mo., May 24 to 27, as previously announced. The main sessions will be devoted to foundry work, appraisal and valuation, and aeronautics. The foundry session will deal with malleable castings; die-castings; gray iron castings; aluminum castings; steel castings; and brass and bronze castings. The appraisal and valuation session will deal with appraisal and valuation methods; fundamental principles of rational valuation; data on the cost of organizing and financing a public utility project; and price levels in relation to value. The aeronautical session will deal with air flow past an airplane wing; use of turbo-compressors for increasing power of airplanes at high altitudes, airplane instruments; and experiments on new types of airplanes. In connection with this session, it is expected that moving pictures will be shown. In addition, papers will be read on the following topics: Weir for gaging the flow of water in open channels; simplification of venturi-meter calculations; flow of air; dissipation of heat by various surfaces; pulverized coal at the Cerro de Pasco Copper Corporation; method for separation of dissolved gases from water and some of its uses; and flow of air through small brass tubes.

The business session will be held Tuesday morning, May 25, followed by a session with papers of local interest on Mississippi River transportation and on housing. Excursions of industrial interest are contemplated to the plants of the Commonwealth Steel Co., Union Electric Light & Power Co., St. Louis Boat & Engineering Co., Busch-Sulzer Diesel Engine Co., and the Mississippi Valley Iron Co.



Inexpensively Constructed Gages for inspecting Internal and External Measurements



Hand Screw Machine Practice

Third Article Describing the Tooling Equipments Used by the Warner & Swasey Co., Cleveland, Ohio, in Machining Various Parts on Hand Screw Machines

THIS article deals with the tooling equipments provided on various Warner & Swasey hand screw machines for the machining of a part made from German silver, two small brass castings, and two steel forgings. A dimensioned drawing of each part, and a lay-out of the tooling equipment used in the machining is presented, together with illustrations of some of the machines. In following the description of the various steps taken in machining some of the parts, it will be necessary to refer to the illustration showing the dimensioned drawing when reference is made to the surfaces of the work, while the illustration showing the lay-out of the tooling equipment used in chucking must be referred to when reference is made to the cutters, chuck, etc., used in the machining of the part.

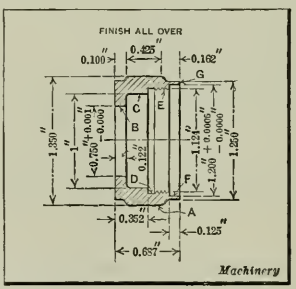


Fig. 1. Drawing of Azimuth Micrometer

Tooling Equipment for Machining Azimuth Micrometers

Fig. 1 shows the drawing of an azimuth micrometer which is used on a panoramic sight. This part is produced from German silver bar stock, 1⅜ inches in diameter. A No. 4 geared friction-head turret screw machine, provided with the tooling equipment illustrated in Fig. 2, is used for the purpose. The part is machined in one chucking which requires 4 minutes. The sequence of the various steps in this chucking are as follows: (1) The stock is fed to the combination stop and starting drill mounted in Face 1 of the turret. (2) A spot is drilled in the end of the stock by the starting drill mounted in Face 1 of the turret. (3) A hole is drilled in the stock by the drill held in the socket mounted in Face 2 of the turret. This hole is drilled to a depth slightly greater than the length of the finished part. At the same time surface *A* is formed by the forged forming cutter *H*, which is held in a tool-block on the rear of the cross-slide. (4) Surfaces *B*, *C*, *E*, and *F* are rough-counterbored by the counterbore held in the plain tool-holder mounted in Face 3 of the turret. (5) Surfaces *B*, *C*, *E*, and *F* are finish-counterbored by the counterbore held in the plain tool-holder mounted in Face 4 of the turret. (6) Recess *D* is turned by cutter *I*, and surface *G* is faced by cutter *J*, these cutters being mounted in the slide-tool held in Face 5 of the turret. (7) Surface *E* is tapped by the tap mounted in the tap- and die-holder held in Face 6 of the turret, which is operated by hand. (8) The completed part is cut from the stock by cutter *K*, which is mounted in a toolpost on the front of the cross-slide. A machine equipped with the tools required in this chucking is shown in Fig. 6. This illustration shows the machine just prior to cutting the completed part from the stock, which is the final step in the operation. The illustration Fig. 3 gives a clear idea of the appearance of the azimuth micrometer at the completion of the machining operations.

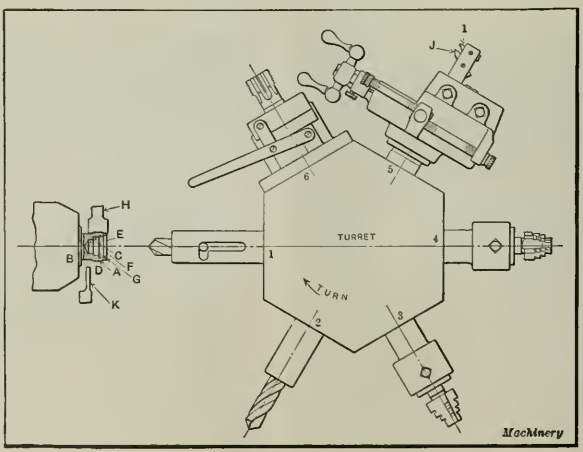


Fig. 2. Tooling Equipment employed in machining Azimuth Micrometer

Machining Brass Elbows for Panoramic Sight

The brass elbow casting which is shown in Fig. 4 is machined as indicated by the heavy lines in Fig. 7, in one chucking on a No. 2 plain-head turret screw machine. This operation requires 3.3 minutes. A lay-out of the tooling equipment with which this machine is provided for the performance of the operation is shown in Fig. 12. The various steps in this chucking are taken in the following succession: (1) The work is mounted on the machine in the special faceplate fixture *I*.



Fig. 3. Azimuth Micrometer

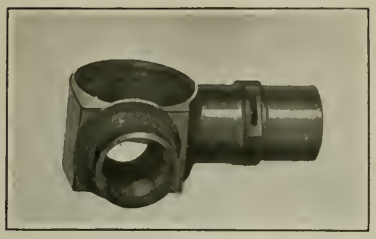


Fig. 4. Elbow for Panoramic Sight



Fig. 5. Rotating Head for Panoramic Sight

(2) Surface *C* is rough-faced by cutter *N* which is mounted on the toolpost on the rear of the cross-slide. (3) Surface *A* is rough-turned and surface *D* is rough-faced by cutter *J;* surface *B* is rough-turned by cutter *K;* surface *C* is rough-faced by cutter *L;* the straight hole in the part is rough-counterbored to the shoulder adjacent to taper surface *H* by counterbore *M*, and surface *H* is rough-bored by this tool. All of these cutters and the counterbore are mounted in the box-tool held in Face 1 of the turret. (4) The straight hole in the part is rough-bored by the cutter mounted in the adjustable boring cutter holder held in Face 2 of the turret. (5) Surface *A* is finish-turned and surface *D* is finish-faced by cutter J_1, surface *B* is finish-turned by cutter K_1; surface *C* is finish-faced by cutter L_1; surface *G* is finish-counterbored and surface *H* is finish-bored by counterbore M_1. All of these cutters and the counterbore are held in the box-tool mounted in Face 3 of the turret. (6) Recess *E* is turned by the cutter mounted in the slide-tool in Face 4 of the turret. (7) Surface *F* is finish-counterbored by the counterbore held in the adjustable tool-holder in Face 5 of the turret. (8) Surface *D* is finish-faced and groove *O* is necked by cutter *P* which is mounted on a toolpost on the front of the cross-slide. (9) Surface *G* is tapped by the tap mounted in the tool-holder held in Face 6 of the turret. (10) The edge of surface *C* adjacent to surface *B* is rounded slightly by means of a file. (11) The part is removed from the machine. This completes the series of operations on the brass elbow, leaving it in the condition shown in Fig. 4.

Fig. 13 shows a machine equipped with the tools required in machining this part, the photograph being taken at the completion of the operation. At the time that this machine was photographed the boring cutter shown in Face 2 of the turret, Fig. 12, was used prior to the tools mounted in the box-tool in Face 1 of the turret, and, of course, the photograph shows these tools in the positions in which they were used at that time. This tooling arrangement, however, has since been modified as shown in Fig. 12.

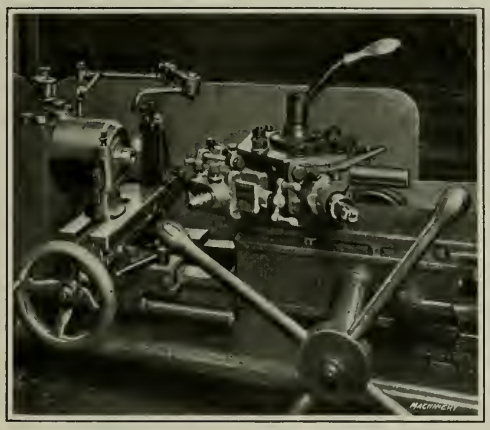


Fig. 6. Machine engaged in Final Operation on Part shown in Fig. 1

Tooling Lay-out Provided for Machining Rotating Heads

A rotating head used on the same instrument as the two pieces, the machining of which has been described in the foregoing, is shown in Fig. 5. This part is also a brass casting and is finished as indicated by the heavy lines in Fig. 8, in 3 minutes. A No. 4 geared friction-head turret screw machine, provided with the tooling lay-out illustrated in Fig. 10, is employed in machining this part. The successive steps in the chucking are as follows: (1) The work is mounted in the faceplate fixture *G*, which is especially provided for the purpose. (2) Surfaces *F* and *A* are rough-counterbored by counterbore *H;* surface *B* is turned by cutter *I*, and surface *C* is rough-faced by cutter *K*, both of these cutters and the counterbore being mounted in the box-tool held in Face 1 of the turret. (3) Surface *C* is finish-faced by the cutter mounted in the slide-tool in Face 2 of the turret. (4) Surfaces *A*, *E*, and *F* are finish-counterbored by the counterbore mounted in the adjustable tool-holder held in Face 3 of the turret. (5) Recess *D* is bored by the cutter held in the

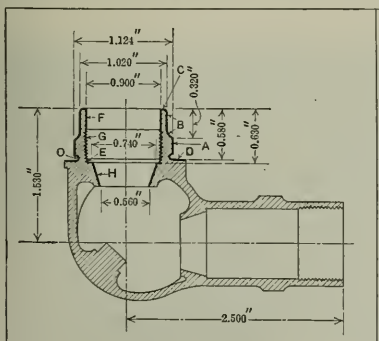


Fig. 7. Drawing of Brass Elbow shown in Fig. 4

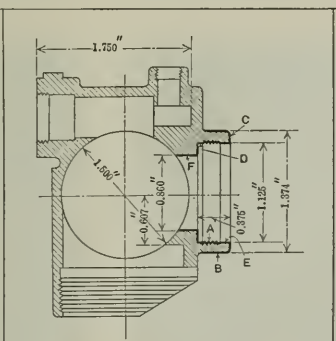


Fig. 8. Drawing of Brass Rotating Head

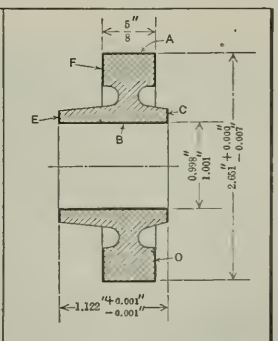


Fig. 9. Drawing of Idler Gear Blank

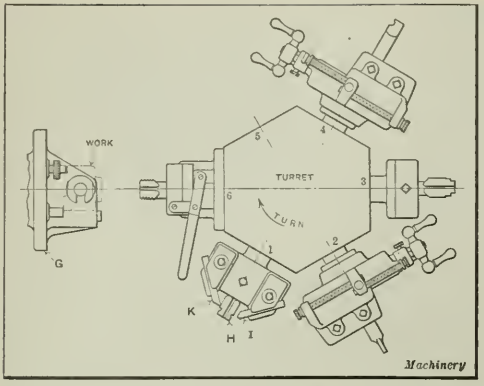


Fig. 10. Equipment for finishing Rotating Head for Panoramic Sight

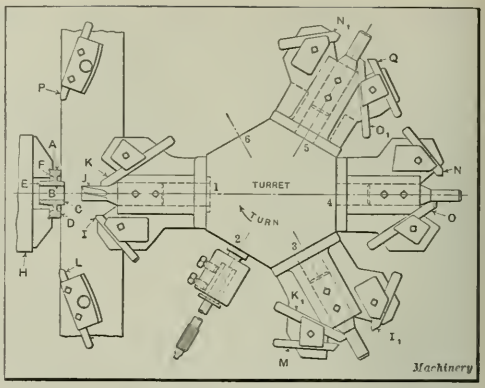


Fig. 11. Tooling Equipment employed in Operations on Idler Gear

slide-tool mounted in Face 4 of the turret. (6) Surface *A* is tapped by the tap held in the hand-operated tap- and die-holder mounted in Face 6 of the turret. (7) The machined casting is removed from the chuck. The machine employed in producing this part is shown in Fig. 14, this illustration showing the turret in position for performing the tapping operation.

Equipment Used in Finishing Idler Gear Blanks

The idler gear blank shown in Fig. 9 is a steel forging which is finished as indicated by the heavy lines. Two chuckings are really required to machine this part, although only one machine is used for both chuckings, and all of the tools required for these chuckings are mounted in the turret at the same time. The first chucking consists of machining surfaces *B*, *C*, and *D* and a portion of surface *A*. The gear blank is then placed in a reverse position in the chuck and surfaces *E* and *F* and the remainder of surface *A* are machined. A No. 4 geared friction-head turret screw machine is used for finishing this gear blank. This machine is equipped with the tools shown in Fig. 11. The time required for both chuckings is 5 minutes.

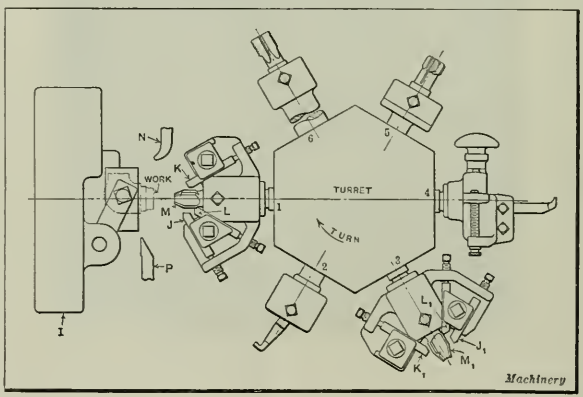


Fig. 12. Tool Lay-out provided for machining Brass Elbow used on Panoramic Sight

The various steps in the first chucking are taken in the following procedure: (1) The work is placed in chuck *H* with the short hub toward the turret. The chuck has three jaws which grip the work along a portion of surface *A*. (2) Surface *A* is rough-turned in front of the jaws by cutter *I*; hole *B* is rough-bored by cutter *J*; and surface *C* is rough-faced by cutter *K*, all of these tools being held in the box-tool mounted in Face 1 of the turret. (3) Surface *D* is rough-faced by cutter *L* which is held in the toolpost on the front of the cross-slide. (4) Hole *B* is reamed by the expansion reamer mounted in Face 2 of the turret. (5) Surface *A* is finish-turned to the chuck jaws by cutter I_1; surface *C* is finish-faced by cutter K_1; and surface *D* is chamfered by cutter *M*, these cutters being mounted in the box-tool held in Face 3 of the turret. This box-tool is provided with a pilot which enters hole *B* of the work during this step in order to insure concentricity of the blank rim with the hole. (6) The work is removed from the chuck and then replaced with the long hub toward the turret, preparatory to taking the steps in the second chucking. The chuck jaws now grip

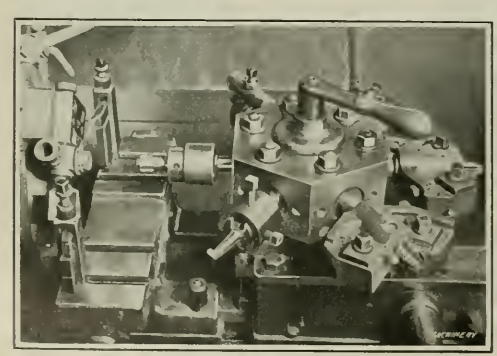


Fig. 13. Set-up of Machine used in finishing Brass Elbow, Fig. 4

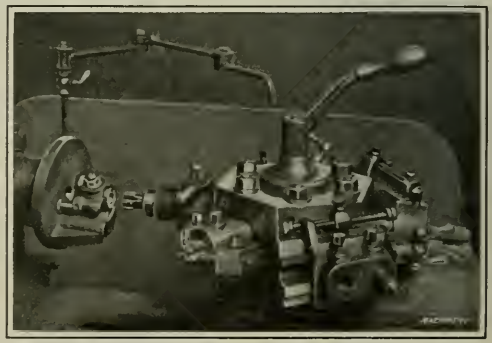


Fig. 14. Machine used in finishing Rotating Head illustrated in Fig. 5

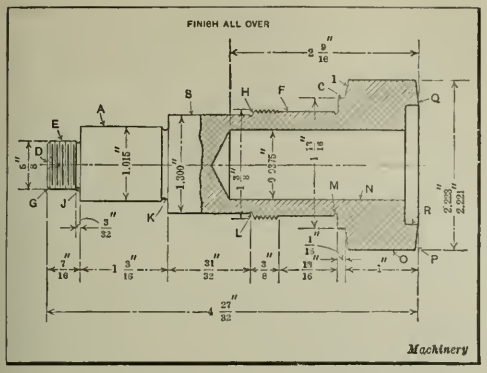


Fig. 15. Dimensioned Drawing of Steel Forging finished in Two Chuckings

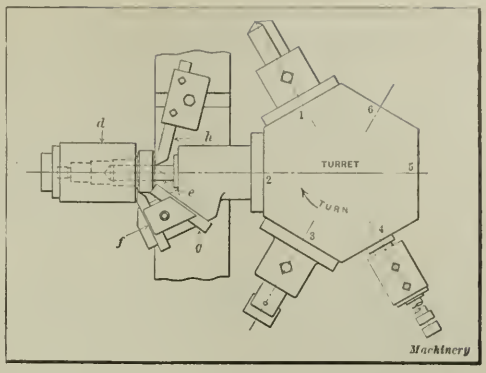


Fig. 16. Equipment for Performance of Second Operation on Steel Forging

the portion of surface *A* of the forging that was finished in the series of operations that comprised the first chucking.

The successive steps in the second chucking are as follows: (1) The remainder of surface *A* is rough-turned by cutter *N*, and surface *E* is rough-faced by cutter *O*, these cutters being mounted in the piloted box-tool held in Face 4 of the turret. (2) Surface *F* is rough-faced by cutter *P*, which is mounted in a toolpost on the rear of the cross-slide. (3) Surface *A* is finish-turned by cutter N_1; surface *E* is finish-faced by cutter O_1; and surface *F* is chamfered by cutter *Q*, these cutters being mounted in the piloted box-tool held in Face 5 of the turret. (4) The gear blank, which has now been completely machined, is removed from the screw machine.

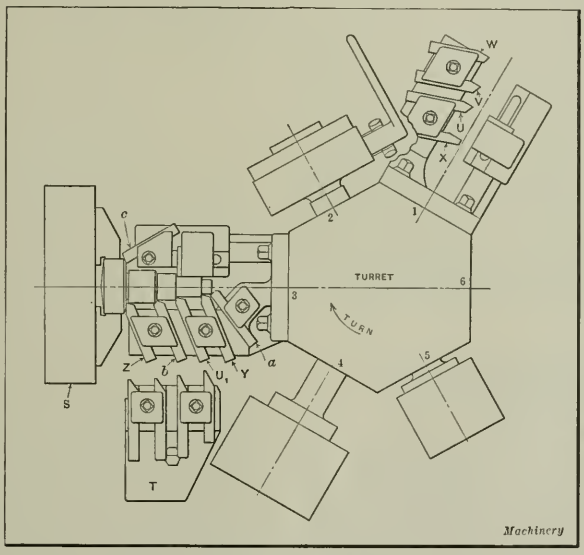


Fig. 17. Lay-out of Tools required in First Chucking on Part shown in Fig. 15

Chuckings Required in Machining a Drive Shaft

The forged steel drive shaft illustrated in Fig. 15 is finished all over in two chuckings performed on No. 4 geared friction-head turret screw machines. The total time required for these chuckings is 9¾ minutes. A lay-out of the tools provided on the machine used in the first chucking is shown in Fig. 17. This operation is performed in 4¾ minutes, the various steps in the operation being taken in the following order: (1) The work is placed in the three-jaw chuck *S* with surface *D* toward the turret, the jaws of the chuck gripping the work around surface *O*. (2) Surface *A* is turned by cutter *U*; surface *B* is turned by cutter *V*; surface *C* is turned by cutter *W*; and surface *D* is faced by cutter *X*; these cutters are mounted in the box-tool held in Face 1 of the turret. (3) A center is drilled in end *D* by the center drilling tool mounted in Face 2 of the turret. (4) Surface *E* is turned by cutter *Y*; surface *A* is turned by cutter U_1; surface *F* is turned by cutter *Z*; chamfer *G* is turned by

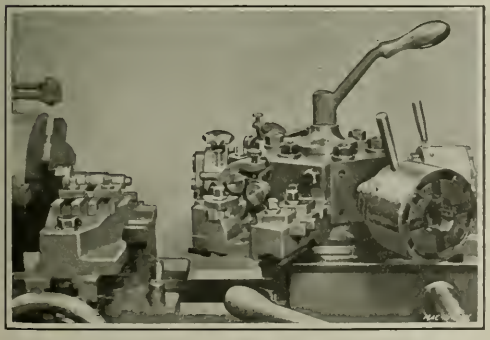


Fig. 18. Machine employed for the First Chucking on Steel Forging

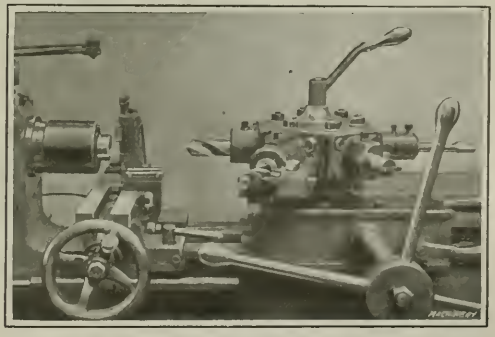


Fig. 19. Set-up of Machine used in Second Chucking on Steel Forging

cutter *a;* chamfer *H* is turned by cutter *b;* and chamfer *I* is turned by cutter c. These cutters are all mounted in the box-tool held in Face 3 of the turret. (5) Grooves *J*, *K*, *L*, and *M* are necked by the four cutters held in tool-block *T* which is mounted on the front of the cross-slide. (6) Part of surface *F* is threaded by the chasers held in the self-opening die-head mounted in Face 4 of the turret. (7) Surface *E* is threaded by the chasers held in the self-opening die-head mounted in Face 5 of the turret. (8) The piece is removed from the chuck. Fig. 18 shows a machine equipped with the tools required for this chucking. The photograph was taken just prior to the removal of the work from the machine.

The second chucking on the steel forging is performed in 5 minutes. The machine used in this chucking is equipped with the tool lay-out shown in Fig. 16. The successive steps in this chucking are as follows: (1) The work is placed in the special collet chuck *d*, the portion of the work finished in the preceding operation being inserted in the chuck, and the collet surfaces tightening on surface *F*. The small end of the work is supported by means of a center in the chuck which enters the center previously drilled in end *D*. (2) A spot is drilled in the center of the forging by the drill mounted in the holder held in Face 1 of the turret, preparatory to the drilling of hole *N*. (3) Hole *N* is drilled to the reaming size by drill *e;* surface *O* is turned by cutter *f;* and chamfer *P* is turned by tool *g;* these cutters and drill *e* are mounted in the box-tool held in Face 2 of the turret. At the same time surface *Q* is faced by cutter *h* which is mounted in a toolpost on the rear of the cross-slide. (4) Surface *R* is counterbored by the double-edged flat cutter mounted in the holder in Face 3 of the turret. (5) Hole *N* is reamed by the reamer held in the floating tool-holder mounted in Face 4 of the turret. (6) The finished forging is removed from the machine. Fig. 19 shows a machine provided with the tooling equipment employed in this second chucking on the forging. This photograph was taken with the turret in position for performing the second step in the chucking.

* * *

INCREASING PRODUCTION BY TEAMWORK

The constant aim toward increased production has resulted in the development of numerous machine tools that undouhtedly accomplish the purpose for which they were intended. Different methods of arranging the machines used in the various operations on a part are also constantly being developed in order to obtain the highest possible rate of production. The various machines used in the production of a part should be so grouped that no time and labor are consumed by the unnecessary transportation of the work between machines. Often when the work is of considerable size the operations can be so timed and so arranged that upon the completion of one operation on a part the same part can be almost immediately placed on the next machine for the succeeding operation. This eliminates the accumulation of much partially completed work about the various machines, and permits the operators of the machines and other workmen to make a united effort toward lessening the production time.

The following examples will illustrate the methods of arranging the machines and men in an automobile plant in order to obtain this teamwork. The diagram accompanying this article shows the installation of the bench and machines used in several operations on malleable-iron differential cases. The operations consist of drilling three holes 5/8 inch in diameter and 3/4 inch deep; eight tap holes 21/64 inch in diameter and 1½ inches deep; and eight flange holes 5/16 inch in diameter and 3/8 inch deep. The work is placed in jigs for the performance of the operations, and the bench is provided to facilitate the loading and unloading of these jigs. A team of six men and three machines are used in the performance of these operations. The small circles in the diagram represent the positions of the men at the bench and machines, and the dotted lines indicate the path of the work during the several operations, while the arrows show the direction of travel of the work.

The men at the right and left ends of the bench load the jigs, and as fast as they are loaded they are given to the operators of the three-spindle drilling machines where the three 5/8-inch diameter holes are drilled. When this operation is completed, the jigs pass to the multiple-spindle drilling machine where the other sixteen holes are drilled. This operation is done in one-half the time consumed in loading a jig or in drilling the three 5/8-inch holes in one piece of work, and so two pieces of work can be machined on the multiple-spindle drilling machine in the same time that is consumed in performing either of these two previous operations. This eliminates the accumulation of much work about the machines and renders unnecessary the large number of jigs which would be otherwise required unless the work were unloaded after each operation. After the operation is performed on the multiple-spindle drilling machine, the jig is sent to the man at the center of the bench who unloads the work. This operation can also be accomplished in one-half the time required in loading, so that this workman is enabled to maintain the rate of production accomplished by the machines and the other workmen. The experience of the

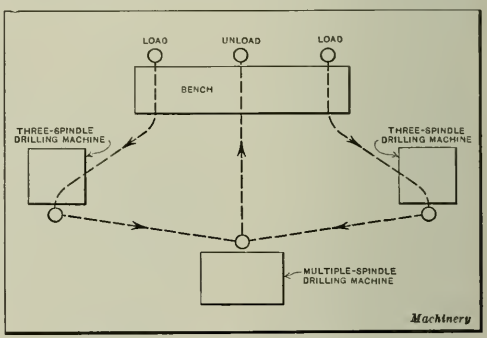


Diagram of Method of grouping Men and Machines to obtain Teamwork

firm using this scheme was that by grouping the men in teams of this sort, cooperation was obtained and the production materially increased. Of course, with this arrangement it is necessary to have someone working in the immediate vicinity of this group who is competent to perform any of the operations when any member of the team desires to be temporarily relieved. This emergency man should be employed in doing some sort of bench or other work which will not require another machine to become idle by his temporary absence from his regular job.

A similar teamwork scheme is used in the department that assembles the gears and spider employed in the differential cases, rivets these parts together, and tests and inspects the rivets. By means of this team the rate of production formerly obtained by twelve men is now accomplished by nine. The duties of the various men in this team are as follows: Man No. 1 files the burrs; No. 2 assembles the differential gears on the cross-piece and oils them; No. 3 assembles the various parts with four temporary loose bolts; No. 4 sets up these bolts with a power stud-setter; No. 5 gives the bolts a preliminary test; No. 6 loosely puts the rivets into the four remaining holes; and No. 7 welds these rivets. The work is then returned to No. 6, who removes the four bolts and replaces them with rivets, after which No. 7 also welds these rivets. The work is then returned to No. 5 who gives the rivets a final inspection and passes it on to No. 8 who puts on a locking clip. No. 9 selects the driving-shaft pinion to be used with this unit and secures it to the unit by wire in order to prevent it from becoming mislaid.

THE DESIGN OF FORGED HAND-LEVERS

By JOHN S. WATTS

The accompanying chart gives data for a series of forged hand-levers from which all dimensions for levers up to 11 feet 9 inches in length can be derived. Levers made to these dimensions, although not over the average weight, will be found strong enough to withstand very rough usage, as in their design the material is properly distributed. As a general rule, the designer believes that he ought to be able to design so simple a thing as a hand-lever without any calculation whatever. However, hand-levers made under such conditions are apt to be either ungainly in appearance and too heavily constructed, or, on the other hand, too flimsy. As hand-levers usually occupy a prominent position on the machine, they should be well designed and so proportioned as to satisfy the eye of the critical observer; otherwise they may spoil the general appearance of the whole machine.

A piece of mechanism, be it ever so simple, made on lines that provide strength only where it is needed to fulfill the functions for which it is intended, will give anyone with only a slight mechanical experience the feeling that it "looks good." It should be borne in mind that within certain limits the appearance of fitness depends principally upon the proportioning of the parts to obtain as nearly as possible uniform strength.

In designing a hand-lever, the leverage should be such that the pull to be exerted on it will not be greater than 15 pounds, if the lever is to be operated frequently, and in any case this pull should not exceed 25 pounds. However, it should be remembered that sometimes machines do not function as easily as intended, and therefore there is a probability of a much greater pull being exerted on the lever in order to overcome these conditions. There is also a not remote possibility of some operator putting excessive weight on the lever when it is already in contact with its stop. To take care of these possibilities, the accompanying chart has been made up on the basis that the hand-levers may have to withstand a pull of 150 pounds, at which pull the stress must not be greater than 6600 pounds per square inch. At this low unit stress, a lever designed according to the specifications of the chart will stand up under any jerking and shocks it could reasonably be expected to be subjected to without vibrating or bending. The maximum pull being thus determined, the dimensions of a standard handle for the end of the lever can be calculated, and since the strain here is the same for all lengths of levers, it is evident that the handles can all be made the same size.

The section of the lever near the shaft end is calculated from the formula for cantilevers with concentrated load, taking 150 pounds as the maximum pull and with H in all cases equal to $W \div 4$, this proportion giving a section as light as possible without sacrificing the necessary stiffness to prevent sidewise deflection. The shaft diameter D given in the chart is that diameter which will carry the torsional moment of 150 pounds times the length of the lever, at a stress of 6600 pounds per square inch, and should be considered as the minimum diameter of the shaft.

In some cases, this shaft may need to be larger than called for on the chart on account of some other strain coming upon it at another point, and this increase in diameter can be made without increasing the diameter of the boss so long as the section of metal around the hole within the boss, as indicated by dimension T, is not less than ¼ inch through at any point. If, to take a larger shaft, the diameter of the boss must be increased, it need only be made equal to $D + \frac{1}{2}$ inch. This part of the lever will then be equal in strength to the rest of the lever as the modulus of section of the boss through which the hole passes will in all cases equal the modulus of section of the rectangle which is W inches long and H inches wide.

To facilitate forging, the boss is made of the shape shown in the sketch instead of being made circular. The width B of the boss is so calculated that the shearing strength of the key will be equal to the torsional strength of the shaft at the unit stress produced by a pull of 150 pounds. The torsional strength of the shaft equals $\frac{\pi}{16} D^3 \times f$ and the shearing strength of the key equals $B \times \frac{D}{4} \times f$. In these equations, f is the unit working stress and $\frac{D}{4}$ the width of

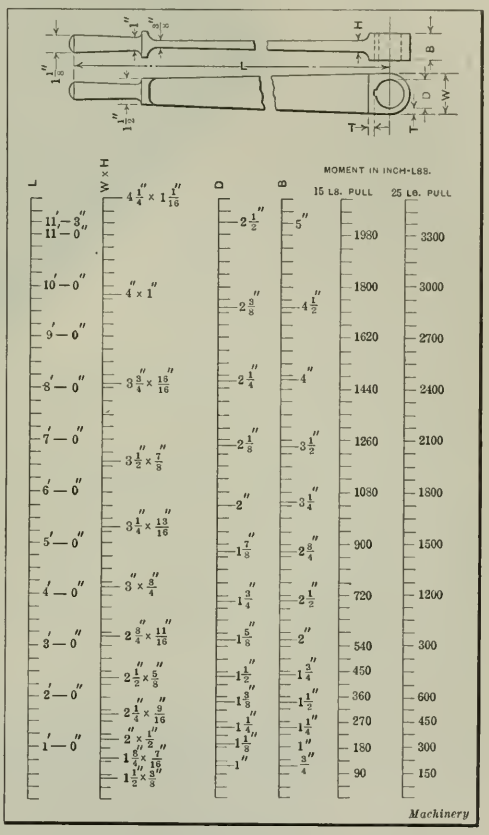


Chart giving Dimensions of Hand-levers, in which a Pull of 150 Pounds on the Handle is provided for

the key. As the torsional strength of the shaft and the shearing strength of the key are to be equal

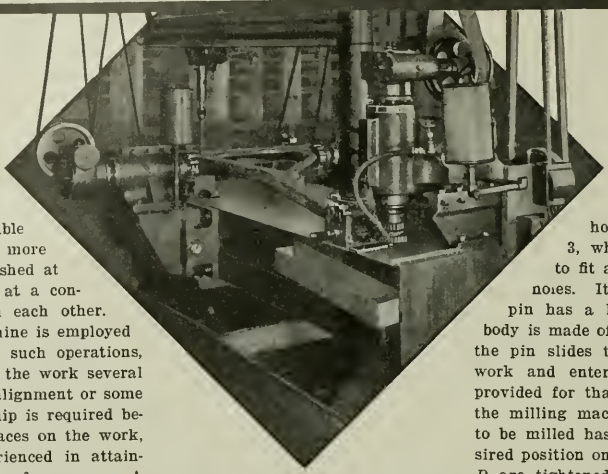
$$B \times \tfrac{1}{4} D \times f = 1/16\ \pi D^3 \times f$$

Therefore

$$B = \frac{1/16\ \pi D^3}{\frac{1}{4} D} = \frac{\pi}{4} D^3$$

The two columns at the right in the chart show the moment of the force at the center of the shaft that the various lengths of levers will produce at a pull of 15 and 25 pounds respectively. To use the chart, follow along the horizontal line for the torsional moment required and read directly the width of the boss B, the diameter of the shaft D, the section $W \times H$, and the length of the lever required to give this moment. For example, if a lever is required to give a torsional moment of 1500 inch-pounds, with a pull on the handle of 25 pounds, B will be 3¼ inches, the shaft will be 2 inches in diameter, the section of the lever will be 3¼ inches × 13/16 inch, and the length, 5 feet.

Special Multiple-Spindle Milling Machines



Milling Machines Designed to Fulfill Unusual Requirements in Quantity Production

IT is often necessary to machine castings of considerable size on which two or more surfaces have to be finished at points that are located at a considerable distance from each other. If a single-purpose machine is employed for the performance of such operations, it is necessary to reset the work several times; and if accurate alignment or some other definite relationship is required between the finished surfaces on the work, difficulty may be experienced in attaining the required degree of accuracy. A typical example of such a piece of work is shown in Fig. 1, which illustrates the sight yoke for a naval gun mount. Among the operations that must be performed on this part are the finishing of surfaces *A* and *B* at one end of the yoke, and of surfaces *C*, *D*, *E*, and *F*, and slot *G*, at the opposite end. According to the method of machining these castings, which was developed by the Illinois Tool Works, 154 E. Erie St., Chicago, Ill., a special milling machine was designed and built to provide for simultaneously machining all of the surfaces to which reference has been made. The machine used for this purpose is illustrated in Fig. 2, while Figs. 3 and 5 show the arrangement of milling cutters to provide for performing the required operations at opposite ends of the work.

In designing a machine of this kind, an important feature is to arrange the cutting tools and clamping mechanism in such a way that the thrust of the tools will not only be balanced as nearly as possible, but that the work will also be so firmly supported that there will be no danger of deflection. In the event of strains being set up in the work, it will be quite evident that although the tools may be set to produce pieces having the required dimensions, the work will spring back to its normal position after being relieved of the thrust of the tools, thus resulting in the production of parts which will differ from specified dimensions by an amount exceeding the permissible limits of tolerance. It will be seen in Fig. 2 that there are two cutter-heads *A* and *B* carried by parallel slides at opposite sides of the machine, to provide for milling the surfaces marked *A* and *B* in Fig. 1. At the opposite end of the machine, there is a cutter-head carried by a slide working at right angles to the other two. A vertical spindle is carried by this head, which is equipped with a gang of five milling cutters *C*, to provide for machining the slot *G* and the four finished faces adjacent to this slot, as indicated in Fig. 1. The arrangement of these cutters will be better understood by referring to Figs. 3 and 5, which show the method of tooling in more detail.

Method of Setting up the Work

In order to provide a locating point from which the different surfaces to be finished on these gun sight yokes may be located in the proper relationship to each other, a practice is made of first drilling and reaming a hole to receive pin *C*, Fig. 3, which is carefully ground to fit accurately in the reamed holes. It will be seen that this pin has a knurled handle, and its body is made of sufficient length so that the pin slides through the hole in the work and enters a corresponding hole provided for that purpose in the bed of the milling machine. After the casting to be milled has been located in the desired position on the machine bed, straps *D* are tightened on two corners of the work, and a clamp shown in Fig. 5 provides for bolting down the opposite end of the casting. It will be seen that this clamp consists of two pivoted straps *E* which drop into notches cut in the end block of the clamp, after which knurled-head screws *F*, which are also mounted on pivoted supports, are swung up into the notches cut in straps *E*, and then tightened to hold these straps down. Each strap *E* is furnished with a set-screw *G* which is tightened down on the end of the casting to hold it firmly during the performance of the milling operation. It will be obvious from Fig. 5 that the reason for adopting this form of clamping mechanism is that clearance must be afforded for the gang of milling cutters which are used for finishing the four surfaces and the slot that have to be milled on the casting. A radial drilling attachment on the milling machine, which is clearly shown in Fig. 2 drills and reams the hole for the locating pin shown at *C* in Fig. 3. A pin placed in this hole is also used to locate the work while performing many of the subsequent machining operations.

Design of the Milling Machine

From the preceding description, it will be apparent that each of the cutter-heads which provides for milling either of the faces marked *A* and *B* in Fig. 1, is mounted on a slide to allow the cutter to be fed along the work for the required distance, to perform the facing operation. At the opposite end of the machine, the cutter-head which mills faces *C*, *D*, *E*, and *F*, and slot *G* is carried by a transverse slide which provides means of feeding the cutters through the relatively short distance that it is required to travel. Attention is called to the fact that individual belt drives are employed to transmit power from overhead countershafts to the milling spindle and to the feed mechanism of each cutter-head. In order to provide for obtaining the desired results in performing repetition milling operations, several interesting features of design were developed in connection with both the feed and driving mechanisms on this machine. These features will be best understood by referring to Figs. 4 and 6, which show the arrangement of the feed mechanism and the spindle driving mechanism, respectively.

Referring first to the illustration of the feed mechanism shown in Fig. 4, the driving pulley will be seen at *A*. From

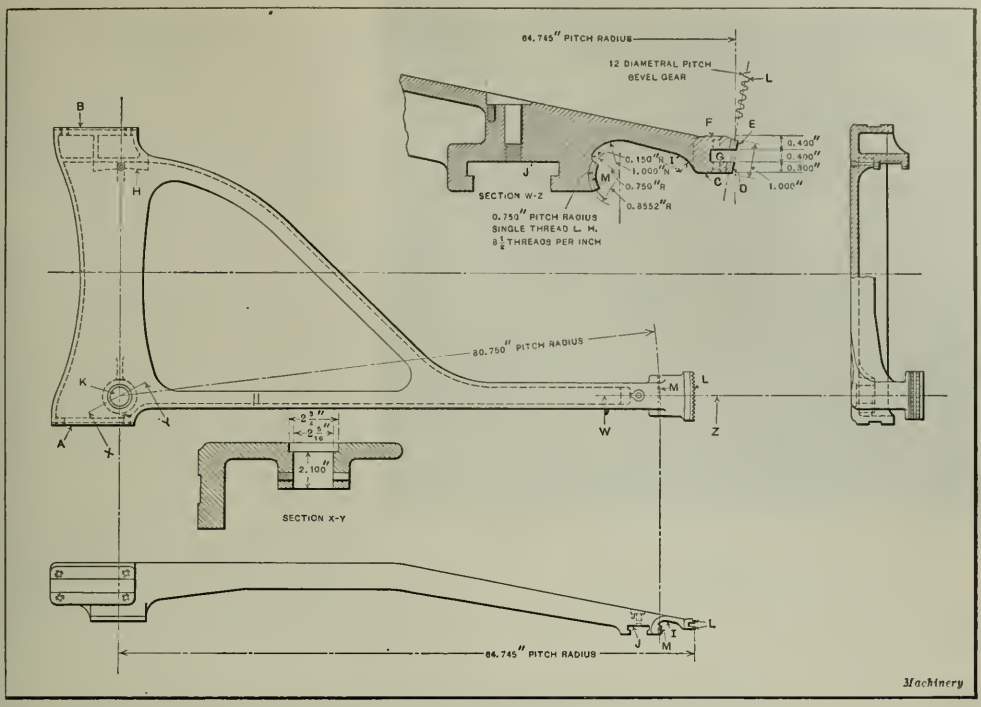


Fig. 1. Naval Gun Sight Yoke of the Type on which Milling Operations have to be performed

this pulley, motion is transmitted to a screw *B* that provides for traversing the cutter-head along a slide on the bed of the milling machine. An interesting form of mechanism has been adopted to provide for the transmission of the desired feed movement from pulley *A* to screw *B*. The pulley is loosely mounted on the extended end of the screw; and this pulley has a pin *C* mounted in it, on which there is carried a pinion *D*. This pinion has sufficient face width so that it comes into mesh with two gears *E* and *F*, gear *E* being connected to feed-screw *B*, while gear *F* is loosely mounted on the screw, although it is prevented from rotating by means of a pin *G*. As pulley *A* revolves, pin *C* carries pinion *D* around with the pulley, this pinion being caused to revolve through its engagement with the fixed gear *F*. Gear *F* has one more tooth than gear *E*, and as a result of this difference in the number of teeth, the screw is made to rotate through an angle corresponding to one tooth space for each revolution of pulley *A*. Through the operation of this "purchase gear" or "hunting tooth" arrangement, the desired reduction of speed is secured between the rotation of pulley *A* and that of feed-screw *B*.

The cutters which mill faces *A* and *B* (Fig. 1) act simultaneously on opposite sides of the work; and the two spindles rotate in the same direction, which makes it necessary to use one right- and one left-hand cutter. With such an arrangement, no torsional strain is developed in the work. Furthermore, the cutters are arranged so that their pressure is directed downward, thus tending to press the work down on the table of the machine and making it unnecessary to apply a clamping force that is sufficiently heavy to be liable to spring the work out of shape. Endwise pressure of each cutter counteracts the pressure of the opposite cutter, and in this way danger of the work shifting its position is practically eliminated. After a cut has been completed, the slide on which the cutter-head is mounted is returned at a high rate of speed through the medium of a hand-operated crank.

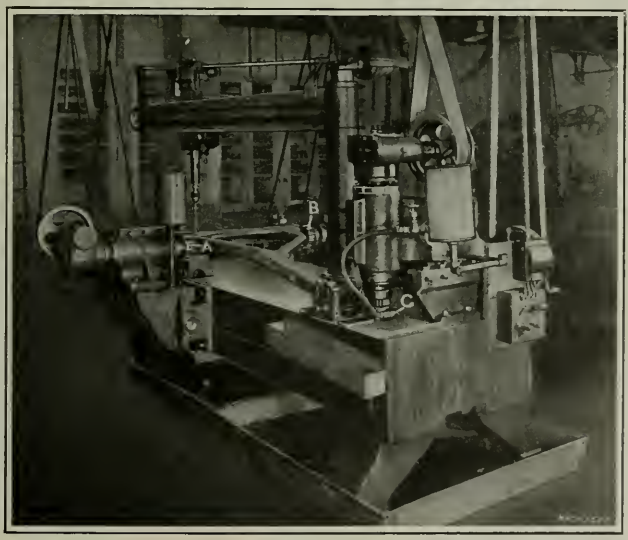


Fig. 2. Special Multiple-spindle Milling and Radial Drilling Machine, for milling Faces A to G Inclusive, and drilling Hole K, Fig. 1

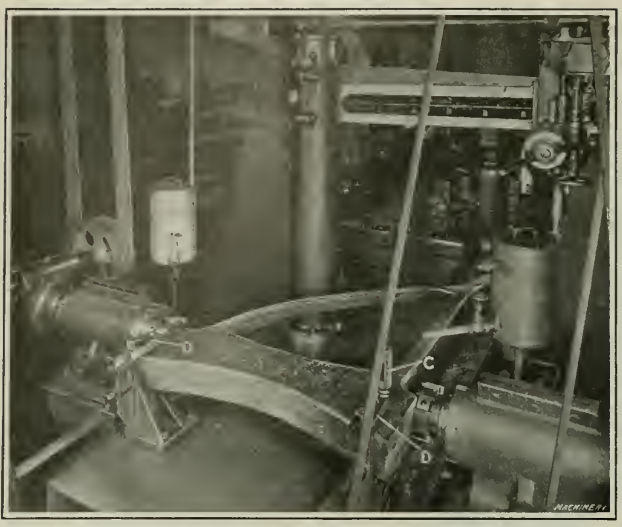


Fig. 3. Close View of Cutters set up on Multiple-spindle Milling Machine shown in Fig. 2, which mill Faces A and B, Fig. 1

Arrangement of the Spindle Driving Mechanism

In working out the design of the cutter-heads for this milling machine, it was necessary to furnish means for obtaining a longitudinal adjustment of the spindle, in order to provide for obtaining exactly the required distance between finished faces *A* and *B* on the work which is shown in Fig. 1. Such adjustment was made possible by having the spindle bearings *A*, Fig. 6, mounted in a sleeve *B*, the position of which may be adjusted in the cutter-head. It will be noticed that each end of the sleeve *B* is threaded and furnished with a pair of lock-collars *C* which abut against the opposite ends of the cutter-head housing. When longitudinal adjustment of the spindle must be made, which is only necessary at infrequent intervals, this is accomplished by first loosening lock-collars *C* and then turning pinion *D*, which meshes with a rack secured to the side of sleeve *B*. When the required position has been obtained, lock-collars *C* are again tightened to lock both the sleeve and the cutter-spindle in exactly the required position. The spindle is driven by a worm and worm-wheel.

It will be evident that there is nothing unusual about the method of driving the spindle or of holding the cutter in a tapered socket bored in the spindle nose. Power is transmitted to the spindle through a worm and wheel shown at *E*, and it will be noticed that the cutter is held in place on the spindle nose by the familiar arrangement of a pull-rod which is manipulated by means of a hex-head nut *F*. At the opposite end of the machine, the cutter-head carries a vertical spindle provided with the same means of vertical adjustment, and essentially the same form of drive as that used for the horizontal spindles. The arrangement of the feed mechanism is also identical, to all intents and purposes, so that a detailed description is uncalled for.

Multiplex Radial Milling Machine

After the machine shown in Fig. 1 has performed the milling operations which have been referred to in the preceding description, the gun sight yoke is transferred to a second multiplex milling machine shown in Fig. 7. This may properly be termed a "radial" milling machine, as it was designed to afford a means of simultaneously milling three curved surfaces on the work. Referring to Fig. 1, the surfaces that are finished on this milling machine are shown at *H*, *I*, and *J*, respectively. It will be seen from this illustration that surfaces *I* and *J* not only conform to two different radii of curvature, but they are also formed, thus requiring the use of special form cutters. To provide for the performance of these three operations at a single setting of the work, the milling machine was so designed that the gun sight yoke casting is pivoted on the machine by means of a push-pin which projects through hole *K* (which was drilled and reamed at the preceding setting of the work) and held in

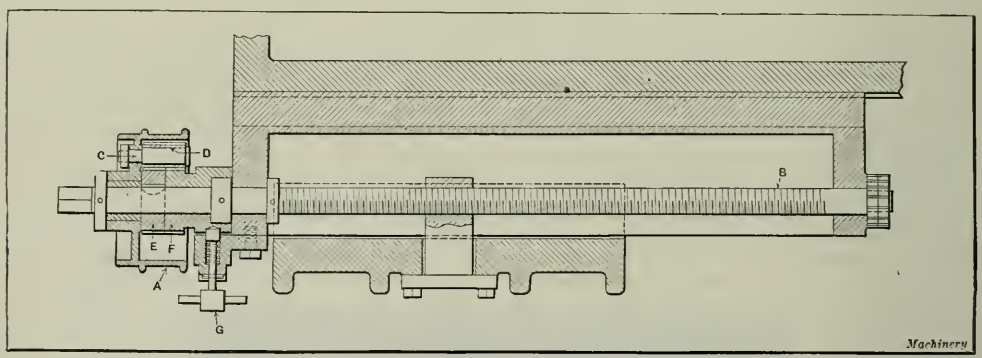


Fig. 4. Arrangement of Differential Gears for transmitting Power from Driving Pulley to Feed-screw

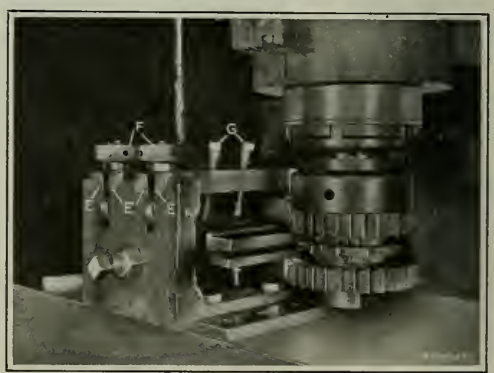


Fig. 5. Close View of Opposite End of Work shown in Fig. 3, and Cutters which mill Faces C, D, E, and F, and Slot G, Fig. 1

such a way that the yoke swings about this pivotal support. Swinging the work past the three milling cutters provides for finishing the surfaces to the specified radii of curvature.

The best idea of the way in which these three curved surfaces are simultaneously milled will be gathered by referring to the illustrations of the machine shown in Figs. 8 and 10. First considering the method of setting up the work, attention is directed to Fig. 8, where it will be seen that the push-pin *A* provides a pivotal support, about which the casting is swung. On the machine there is a fixture *B* in which the casting is held by clamps *C* at the three corners; and both this fixture and the casting carried by it are pivoted on pin *A*, which projects down through them into a hole in the machine bed. The under side of the fixture is finished to slide on finished bearing surfaces provided on the top of the machine, and the swinging movement about pin *A* is accomplished by means of a feed-screw.

The feed-screw, shown in the foreground in Fig. 10, is driven by a belt from an overhead shaft, and in order to provide the required reduction of speed from the driving pulley to the feed-screw, a differential gear transmission is employed, which is of similar design to the one which was described in connection with Fig. 4. The feed-screw runs in a nut mounted on the under side of the work-holding fixture, and causes this entire fixture to rotate about its pivotal support in the manner which has already been described. The same form of drive is provided to the spindles of each of the cutter-heads on this machine as those which were described in connection with the machine shown in Figs. 2 to 6, inclusive, and the same method is also employed to provide longitudinal adjustment for the milling spindles. In the present case, however, it will be noticed that the cutter-heads occupy a fixed position on the machine instead of being furnished with a feed movement, as in the machine

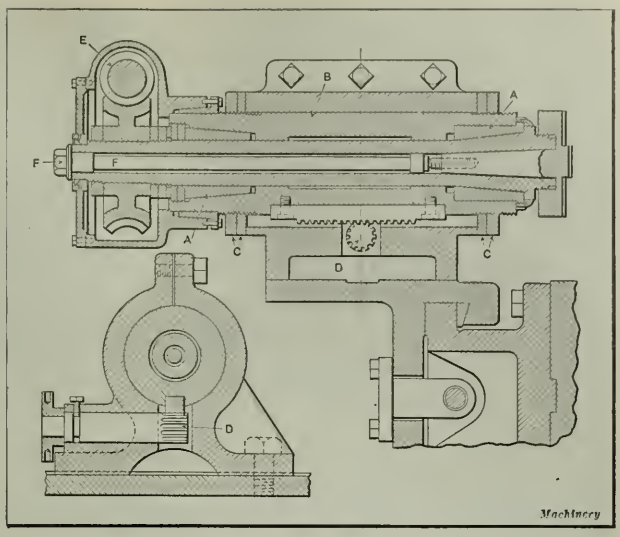


Fig. 6. Construction of Milling Machine Spindle Bearings, showing Method of adjusting Distance between Cutters

used for the performance of the preceding operations on this piece of work.

Combination Gear-cutting and Hobbing Machine

So far as this article is concerned, the final machining operation on gun sight yokes is performed on the machine shown in Figs. 9 and 11. From these illustrations it will be apparent that the casting is set up on this machine and two different attachments are used to provide for cutting the bevel gear teeth *L*, Fig. 1, and for hobbing worm-wheel segment *M*. In setting the casting up for performing the bevel-gear cutting and worm-segment hobbing operations, the hole *K* which was drilled on the first machine is again used as a locating point. A mandrel passes through this hole to locate the work, and the casting is then bolted down to the bed of the machine. The bevel-gear cutting attachment is first set up, as shown at the right-hand side of Fig. 11. This attachment is furnished with a cutter-head which moves on a vertical slide secured to the body of the attachment. The head is fed down by power; and after reaching the bottom of its stroke, the downward feed is automatically tripped, after which the operator returns the head to the starting point by hand.

At the right-hand side of the machine (not shown in the illustration), there is an index mechanism which provides for swinging the casting about its pivotal support in the drilled hole *K*, after the cutter-head has been returned to its starting position, in order to locate the work for cutting the next gear tooth. It will be seen from Figs. 9 and 11 that power for driving the attachment is transmitted from pulley *A* by means of a

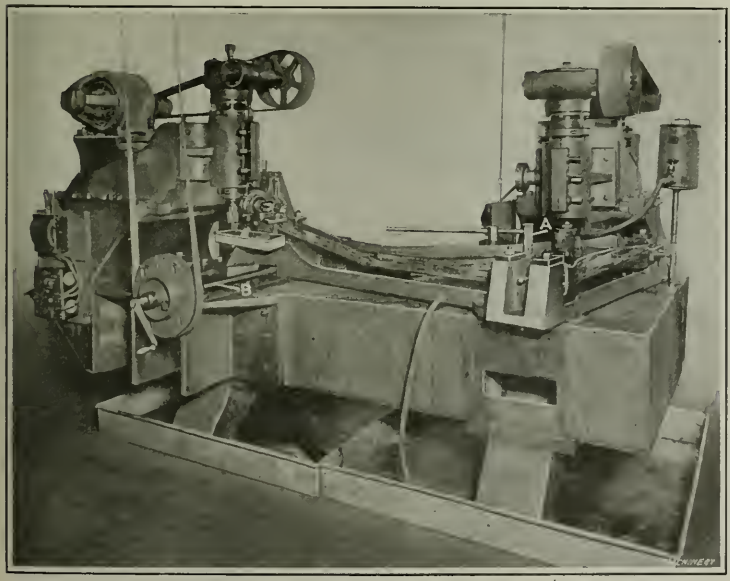


Fig. 7. Multiplex Radial Milling Machine equipped with Form Cutters to mill Faces H, I, and J (as shown in Fig. 1) to the Reqnired Radii of Curvature

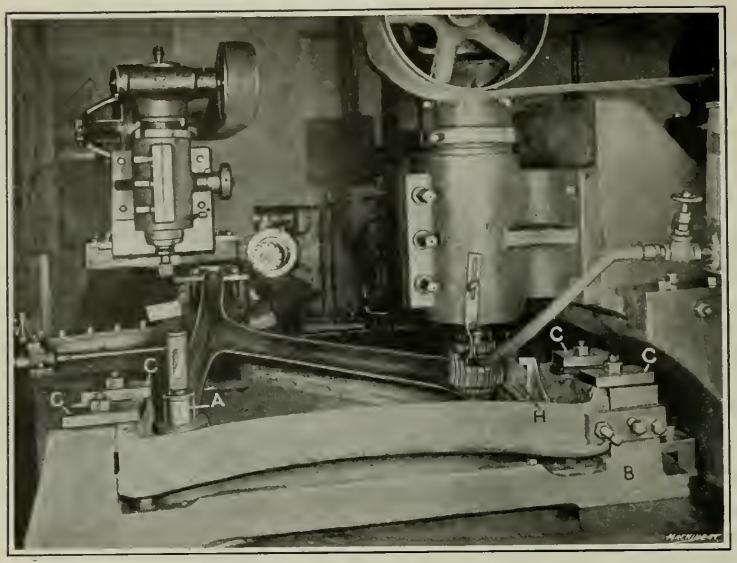


Fig. 8. Close View of Work and Form Cutter milling Face H (Fig. 1), and Pivot A about which Work is swung to control Radii of Curvature of Milled Surfaces

universal jointed rod *B*. From the shaft of the bevel-gear cutting attachment, to which the universal jointed rod *B* is connected, power is transmitted through gearing to the bevel-gear cutter. The small belt *C*, Fig. 11, carries power up to a horizontal shaft and thence through a worm and wheel *D* to the vertical screw that provides for feeding the gear-cutter downward across the face of the bevel-gear segment. After the feed has been tripped, the operator returns the gear-cutter to the starting point by means of handwheel *E*, which is carried at the top of the screw. At this point, the index mechanism is turned to locate the work for cutting the next tooth, after which the power feed movement is once more engaged. By repeating these processes for each of the tooth spaces to be cut, a very satisfactory job of bevel-gear cutting is accomplished.

After the bevel-gear teeth have been cut, the gear-cutting attachment is removed from the machine and the hobbing attachment is set up in its place, to provide for generating teeth of the worm-wheel segment, as shown in Fig. 9. It will be apparent that the same pulley *A* and universal jointed rod *B* that were employed to drive the bevel-gear cutting attachment are used in this case to deliver power to the hobbing attachment. Power is transmitted through gears to a horizontal shaft *E*, and thence through spur gears *F* to a shaft on which there is mounted a worm *G* of the same lead as the worm-wheel segment which is to be generated by hob *H*. Worm *G* runs in mesh with a nut secured to link *I*; and this link is connected by a pivoted intermediate link *J* to the end of the work. Movement imparted to the mechanism by means of worm *G* results in swinging the work about its pivotal support in hole *K*, thus feeding the face of the work in which the worm-wheel segment is to be generated past hob *H*. As a result of this arrangement, worm *G* not only provides for feeding the work past the hob, but it also governs the lead of the teeth which are generated by the hobbing attachment. The hobbing attachment is mounted on a slide which is arranged in such a way that after each traverse of the hob across the worm-wheel segment has been completed, the hob may be withdrawn from the work and returned to the starting point, while the feed-worm is held in engagement with its nut. A reversible countershaft is used to provide for the forward and backward movements of the hobbing attachment. After each successive cut, the hob is fed in slightly nearer to the center of rotation, so that a cut of suitable depth is taken at each traverse across the work until the full depth has been reached.

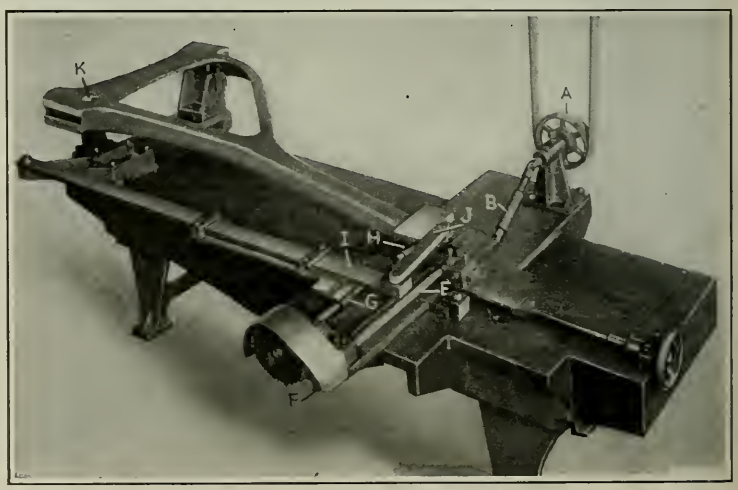


Fig. 9. Combination Bevel-gear Cutting and Worm-wheel Hobbing Machine equipped for generating Worm-wheel Teeth

Simplex Radial Milling Machine

There are many machine shops in which the necessity arises for finishing a piece of work to a "radius," which is the name used by many men in the shop to designate the arc of a circle. Various methods have been employed for the performance of such operations, among which one of the most familiar is to make use of a radius planing attachment. In the manufacture of naval gun sights, it is necessary to mill the sight-bar blank to a specified radius of curvature, after which spur gear teeth are cut in this part. At the plant of the Illinois Tool Works, two interesting special machines were designed and built for the performance of the radius milling operation and of the gear-cutting operation, respectively. Figs. 13 and 14 show the milling machine in operation, and from these illustrations it will be apparent that a form cutter is used, which is built up from a cylindrical cutter and an angular cutter mounted together on the same arbor. The straight part of the cutter is used to mill

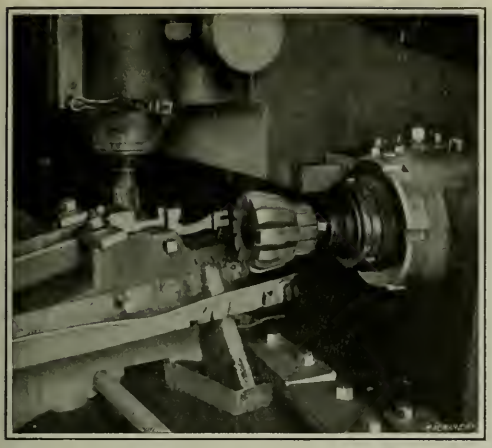


Fig. 10. Close View of Fixture and Work shown in Fig. 8, showing Cutters milling Faces I and J (Fig. 1)

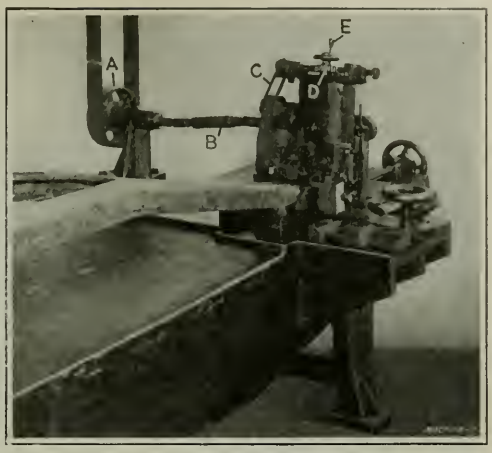


Fig. 11. Combination Bevel-gear Cutting and Worm-wheel Hobbing Machine equipped for cutting Bevel Gear Teeth

the large curved surfaces on the work, and the angular cutter bevels off the upper edge, to reduce the work to the desired form, without requiring the performance of a second operation. It will be seen in Fig. 13 that this machine is provided with a work-holding fixture, having the general shape of the letter T, which is pivoted at *A*. The location of this pivotal support may be adjusted as required, in order to obtain the desired radius of curvature for the milled surface of the work.

To provide for obtaining the required feed movement to traverse the work past the cutter, use is made of the mechanism illustrated in Fig. 12. Here it will be seen that the feed-screw *A* runs in a nut *B*, that is a sliding fit in a guide cut in the bed of the machine. Nut *B* carries a pin *C* that fits into a hole of corresponding size in block *D*. This block slides in a guide *E* cut in the work-holding fixture, so that as the feed-nut is traversed crosswise in its guide, the required radial movement of the block *D* in the slotted work-holding fixture is allowed to compensate for the constant change in the distance of nut *B* from the center of rotation *A* of the work-holding fixture, as nut *B* moves along in its guide. The same form of differential gear mechanism, which has already been described is used for obtaining the required reduction between the speed of the driving pulley and that of the feed-screw.

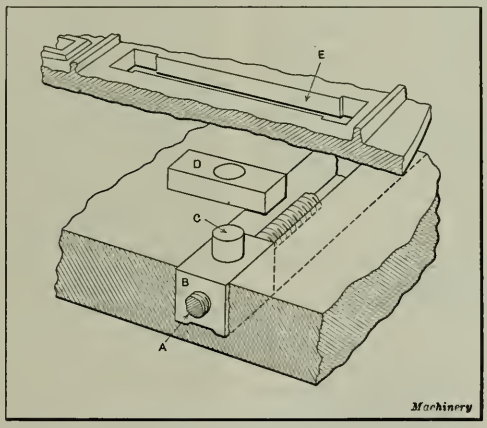


Fig. 12. Details of Design of the Feed Mechanism of the Machine shown in Figs. 13 and 14

Cutting Gear Teeth in Sight Bars

After the gun sight bar has been milled to the required radius of curvature, it is set up on the special milling machine shown in Fig. 15, which provides for cutting the spur gear teeth. As in the case of machines shown in the preceding illustrations, it will be evident that a work-holding fixture is employed in the present instance, which is pivoted to the bed of the machine in order to provide for the utilization of a feed-screw to swing the fixture on its pivotal center, and thus keep the

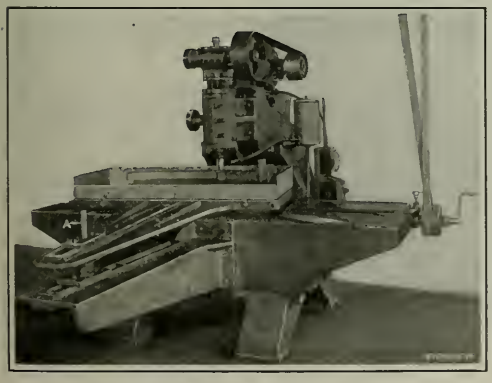


Fig. 13. Simplex Radial Milling Machine milling the "Radius" and beveling the Edge of a Naval Gun Sight Bar

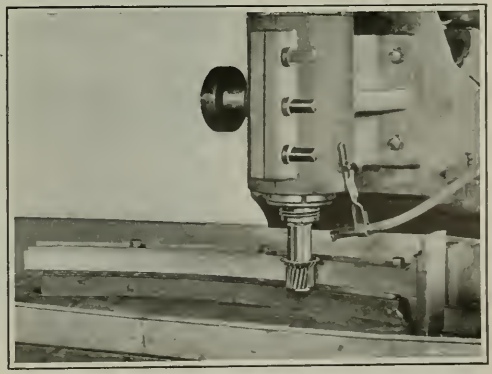


Fig. 14. Close View of the Work and Milling Cutters used on the Radial Milling Machine shown in Fig. 13

curved surface of the work in contact with the gear-cutter. The design of the work-holding fixture and of the feed mechanism is the same as that used on the machine shown in Figs. 12 and 13, which has been fully described. It will be evident that the cutter-head on this machine is carried by a vertical slide, so that the cutter may be fed down across the face of the work. This feed movement is accomplished by means of a belt which runs over pulley *A*. At the bottom of the downward feed movement, an automatic trip disengages the power feed and allows the operator to return the cutter to the starting point by turning crank *B*, which is mounted at the top of the feed-screw. Then it is necessary to index the work ready for taking the next cut, and this is done by turning crank *C*, which rotates a worm that runs in mesh with the segment gear *D* that is of the same pitch as the gear to be cut. Turning crank *C* through a half revolution allows the index-pin to enter hole *E;* in other words, half a turn of crank *C* is responsible for moving the work through an interval corresponding to one tooth space. This cycle of feed movements for the cutter-head and index movements of the work must be repeated as many times as there are teeth to be cut in the segment gear. In cutting these teeth, a roughing and finishing cut are taken. During the roughing operation, three teeth are cut for each downward movement of the tool-slide; but where finishing, only one tooth is cut at a time.

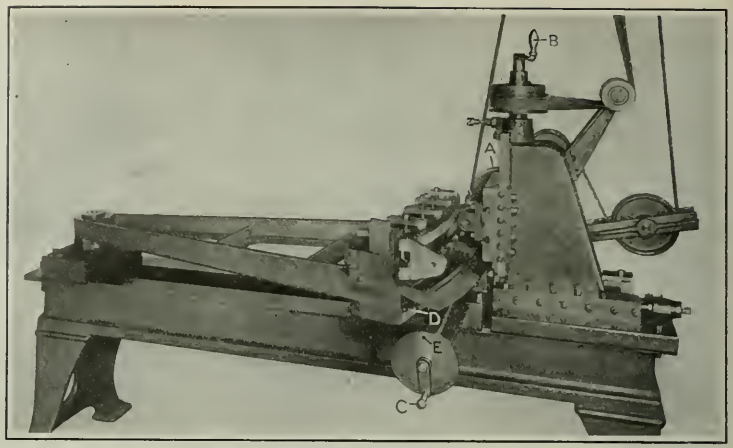


Fig. 15. Special Gear-cutting Machine used for cutting Teeth in Naval Gun Sight Bars, after they have been milled on the Machine shown in Figs. 13 and 14

* * *

CHUCKING AND REVERSE CHUCKING IN PATTERNMAKING

By M. E. DUGGAN

The chucking and reverse chucking of stock in a patternmaker's lathe is a process which usually consumes considerable time. For this reason machine parts requiring castings should, when possible, be so designed that in making the patterns, such work as must be done on the lathe will require but one chucking. There are cases, however, when it becomes necessary to reverse the work in the chuck in order to produce a properly finished pattern. When this must be done, the writer employs the following method, using tools which are especially designed for this class of work.

In Fig. 1, is shown a single-screw chuck, which differs from the standard stock chuck in that the faceplate is 4 inches in diameter instead of 3¼ inches, and the face is slightly concave instead of being flat. A No. 16 wood-screw having a good thread is fitted in the center hole of the chuck as shown, care being taken to see that the screw runs true. The wooden washers *A* and *B* are employed when turning very thin pieces so that the work need only be screwed on a short distance. Before chucking the work, a hole is drilled for the screw, using a 5/32-inch drill which is kept especially for this purpose. The work is then screwed up tight against the faceplate, and by this method a good thread is produced in the fiber of the wood.

When chucking pieces in which the grain of the wood is parallel with the screw, the hole is first filled with shellac in order that firm threads may be obtained. After turning one side of the work, the tailstock center *C*, Fig. 2, is advanced into the work a short distance. A 5/32-inch drill *D*, held in the wooden handle, is then employed to drill a hole in the position located by center *C*. The piece can now be reversed and if the centering and drilling has been carefully done, the work will be found to run true. The writer has employed this method in turning work 14⅝ inches in diameter and 5⅛ inches thick with satisfactory results.

* * *

The Pennsylvania Manufacturers' Association, at a meeting in Philadelphia, unanimously endorsed a resolution which said, in part, that the present inefficiency of labor, which has reduced production to less than 60 per cent of normal, is the primary cause of high prices from which relief can be obtained only by increased production.

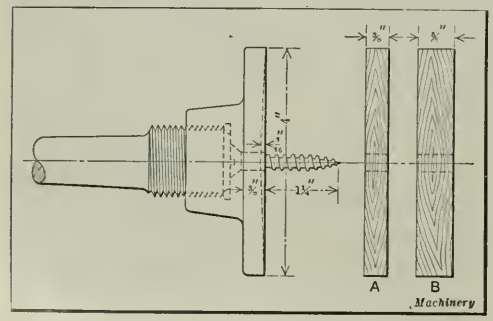


Fig. 1. Single-screw Chuck and Wooden Washers used for holding Work on Patternmaker's Lathe

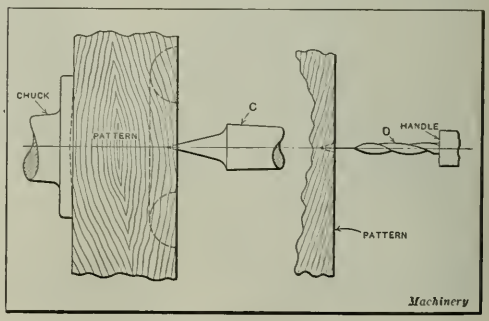


Fig. 2. Centering Tool and Drill used to produce Hole for Chuck Screw when Work is to be reversed

Manufacturing Krasco Spring Motors



Second of Two Articles Dealing with Time-saving Methods Used in Machining Phonograph Motors in the Plant of the Krasberg Engineering & Mfg. Corporation

IN the first article dealing with the manufacture of "Krasco" phonograph motors, published in the April number of MACHINERY, a general description was given of the arrangement of the departments in the phonograph section of the Krasberg Engineering & Mfg. Corporation's plant in Chicago. In the present article a detailed description will be given of some of the interesting methods which are used in machining phonograph motor parts. It will be apparent to any experienced mechanic that practically all of the jigs and fixtures which are employed in this connection have been so designed that they may be loaded with a minimum loss of time, and in this way they have been made an important factor in organizing and equipping the plant to successfully handle a business where active competition makes it necessary to quote very close prices.

Fixture for Cutting Small Bevel Gears on Hand Milling Machine

It will be recalled that a pair of small bevel gears is used in the drive from the power springs of the motor to the vertical turntable shaft. For cutting the teeth of these gears, use is made of a very ingeniously constructed fixture shown in Figs. 9 and 10, which is used on a Bristol hand milling machine. An interesting feature of this fixture is that the arbor carrying the gear blank is held in a horizontal position with the work located to engage the rotary gear-cutter on a line about midway between its center and bottom, so that the curvature of the cutter may be utilized to produce the required bevel angle in the gear teeth. There are limit stops controlling the hand-feed movement of the milling machine table in either direction, and as the table is reciprocated back and forth by means of the hand-feed lever, a space between two teeth is cut at each forward stroke and the fixture is automatically indexed during each return stroke, to bring the work into position for cutting the next space.

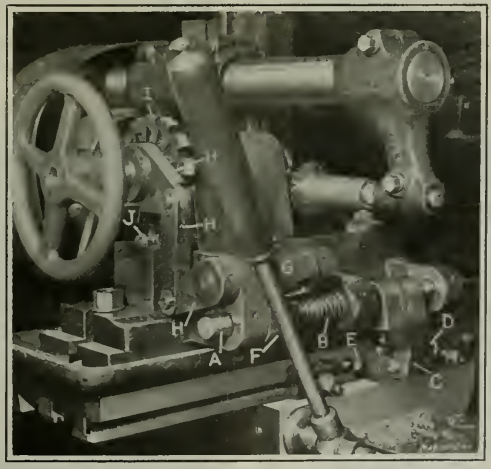


Fig. 9. Hand Milling Machine equipped with a Quick-acting Fixture having an Automatic Index Mechanism, for Use in cutting Bevel Gear Teeth

Small-sized bevel gears can be cut very rapidly by this method, and as the same form of equipment could be employed in making bevel gears for many other products, it will be of interest to learn in detail the way in which the fixture operates. Horizontal rod *A* is held in a fixed position by means of spring *B* that holds the end of this rod against a stationary stop. Pivoted on rod *A* there is a block *C* which may be swung into such a position that it is interposed between limit stops *D* and *E* carried by the milling machine table, in order to limit the feed movement of the table in both directions. Block *F* is carried by the fixed rod *A*, and it has a pin mounted in its upper surface that runs in the groove of cam *G*. As the reciprocating movement of the table carries cam *G* back and forth over block *F*, the cam is caused to have an oscillatory movement. This cam movement is transmitted through a series of links *H* to the index-plate *I*. It will be seen that ratchet teeth are cut in the side face of the index-plate, and on the inside of the last of the three links *H* there is a pawl which transmits the index movement to the plate during each backward movement of the milling machine table. On each forward movement of the table, a cam surface at the bottom of the last link *H* runs over roller *J* and causes the plunger on which this roller is carried to be depressed in order to withdraw the locking pin from a notch in the index-plate *I*, so that the work may be indexed into position for taking the next cut while the milling machine table is returning to its starting position.

Milling the Worm in the Governor Shaft

In connection with the description of the "Krasco" motor, it was explained that there is a worm-wheel on the turntable shaft which trans-

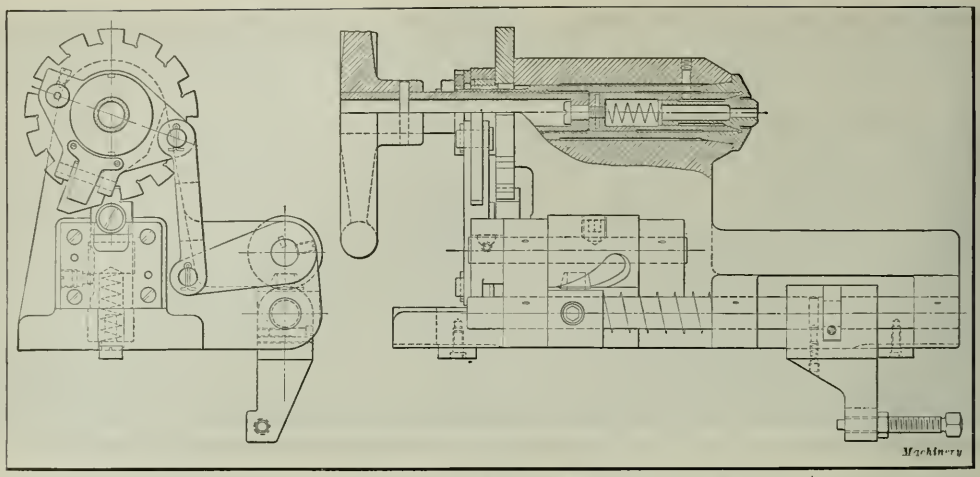


Fig. 10. End View and Partial Longitudinal Section of Bevel Gear Milling Fixture used on Machine shown in Fig. 9

mits motion to a governor that regulates the speed of rotation of the records. A practice is made of milling the worm in an enlarged section of the governor shaft provided for that purpose, and Fig. 11 shows the fixture set up on a Bristol hand milling machine which is used for the performance of this operation. Before starting to describe the fixture, attention is called to the fact that the feed movement of the milling machine table is not utilized. The fixture is set at such an angle to the cutter-spindle that provision is made for obtaining the correct helix angle for the worm as it is fed under the cutter by means of a lead-screw *A*. In using this fixture, a blank is placed in a draw-in collet carried by the fixture, which is tightened by means of a small wheel *B*. After the work has been set up in this way, a handwheel *C* is turned to allow screw *A* to traverse the work under the milling cutter. The worms cut with this apparatus are double-threaded, and after the first thread has been cut the work is returned to the starting point; then it is necessary to release the nut on screw *A*, and after this has been done, an index-pin *D* provides for locating the work for taking the second cut at a point half a pitch of the worm thread from the position at which the first cut was started. This makes a simple and effective method of machining work of this kind.

Drilling and Tapping Holes in Faces of Nuts

In the type of centrifugal governor used on "Krasco" spring motors, there are three weights held by straps made of thin sheet steel, these straps being secured to hexagonal nuts mounted on the governor shaft. To provide for assembling the steel straps on these nuts, it is necessary to drill and tap holes to receive the screws which are used for the purpose. Fig. 12 shows an equipment that gives very satisfactory results in handling work of this kind. For performing the drilling operation, four blanks are loaded into a hexagonal-shaped drilling jig in which the nuts *A* are held by means of a pivoted strap *B* that is clamped by screw *C* which enters its notched end. Then a screw turned by a cross-pin *D* secures the four blanks in place. In each face of this jig there are four drill bushings, and after holes have been drilled in the work through four of these bushings, the jig is turned on another face ready to drill the next sequence of holes in another side of the four pieces of work. After all of the holes have been drilled in this way, the drilled pieces are transferred to a fixture *F* located under another spindle of the drilling machine. This fixture consists of a plate with a slot milled in it in a position directly under the spindle, and of sufficient width so that nuts may be set up edgewise in the slot, as may be seen by referring to the illustration.

With pieces of work set up in this way, the tapping spindle is moved downward to tap holes in all of the pieces of work. In tapping, the operator holds the nut between his thumb and index finger, and after the hole has been tapped he simply pushes it out of the slot and takes hold of the

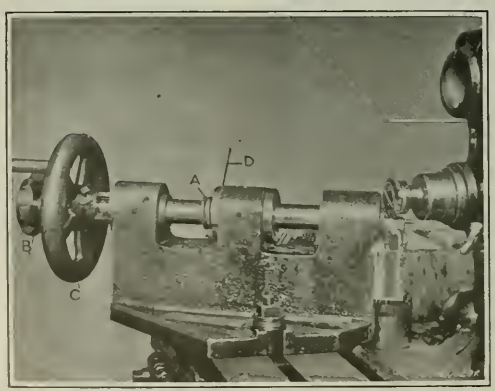


Fig. 11. Fixture for cutting Double-thread Speed Governor Worms on Hand Milling Machine

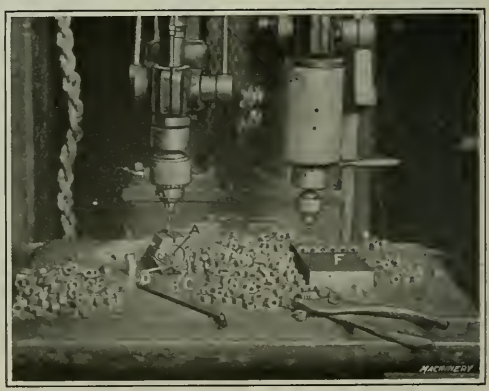


Fig. 12. Two-spindle Drilling Machine and Jigs for drilling and tapping Holes in Hexagonal Nuts

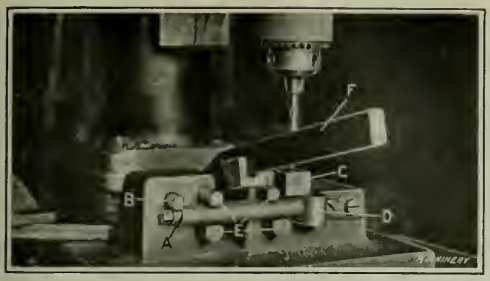


Fig. 13. Sensitive Drilling Machine equipped with a Quick-acting Jig for drilling Cross-holes in Winding Arbors

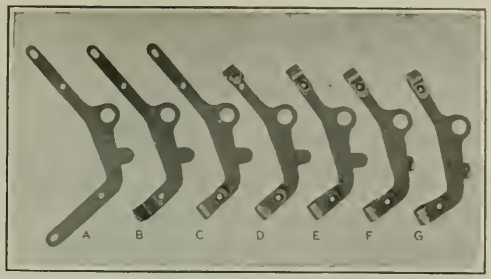


Fig. 14. Successive Steps in performing Blanking and Forming Operations for making Piece shown Completed at G

next piece of work which is drawn over into the operating position. After all of the pieces in the fixture have been tapped, the slot in the fixture is refilled with work and the operation is continued, this order of movements being repeated until threads have been cut in all of the holes in the work. Attention is called to the fact that on each governor spindle of "Krasco" phonograph motors there are two of these pieces that have the general appearance of nuts, although one of them should be called a hexagonal-shaped bushing, as there is no thread in the axial hole, and this hole must be perfectly smooth on the inside so that the bushing will slide freely on the controller shaft. To enable it to successfully fulfill this requirement, it is necessary to remove the burrs which are produced by drilling and tapping holes in the work. For this purpose, the bushing is held in a pair of pliers shown at *G* to prevent rotation of the work while a reamer, subsequently set up in place of the small twist drill, is fed down into the hole in the work.

Drilling Cross-hole in Winding Arbor

During the performance of machining operations which are required on the winding arbor, it is necessary to drill a small cross-hole at the right-hand end of the arbor as shown in Fig. 13, and this hole must be located at a specified distance from shoulder *A* on the work. In designing a jig for the performance of this operation, the problem was to afford a means of rapidly handling the work, and at the same time enable the hole to be accurately located in relation to shoulder *A*. This result was finally accomplished by the use of a pin *B* on the jig, against which shoulder *A* is located, this pin being so placed in relation to the drill bushing in block *C* that the proper spacing is obtained between the hole and shoulder on the work. Spring *D* assures holding the shoulder on the work firmly in contact with pin *B*. To facilitate loading and unloading the fixture, four pins *E* are furnished, between which the winding arbor is simply pushed into place; and to prevent rotation of the work while the hole is being drilled, block *C* is held down into firm contact with the top of the winding arbor by means of handlever *F*. A very satisfactory rate of production is obtainable by this fixture.

Blanking, Piercing, and Folding Dies

Fig. 14 shows a part of the "Krasco" motor at successive stages in the process of manufacture, and Fig. 15 illustrates the punches and dies used for the production of this part. These die illustrations are not complete tool drawings, but they illustrate the kinematic outline of the different mechanisms in sufficient detail so that any experienced mechanic will understand the principles which are involved in their

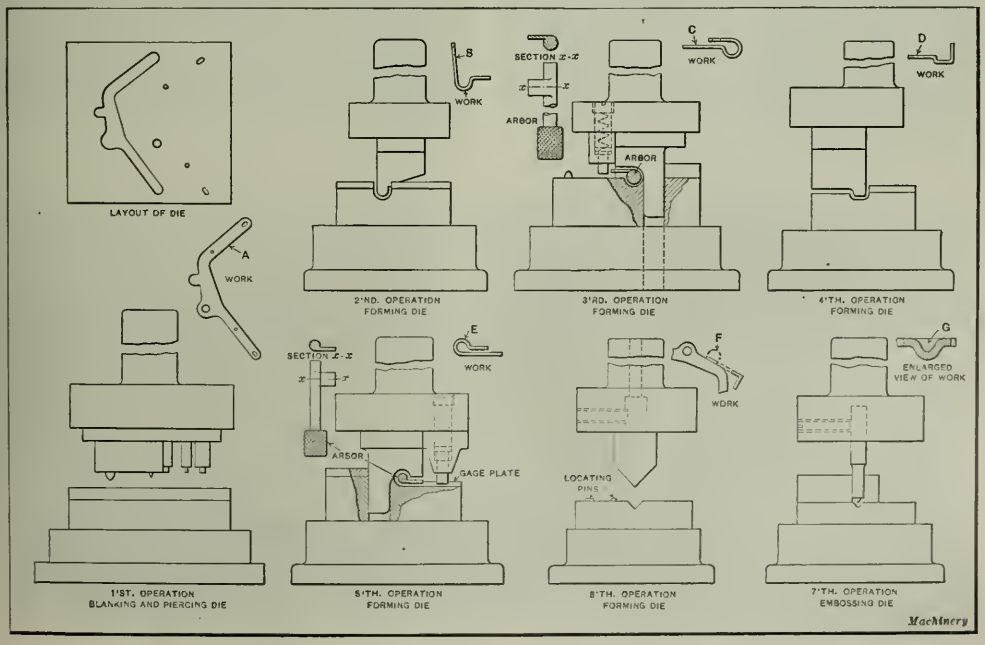


Fig. 15. Dies used for performing Successive Operations to bring the Work to the Various Stages shown in Fig. 14

use. The piece marked *A* in Fig. 14 is produced in the combination piercing and blanking die shown at the left-hand side of Fig. 15. This die is of the follow type, and as the ribbon stock is fed through from the side, five holes are pierced in one piece at the same time that a second piece is blanked out of the strip of metal; the holes were pierced in this second piece by the preceding downward movement of the power press ram. Next in the order of operations comes the turning up of lug *B*. The second-operation die used for this purpose is formed with male and female members which engage the end of the work and bend up the lug to the required position. At the third operation this lug must be folded over into the final position, as shown at *C*. With the work in the condition indicated at *B*, it is slipped under the arbor on the third-operation die, and when the upper die member comes down, it folds the lug on the work around the arbor to obtain the desired result.

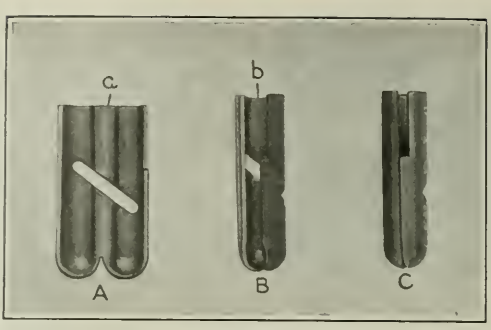


Fig. 16. Condition of Work at Successive Steps in forming the Piece shown Completed at C

One end of the work has not been completed, and it is necessary to start folding operations at the opposite end. The fourth-operation die provides for turning up lug *D*. This result is accomplished by male and female members on the upper and lower dies, which bend the work to the desired form. As in the case of the third-operation die, the next folding operation is performed by a die which has an arbor around which the work is bent to bring it to the form shown at *E*. By referring to the pieces shown at *E* and *F* in Fig. 14, it will be seen that the sixth operation consists of bending up a small lug near the center of the work *F*. For this purpose, the sixth-operation die is employed, which is of very simple design, consisting of a V-notch in the lower die member, and an angular punch which enters this notch. Locating pins fit into holes in the work to bring it into position, and when the ram of the press descends, it bends the lug to the desired form. A slight indentation must be made in this lug which has just been formed on the work, and this result is accomplished by means of the seventh-operation punch and die, the use of which is self-explanatory.

At *A*, *B*, and *C* in Fig. 16, there are shown successive forming operations which are performed on a sheet-steel part after the blanks have been stamped out by a preliminary operation. By comparing the form of the work at different stages in Fig. 16, with the form of dies shown in Fig. 17 that are used successively to bring the work to the final condition shown, the method of operation should be apparent with very little explanation. It will be noticed that the upper and lower members of the die shown at *A* are formed so that they bring the work to the condition shown at *A*, Fig. 16, with a convex corrugation *a* at the center. For performing the second operation, the upper die *B* has an inner projecting member which comes down on the top of this corrugation, so that the application of pressure causes the work to be folded up as shown at *B*, Fig. 16, leaving just enough space at *b* for the projecting member of the upper die to be withdrawn. Pieces of the form shown at *B* are then slipped over the arbor on the lower member of die *C*, with the opening in the work at the top. Then the upper member of the die *C* comes down and applies pressure, which forms the work around the arbor and closes the side seam in the work.

Machining Operations on Motor Frame Castings

The frame of the "Krasco" spring motor is made of a gray iron casting, and the first operation in machining consists of disk-grinding the upper face of the frame which will subsequently be screwed against the inside of the phonograph cabinet. After disk-grinding, it is necessary to drill six holes in the ground face, and Fig. 18 illustrates a Simplex upright drilling machine equipped with a Hoefer multiple-spindle auxiliary head that provides for simultaneously drilling these holes. This equipment is of standard design, but an interesting jig is used on the drilling machine, which has been carefully designed with a view to increasing the speed with which the castings may be set up in the jig and drilled pieces removed. This result is accomplished by having the plate in which the drill bushings are mounted supported on trunnions, so that it may be swung over to bring the plate to the position illustrated in Fig. 18. The reason for adopting this principle of design is that it is a very much easier matter to clamp the casting *A* into place on top of the bushing plate than it would be to secure it underneath

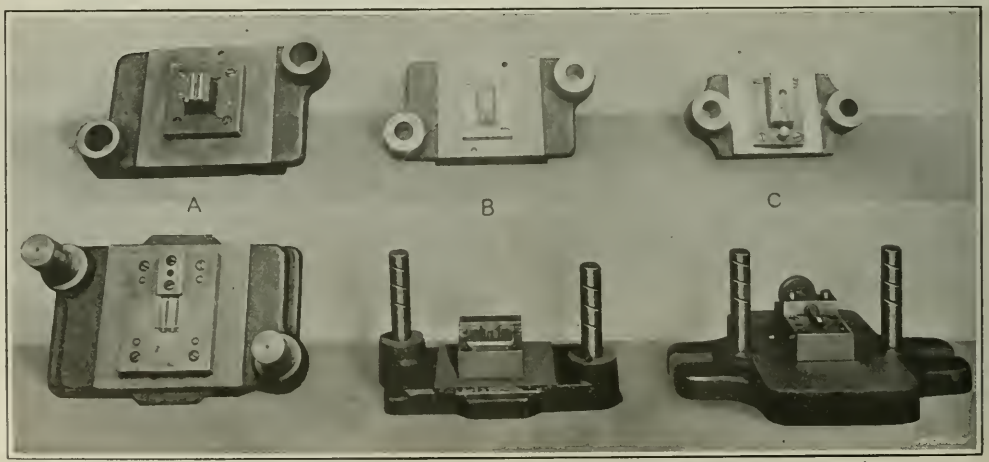


Fig. 17. Dies A, B, and C are used for bringing Work to the Condition shown by Corresponding Reference Letters in Fig. 16

this plate. It has been mentioned that the surface in which the holes are to be drilled was disk-ground, and this finished face of the work is utilized as a locating surface.

There are locating pads cast on the work, which engage three points provided on the vertical back wall and right-hand side wall of the jig plate for that purpose. The casting is pressed back into this locating vee by means of a clamping screw *B*. After a preliminary location has been obtained in this way, clamping member *C* is brought down so that the pins carried by it hold the ground surface of the work firmly against the under side of the jig plate, in which position it is clamped by means of capstan screw *D* which fits into notch *E* on the clamping member and secures it firmly against the work. After the casting has been set up in this way, treadle *F* is depressed in order to release the stop-bars *G* from beneath the jig plate and allow it to be swung on its trunnion by turning crank-handle *H*, in order to bring the jig bushings to the top and in position under the drills carried by the auxiliary head. When the jig has been swung into this position, another pair of supporting bars, similar to those shown at *G*, swing into place under the jig and hold it up ready for performing the drilling operation. It will be noted that crank-handle *H* is counterweighted in order to reduce to a minimum the amount of physical effort required to swing the jig plate back and forth between the loading and drilling positions.

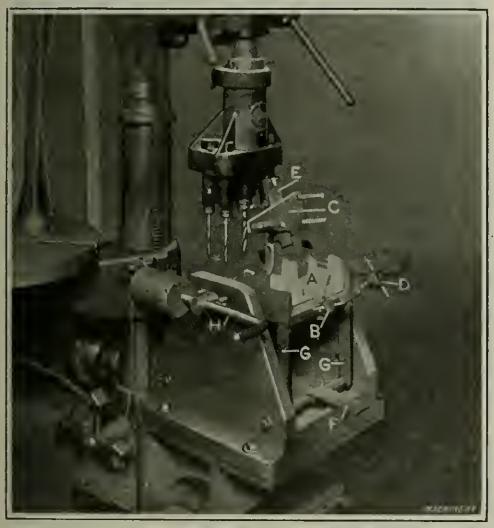


Fig. 18. Drill Jig which turns over to facilitate the Work of loading and unloading

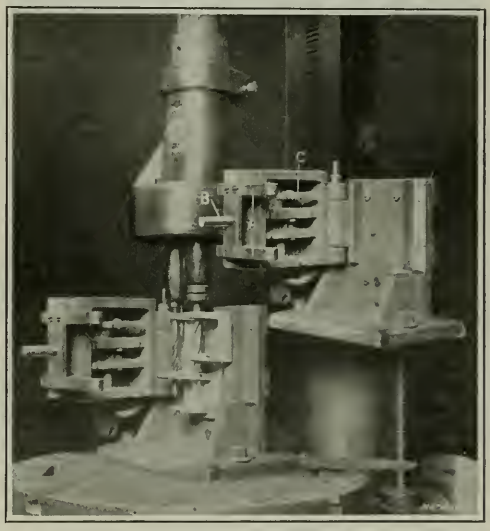


Fig. 19. Jig for drilling Holes in Legs of Frame. This Jig is shown loaded and emptied

Box Jig for Drilling Four Holes from Right-hand End of Work

While held in the jig provided on the machine shown in Fig. 19, four holes are drilled in the frame casting from the right-hand end. As in the jig shown in the preceding illustration, the work is located from the surface that was ground in the first operation, in addition to which four locating pins on the vertical face of the jig enter the holes which have been drilled in this finished surface. A Simplex drilling machine equipped with a Hoefer head is used for the performance of this drilling operation, and while the job consists nominally of drilling four holes, it is more properly a case of drilling seven holes, because three of the four drills carried by the head pass through two of the projections on the casting. After the work has been set up in the fixture, the front of the box jig is closed and held shut by means of two spring latches *A*, which are released by means of handle *B* after the operation has been completed. The work is clamped back against the vertical locating face of the jig by means of a screw turned by a small capstan wheel, which causes a pivoted equallzer *C* to press the work back against the locating points on the back wall of the jig. The reason for having this pivoted equalizer is to compensate for any slight differences in the form of the castings which would otherwise interfere with their being securely held for drilling. The pins and locating points on the vertical back wall of the jig are clearly shown in the right-hand view of the jig without the casting in place.

Drilling Four Holes in the Left-hand End

Next in the order of operations on the frame castings comes the drilling of four holes in the left-hand end of the work. Location is obtained from the ground surface of the casting, which is held against stops carried by the vertical back face inside of the box jig, the casting being slipped over pins in this face which hold it accurately in the desired position. This arrangement is similar to that of the jig shown in the preceding illustrations. Provision is made for clamping the casting back against the locating points of the jig shown in Fig. 20 by means of a pivoted equalizing clamp *A* which is provided with three points that engage the work. By having this member pivoted, provision is made to afford compensation for slight differences in the form of the castings. This clamp comes into play when the jig is closed, and the combined result of fastening the jig and clamping the work is accomplished by a notched cam *B* that slips over pin *C* and is turned by the T-head handle *D* to provide for forcing the equalizing clamp *A* inward, thus securing the work in place for drilling.

Drilling Four Holes in the Back of the Frame

In Fig. 21 there is shown a drilling machine equipped with a four-spindle Hoefer auxiliary head and a box jig for use in drilling four holes in the back of the frame. As in the preceding cases, the work is located against the vertical back surface of this jig by means of pins which enter the drilled holes in the top surface of the frame. Clamping is accomplished by means of a floating member that carries three points *A* that engage the work, the floating support affording sufficient compensation to assure having these clamping points in firm contact with the work, regardless of slight inequalities in the castings. Clamping is accom-

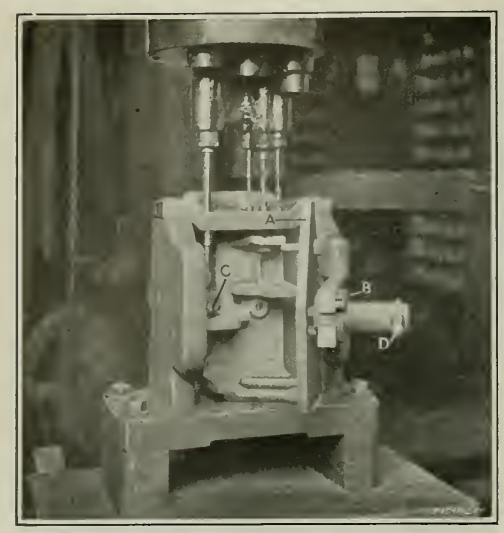


Fig. 20. The Casting to be drilled is located against a Finished Face inside the Jig, with Pilots entering Drilled Holes in the Work

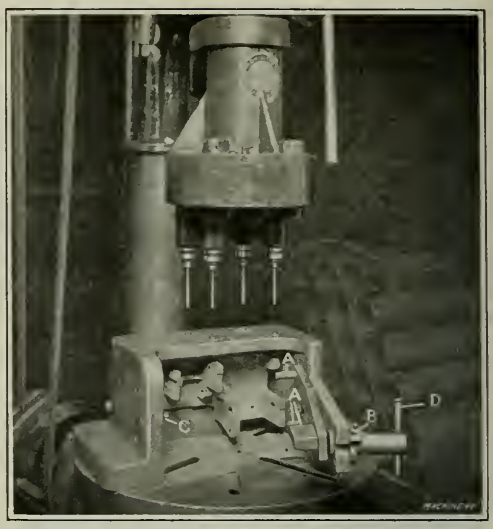


Fig. 21. Jig arranged with Cam-locking Mechanism and Floating Three-point Clamp to hold the Work back against the Locating Surface

plished by means of a slotted cam *B* which slips over pin *C* carried by the frame of the jig, the cam being turned by means of a T-headed handle *D*.

Milling the Legs of the Frames

It is necessary to mill the bottoms of two legs on the frame in order to afford a fit for the bearing plate, and to mill the sides of two flanges in order to form surfaces to receive a spring plate at the left-hand end and a thrust washer on the spring shaft at the right-hand end of the frame. For the performance of these operations, a Briggs milling machine is used, which is equipped with a string fixture as illustrated in Fig. 22. It will be apparent that this fixture is of extremely simple design, consisting of a bedplate with straps that hold down the castings, the location of the castings being accomplished by pins on the bed of the fixture that enter drilled holes in the work. The way in which a gang of four cutters on the milling machine arbor is used to mill the four surfaces on the work will be apparent from the illustration.

Painting the Frame Castings

In order to improve the appearance of the motor frame and to protect it from rust, a practice is made of spraying the castings with aluminum paint, one of the DeVilbiss "Floco guns" being used for the purpose. Fig. 23 shows the painting department, and it will be seen that a draft hood is provided in which the work is held while being sprayed, in order that all noxious vapors may be drawn into the exhaust system and not prove detrimental to the health of the operators. After the castings have been painted, they are allowed to stand for a considerable period of time in order that the cast iron may become thoroughly seasoned.

* * *

Arrangements for holding the 1920 Congress of the National Safety Council in Milwaukee have just been completed, and steps have also been taken for the immediate organization of a permanent local council so that both public safety and industrial safety work may be well under way when the Ninth Annual Safety Congress convenes on September 27.

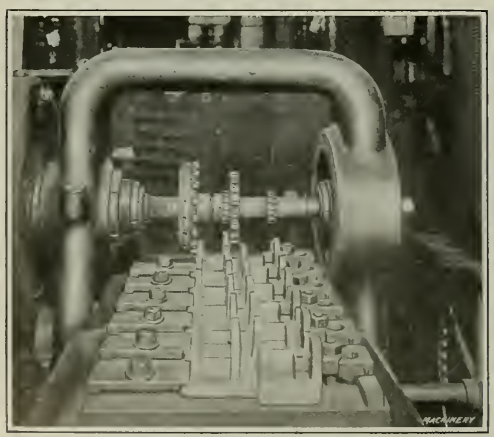


Fig. 22. Milling Machine equipped with String Type of Fixture for straddle-milling Bottoms of Two Legs and Sides of Two Flanges on Motor Frame Castings



Fig. 23. Spraying the Frames with Aluminum Paint is done in an Exhaust Hood and the Paint is dried in an Oven at the Right-hand Side of the Illustration

LETTERS ON PRACTICAL SUBJECTS

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CARDBOARD MACHINERY MODELS

The method described in this article deals with what the writer believes to be a new idea connected with the designing of machinery. It is a method whereby the designer is enabled to visualize the new machine, which will enable him to make improvements in the design before instead of after the machine has been actually built. A simple way to tell just what the appearance of the machine will be when finished is to construct a full-sized model of it from cardboard and to paint it so that it will have the same general appearance as the actual machine. This method makes it possible for the mechanical features of the design to be worked out to a degree which at first may seem almost unbelievable. The matter of clearances of moving parts, one of the greatest obstacles with which the designer has to contend, becomes a simple matter when an actual model is available to work on.

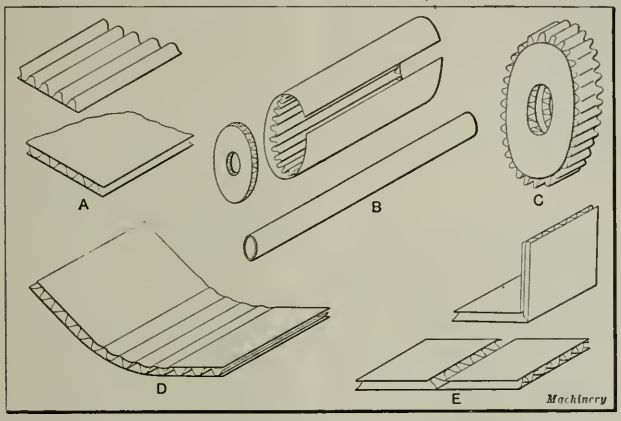


Fig. 1. A Few Shapes into which the Cardboard may be made when constructing Working Models

To construct the model is not as difficult a job as would first appear. The material used is ordinary corrugated box-board, such as shown at *A*, Fig. 1. This material, either single- or double-faced, may be bought in rolls or in large sheets at a reasonable cost. Some sort of stay material, such as a roll of strong gummed tape, must be employed to hold the parts of the model together. With this equipment and a sharp knife the details may be constructed with surprising ease. An example of what can be accomplished is shown in the various views in Fig. 1. *B* is a cylinder before being assembled. A piece of single-faced cardboard is rolled up and a strip of stay material pasted along the seam. Part of the corrugations are cut away at each end before rolling up, so as to provide a recess into which the end disks, or heads, will fit. The cylinder shaft is a tube made from plain wrapping paper, rolled up on a shaft and pasted along the edge, the ends being made from double-faced board fastened in place with the stay material. For constructing parts which have large or irregular curves, as for instance the legs of the machine shown in Figs. 2 and 3, it is preferable to use double-faced board and crease it down slightly into each corrugation, as shown in Fig. 1 at *D*. This will permit the material to be formed without difficulty. If the inside of the curve must be smooth, this is accomplished by simply pasting a piece of wrapping paper over it. It is usual to make flat surfaces of double-faced board, and it is sometimes best to use two thicknesses when extra strength is desired, placing the two boards so that the corrugations are at right angles to each other.

An angle-plate is constructed as shown at *E*. Double-faced board is used, being cut as shown in the illustration, from which it will be seen that the material is not cut through on one face. This gives an even outside corner when the material is bent to the shape of the angle-plate. A spur gear may be easily constructed in the manner shown at *C*, using two double-faced board disks, and wrapping and pasting a strip of single-faced material around the outside edges. Bevel gears that will actually run together may be made by removing the corrugated strip and pasting it on the surface of a cone.

The model illustrated in Figs. 2 and 3, it will be seen, is not of a completed machine, but gives a good idea of the possibilities of the methods described. This idea may be employed in preparing photographs in advance of the completion of the machine, making it possible to place it before the prospective purchasers as soon as the engineering department has approved of the design and construction.

Rochester, N. Y. GEORGE C. HANNEMAN

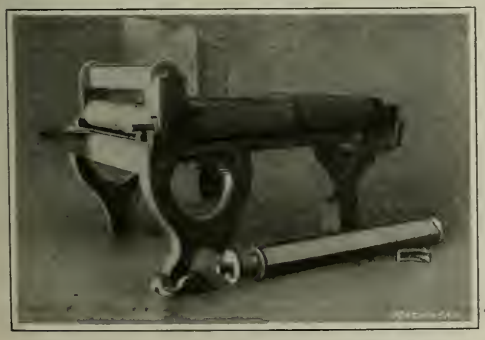


Fig. 2. Example of Partially Constructed Cardboard Model

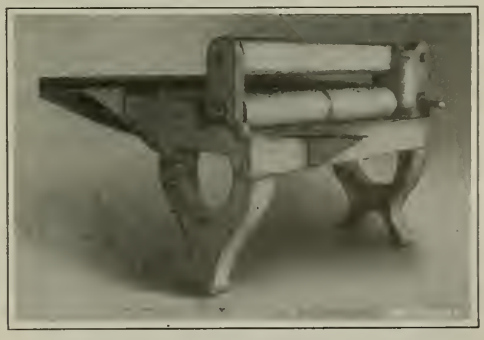


Fig. 3. Another View of the Model shown in Fig. 2

FORMULAS FOR FINDING THE AREA OF A CIRCULAR SEGMENT

In the November number of MACHINERY, page 272, there was published a formula for finding the approximate area of a circular segment when the length of the chord and the height of the segment are known. In checking this formula, the writer compared it with formulas which are slightly different and which, for general use, give more accurate results. The accompanying table contains values which furnish a comparison between three approximate formulas and the exact formula which may be found in MACHINERY'S HANDBOOK on page 132. In the table, the four formulas are arranged and numbered according to the accuracy of the results obtainable by each.

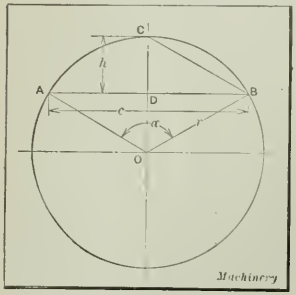


Diagram used in deriving Formula for finding the Area of a Segment

Formula 1: $A = 1/2\,[rl - c\,(c - h)]$

in which c and h are known;

$$r = \frac{c^2 + 4h^2}{8h};$$

$$l = \frac{\pi r a}{180}, \text{ in which } \sin\frac{1}{2}a = \frac{c}{2r}$$

Formula (1) will give exact results provided the value of l is very accurately calculated. The value of l is usually expressed as follows:

$l = 0.01745ra$, in which a is expressed in degrees.

A still closer approximation will be obtained by using the following constant:

$l = 0.00000484814ra$, in which a is expressed in seconds

Formula (1) may also be written in the form:

$$A = r^2\left(\frac{a}{2} - \sin\frac{a}{2} \times \cos\frac{a}{2}\right)$$

In this latter formula a is expressed in radians and not in degrees.

Formula 2: $$A = \frac{4h^2}{3}\sqrt{\frac{c^2}{4h^2}} + 0.392$$

This formula gives results (for segments less than a semicircle) which will be correct to three figures.

Formula 3: $$A = \frac{h^2}{2c} + \frac{2ch}{3}$$

This formula is much more easily handled than Formula (2), but Formula (2) is the best approximation. The derivation of Formula (3) may be followed by referring to the accompanying diagram. The area of the segment may be written:

$$ACBA = \frac{\text{arc } ACB \times OB}{2} - \frac{AB \times OD}{2}$$

$$OB = \frac{c^2 + 4h^2}{8h}$$

and

$$OD = OB - h = \frac{c^2 - 4h^2}{8h}$$

The length of arc ACB, when expressed according to Huygens' approximation, is

$$ACB = \frac{8BC - AB}{3}$$

$$BC = \sqrt{\left(\frac{c}{2}\right)^2 + h^2} = \frac{1}{2}(c^2 + 4h^2)^{\frac{1}{2}} = \frac{1}{2}c\left(1 + \frac{4h^2}{c^2}\right)^{\frac{1}{2}}$$

Expanding the binomial in the parentheses of the last expression, by the well-known binomial theorem

$$BC = \frac{1}{2}c\left(1 + \frac{2h^2}{c^2} - \frac{2h^4}{c^4} \cdots\right)$$

$$= \frac{c}{2} + \frac{h^2}{c} - \frac{h^4}{c^3}, \text{ approximately}$$

The Huygens' formula for finding the length of ACB may now be written

$$ACB = \frac{1}{3}\left(4c + \frac{8h^2}{c} - \frac{8h^4}{c^3} - c\right)$$

$$= c + \frac{8h^2}{3c} - \frac{8h^4}{3c^3}$$

Substituting the values in the original equation

$$ACBA = \left(c + \frac{8h^2}{3c} - \frac{8h^4}{3c^3}\right) \times \left(\frac{c^2 + 4h^2}{16h}\right) - \frac{c}{2}\left(\frac{c^2 - 4h^2}{8h}\right)$$

Expanding and simplifying the terms in the above equation

$$ACBA = \frac{2ch}{3} + \frac{h^3}{2c} - \frac{2h^5}{3c^3}$$

We may reject the last term in this equation since the value of h is supposed to be small compared with that of c; therefore

$$\text{Area} = \frac{2ch}{3} + \frac{h^3}{2c} \text{ approximately}$$

This formula is accurate to within three figures when the height of the segment does not exceed the length of one-fourth the chord; and the error will be less than 1 per cent when the segment is a semicircle.

Formula 4: $$A = \frac{h^2}{2c} + 0.6604ch$$

COMPARISON OF VARIOUS SEGMENT AREA FORMULAS

Values of c and h Inches	Formula (1)	Formula (2)	Formula (3)	Formula (4)
$c = 10;\ h = 5$	39.2699	39.32770	39.58330	39.27000
Error	0.0000	— 0.05780	+ 0.31340	+ 0.00010
$c = 2;\ h = 1$	1.5708	1.57310	1.58330	1.57080
Error	0.0000	+ 0.00230	+ 0.01250	0.00000
$c = 4;\ h = 1$	2.7956	2.79430	2.79170	2.76660
Error	0.0000	— 0.00130	— 0.00390	— 0.02900
$c = 10;\ h = 3$	21.3736	21.36530	21.35000	21.16200
Error	0.0000	— 0.00830	— 0.02360	— 0.21160
$c = 10;\ h = 0.25$	1.6678	1.66748	1.66745	1.65178
Error	0.0000	— 0.00032	— 0.00035	— 0.01602
$c = 40;\ h = 1$	26.6859	26.67970	26.67910	26.42850
Error	0.0000	— 0.00620	— 0.00680	— 0.25740

Machinery

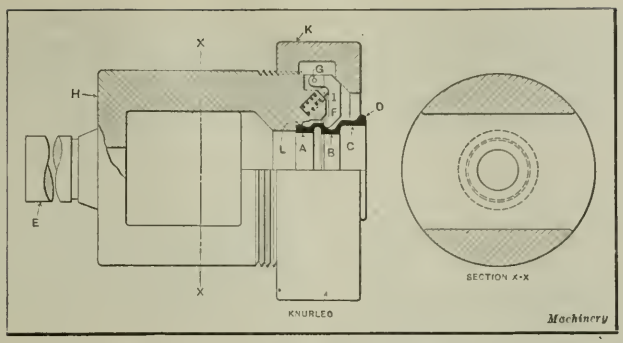
This is the formula previously published and gives results correct to four figures for a semicircle, but for general use is not as accurate as either of the other two approximate formulas. This fact will be apparent by inspecting the values given in the accompanying table.

Cleveland, Ohio WILLIAM W. JOHNSON

INTERNAL GRINDING FIXTURE

The fixture shown in the accompanying illustration was designed for holding the small delicate piece of work D when grinding the inside surfaces A, B, and C. The diameters of these surfaces are held to a 0.00025 inch limit and each surface must be concentric with the center of the piece. It was found by experiments that if the part was clamped on one of the outside surfaces or on the ends, it was difficult to machine them within the required limits. However, by means of the fixture illustrated very satisfactory results were obtained.

The work is held in holder *H* as indicated, shoulder *L* being ground so that the previously finished outside surface on one end of the work may be seated there. Four levers *F* are provided to exert pressure on one of the outside surfaces of the work as shown. These levers swivel on pins *G* and come in contact with the work when the taper surface on the inside of the knurled and threaded collar *K* comes in contact with the levers as the collar is screwed up on holder *H*. The grip required on the work is so slight that this collar can readily be screwed up by hand. The threads on the holder are cut eighteen per inch so that the levers do not press against the work too quickly when collar *K* is tightened, which would be the case if the threads were coarse. Four plungers *I* are provided for forcing the levers sufficiently away from the work when collar *K* is loosened, to permit the easy removal of the work after the performance of the grinding operation. Each one of these plungers is actuated by a small expansion coil spring.



Fixture designed for holding Delicate Work during Internal Grinding Operation

Holder *H* is made of cold-drawn steel, hardened. It is provided with an opening in order to permit the operator to gage the diameter of surface *A* which, on account of being larger than the diameter of surface *B*, cannot readily be gaged from the outer end of the work. This opening is 3½ inches long by 3 inches wide, being of a sufficent size to allow the operator's fingers to be inserted into it when gaging the diameter of surface *A* by means of a pin gage provided with a long handle. End *E* was made to suit the spindle of the internal grinding machine on which the fixture is used. Although this fixture was originally developed for internal grinding operations only, with certain modifications it has also been adapted for finish-turning and reaming operations on parts of a similar size and delicacy.

Aurora, Ill. A. H. Boehm

GENERAL-PURPOSE DRILL JIG

The drill jig shown in the accompanying illustration is so designed that it can be used for holding work of many different kinds and sizes, and as it consists principally of a simple casting and clamping device, the cost of construction is low. The strap *A* which clamps the work in place can be of any length within the scope of the jig casting, and the writer has often found it convenient to cut out a place in the base to receive the lower end of this strap when it is desired to employ the jig to hold comparatively large pieces of work.

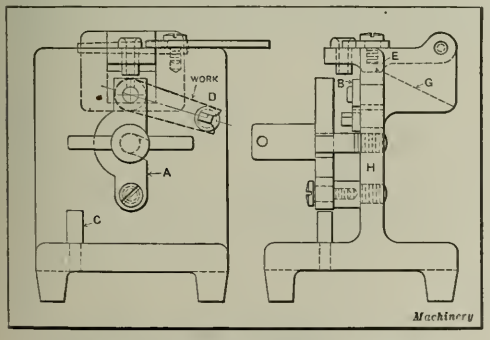
Various styles of plates can be attached to the jig to take the place of stud *B*, thereby accommodating various shapes and sizes of work. Stud *C* is a stop which keeps strap *A* in a convenient position for swinging into place after reloading the jig. A stud such as is employed at *D* may be used to support the work at the required angle or position for drilling. This means of support may, of course, be varied to suit the work. The leaf in which the drill bushing is held can be thrown back and the hole tapped without changing the work from its original position in the drill jig. When in position for drilling, the leaf will seat at *E*. A chip clearance space is provided as indicated by the dotted line at *G*, and surface *H* is planed —a feature which is of great advantage when locating studs and stops for various types of work.

Devon, Conn. Charles W. Oviatt

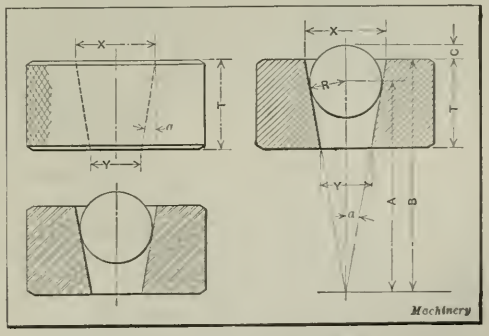
USE OF A STEEL BALL IN THE INSPECTION OF TAPERED RING GAGES

The realization of the fact that a great many tool inspectors and practical machinists do not appreciate the value of the standard steel ball as a measuring tool, prompts the writer to describe an accurate and convenient method of using a steel ball when inspecting a tapered ring gage. In this case the ball is used as shown in the lower left-hand corner of the illustration to determine the dimensions indicated by *X* and *Y*, angle *a* being known. The ball should be of such size as to project above the face of the gage. This, however, is not necessary, although preferable, as it permits the required measurements to be more readily obtained. After measuring the distance *C*, the calculation of dimension *X* is as follows: First obtain dimension *A*, which equals *R* divided by sin *a*. Then adding *R* to *A* and subtracting *C* we obtain dimension *B*. Dimension *X* may then be obtained by multiplying 2*B* by the tangent of angle *a*. The formulas for *X* and *Y* can therefore be written as follows:

$$X = 2\left(\frac{R}{\sin a} + R - C\right)\tan a$$



Drill Jig which may be employed in drilling Small Parts of Various Kinds and Sizes



Tapered Ring Gage and Diagram illustrating Method of finding Dimensions X and Y by Use of Steel Ball

$$Y = X - (2T \tan a)$$

Example—If in the accompanying illustration angle a = 9 degrees, T = 1.250 inches, C = 0.250 inch and R = 0.500 inch, what are the dimensions X and Y?

Applying the above formula,

$$X = 2\left(\frac{0.500}{0.15643} + 0.500 - 0.250\right) \times 0.15838$$

Solving this equation,

$$X = 1.0917 \text{ inches}$$

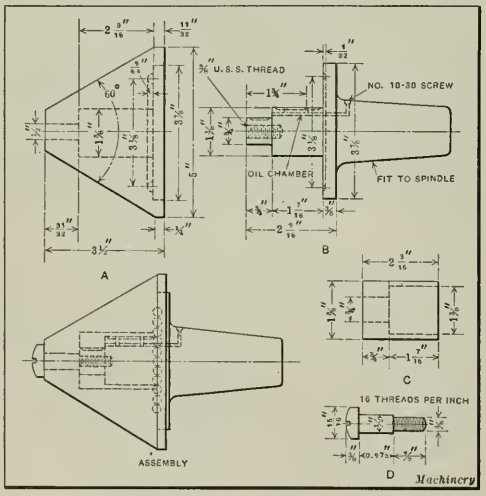
Then

$$Y = 1.0917 - (2.500 \times 0.15838) = 0.6957 \text{ inch}$$

Rochester, N. Y. J. Olson

BALL BEARING CENTER FOR USE IN TURNING HOLLOW WORK

Details and an assembly view of a ball bearing center are shown in the accompanying illustration. This center was designed for use in turning and grinding hollow work such as pipe, hollow crankpins and wrist-pins, hollow axles, etc. The center consists of a main body *B*, the shank of which is turned to fit the spindle of the lathe or grinding machine in which it is to be used. The other end of the body is machined to receive a phosphor-bronze sleeve *C*. This sleeve is a forced fit on the body and is the bearing on which the cone *A* revolves. The illustration shows an annular groove in the collar of the body and a similar groove in the recess of the cone, and when the tool is assembled, these form the raceway for the ball bearing, in which thirty-nine steel balls, ¼ inch in diameter, are used. By this means the end thrust is adequately taken care of and the friction caused by the revolving cone greatly reduced. Provision is also made for lubricating the cone while it is in use, as shown by the oil-hole in the shank of the body leading to the oil-groove. It will be observed that special precaution has been taken in this design to prevent all foreign matter from entering the ball bearing through the oil-holes, by keeping the oil passage covered. In the assembly view, it will be seen that the shoulder screw *D* is used to hold the cone on its bearing and that the length of the body of this screw



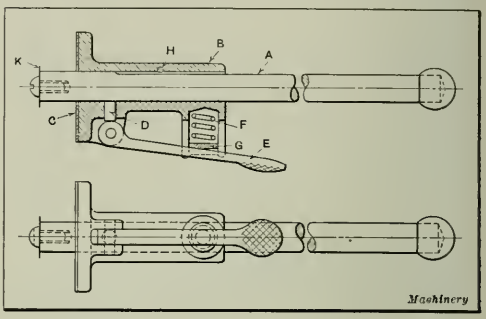
Details of Pipe Center equipped with Ball Bearing

provides sufficient clearance to permit the cone to revolve freely. In truing up or grinding the cone, it is only necessary to place a washer under the head of the screw and tighten it, in order to hold the cone firm and prevent it from revolving when being ground. Although this center was designed for a special class of work, it could be put to more general use.

Norman McCleod

PATTERNMAKER'S SCRATCH-GAGE

The scratch-gage illustrated is a distinct improvement over the regulation type of patternmaker's scratch-gage. When laying out small split patterns and core-boxes, the patternmaker is frequently compelled to set his gage several times, and it is well known that on the type of gage which employs a thumb-screw for locking purposes, a considerable amount of time is consumed in setting. The tool shown in the illustration was devised to overcome this objection. It consists of a handle made of hardened drill rod, faced square on one end and tapped for a No. 10-24 screw. One side of this rod handle is flattened slightly as shown at *A*, so that the small pin *H* will bear against it and prevent the slide *B* from turning on the rod. This slide is made of cast aluminum and is faced with a thin piece of steel *C*. This steel face is brazed to the machine face of the aluminum casting, by



Scratch-gage with Thumb-lever for Quick Setting

first tinning the surface of the casting with a good grade of aluminum solder. The face of the steel piece *C* and of the casting are then tinned with an ordinary half-and-half solder and clamped together while hot. The steel face is then trued up by taking a light cut across it. The thumb-lever *E* is made of tool steel and is hinged on a pin in the casting. The end of the lever that is attached to the casting is machined to the form of an eccentric cam having a throw of from 0.002 to 0.003 inch, and operates against a hardened drill-rod pin *D*. When the thumb-lever is released, the coil spring *F*, contained in a recess in the casting *B*, will force the plunger *G* against the lever, pressing the pin *D* against the rod *A* and securing the casting in position. The scriber *K* is made from a square piece of thin tool steel—a piece of hacksaw blade will answer the purpose very well.

It has been the writer's experience that this type of scriber when honed to a very sharp edge gives a finer and more distinct line on white pine or mahogany than the roller type of scriber which is sometimes used. A knob forced on the end of the rod handle will prevent the slide from coming off the rod. It can readily be seen that, by grasping the rod of this gage with one hand and holding down lever *E* with the thumb, the gage may be set very readily with one hand, leaving the other free to use the scale.

Flint, Mich. T. L. Stalker

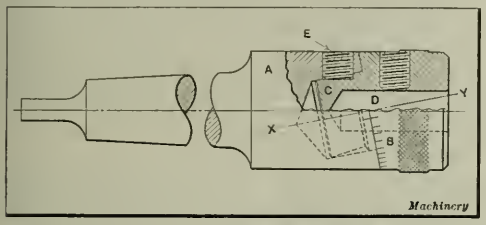
* * *

Before the war, Spanish needs for emery paper and cloth were supplied mainly by Germany and England; but these sources were largely cut off during the war, and others were sought. Spain has one factory that produces these materials, but the output is not only small but also of very poor quality. Portugal formed the principal source of supply, and still does, due to the present depreciated condition of Portuguese currency, but the product is unsatisfactory. Although material imported from the United States is higher in price, its quality is so much better that it is probable that it will be substituted for Portuguese abrasives as soon as the currency situation becomes more normal, thus removing the great incentive for purchase in Portugal.

SHOP AND DRAFTING-ROOM KINKS

BORING-TOOL HOLDER FOR MILLING MACHINE

The boring-tool holder which is here illustrated is intended for use in a milling machine and is designed to hold ordinary forged-end boring tools. In making this holder, the shank and body *A* are first turned in the usual manner. It is then tilted in the chuck to a convenient angle and faced off. The hole into which part *B* fits is then bored



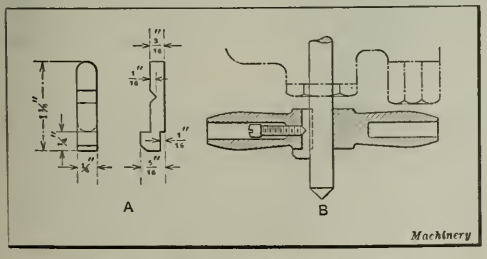
Adjustable Boring-tool Holder for Milling Machine

while the work is in this position. Piece *B* is then made, the end *C* being turned while it is held between centers which permit it to revolve about axis *X*–*Y*. This requires a much larger piece of stock than that shown in the finished state. This end should be a close sliding fit in *A*. The piece *B* is then inserted into *A* and held there by a set-screw as shown. The outside surface is then turned off even with that of part *A* and the end is faced off square with the longitudinal axis of the arbor. The hole for the inserted tool is then drilled and a set-screw is provided for holding the tool. Now by loosening the set-screw *E* and turning part *B*, hole *D* will revolve about *X*–*Y* as an axis which will permit the boring tool to be adjusted to bore any size hole within its capacity. The edges of *A* and *B* may be graduated where they come together, but the accuracy of such graduations would depend upon the length of the tool. Therefore they will be found convenient only as a means of obtaining an approximately accurate setting.

Philadelphia, Pa. PAUL H. BYER

SAFETY KEY FOR PNEUMATIC DRILL HANDWHEEL

The handwheel mounted on the feed-screw of air drills is often fastened on the screw by means of a set-screw only, and it frequently happens that this set-screw works loose and allows the wheel to come off. Such an occurrence is dangerous because the operator is liable to injury through the machine falling on him, or the machine may receive mechanical injury by falling. An accident of this sort can be prevented by means of the key shown at *A* in the accompanying illustration. The feed-screw of the drill should be provided with a keyway of the same length as the bottom surface of the key, and after the key has been inserted in the keyway the wheel should be mounted on the screw as shown at *B*. After this has been done, the screw should be replaced in the drill. A V-groove is provided on the top of the key to suit the point of the set-screw.



Detail of Safety Key and Method of Application

It is apparent that the shoulder on the bottom of the key, prevents it from coming out even if the set-screw becomes loose. The wheel also cannot get out of place because of the shoulder on the top of the key, and so all danger of accidents of the type referred to is eliminated. This safety set-screw has proved very satisfactory in the shops in which it has been used. NORMAN MCCLEOD

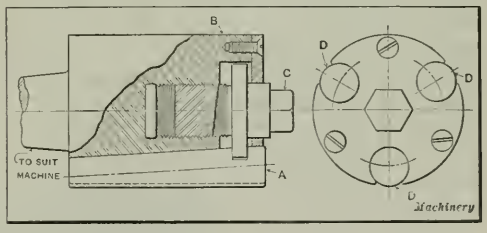
KINK FOR DRAFTSMEN

Draftsmen who find that the jaws of the lead-holding clamp of a compass have become so smooth that it is difficult to tighten them sufficiently to hold the lead, can easily overcome this difficulty in the following way: First remove the clamping screw and insert a tap in place of the lead; then press the jaws together gently with the fingers and run the tap back and forth five or six times.

Cleveland, Ohio O. T. ROOF

EXPANSION ARBOR

A simple and efficient expanding arbor is shown in the accompanying illustration. In its construction, three evenly spaced holes are drilled and reamed in the body *B* at a slight



Three-point Bearing Expansion Arbor

angle with the center line, and pins *A* made to a sliding fit for these holes are inserted as shown after the body has been turned to a diameter slightly under that of the minimum bore of the part the arbor is intended to hold. The pins are then brought as far forward as possible by means of the actuating screw *C*. While in this position the projecting portions of the pins at *D* are ground concentric with the body so that the arbor will fit the minimum diameter of the hole in the work. F. S. W.

* * *

Consul William J. Grace reports from Sheffield, England, under date of March 6, heavy advances in iron and steel prices in the Sheffield district of England. Basic pig iron is now selling for £11 10s with further price advances probable, as the output of basic pig iron is much below the demand of the steel furnaces. Consul Grace further reports that extensive developments are under way for the manufacture of articles from stainless steel for hardware purposes, automobile engine valves, etc. Prices of ferro-vanadium and tungsten have also advanced.

Standard Sizes for Shafting

Committee of the American Society of Mechanical Engineers Recommends Fourteen Sizes of Transmission Shafting, and Large Reduction in Number of Sizes of Machinery Shafting

THE desirability of reducing the number of sizes of shafting and in consequence the number of parts of power transmission equipment that must be carried in stock has long been recognized. It remained for the conditions of the war, however, to bring about definite action in this regard, from the standpoint of the conservation of materials. The activities of the committee of the American Society of Mechanical Engineers on War Industries Readjustment brought to light the fact that an immense amount of steel is continuously tied up in manufacturers' and dealers' stocks of shafting and that a corresponding amount of cast iron is also held in stock in the form of hangers, bearings, couplings, collars, bushings, pulleys, etc. At the suggestion of the chairman of the Committee on War Industries Readjustment, therefore, a committee was formed to investigate the subject of the standardization of shafting sizes. The personnel of this committee is as follows: Cloyd M. Chapman, chairman; George N. Van Derhoef, Hunter Morrison. Louis W. Williams, and Russell E. Nelles.

Shafting Used for Transmission of Power

This committee was confronted with two distinct but closely related problems, namely, the standardization of the diameters of shafting used for the transmission of power, such as lineshafts, countershafts, etc., and the standardization of the diameters of shafting used by machinery manufacturers in making up their product. The first of these problems seemed to be the simpler of the two. While a large number of sizes of transmission shafting are now listed and stocked, it was believed that comparatively few of these are in extensive general use. Accordingly, a letter was sent to thirty-six of the largest manufacturers and dealers in transmission shafting asking for statistics on the consumption of each size of shafting handled by them. About twenty of the largest concerns in the industry furnished complete statements of their sales over periods of time chosen by themselves. These data were reduced by the committee to a uniform basis of percentages. The amount of each size sold was expressed as a percentage of the total sales, both on a weight basis and on a lineal-foot basis. From these data, plotted in the form of a diagram, it was evident which of the sizes were popular and generally used and which were more rarely called for. A tentative list of twelve sizes was prepared from this diagram and sent to forty-six other dealers in transmission shafting and shafting supplies from whom twenty replies were received.

In the letters to these firms, the committee expressed the opinion that the custom of using shafting 1/16 inch under the unit sizes is so firmly and so nearly universally established in this country, that it would be unwise to attempt to adopt sizes in even inches and fractions as standard. It was pointed out, also, that certain sizes stand out preeminently as "popular sizes" and that others are sold in relatively small quantities. It therefore seemed feasible to reduce the number of sizes now listed by the trade from fifty or sixty down to twelve or fifteen.

The response to these letters was practically unanimous in opinion. The transmission shafting users and dealers approved the plan of standardization, and the sizes suggested were generally approved except that the diameters 1 11/16 inches and 2 3/16 inches were in many cases requested to be included. After due consideration the committee decided to include these two sizes in the original list, making the fourteen sizes now adopted as standard.

Shafting Sizes Used in Machine Design

The second problem was a more intricate one. The number of sizes now produced by the rolling mills for use in machinery is very large. Almost every sixty-fourth of every inch up to three inches is drawn. If a reasonable number of these sizes could be eliminated or classed as "specials" and a comparatively few sizes selected as standard or stock sizes, a great saving would be effected. In order to get the opinions of leading consumers of shafting for machinery purposes, the committee decided to lay the plan before 225 large consumers of this material. It was explained that it was not intended that the adoption of certain sizes as standard should make it impossible to secure any other size required on special order.

In the case of machinery shafting the users were equally unanimous in their approval of the plan to standardize sizes, but recommendations as to size intervals varied greatly. However, these recommendations, in so far as they were definite and specific enough, were tabulated and a diagram constructed showing the relative popularity of the various size increments for each inch of diameter.

Approval of Commercial Trade Association

With these data accumulated and sifted down to usable form, the committee felt that it was in a position to present its information and preliminary deductions to representatives of other interested organizations. Accordingly, invitations were issued to twelve societies and associations requesting them to consider the proposed lists of standard sizes and to appoint representatives to confer with the committee before its report was finally formulated. The seven organizations listed below responded, and the standard sizes which follow have the unanimous approval of these representatives and, as far as can be learned, of their associations: American Hardware Manufacturers' Association; American Railway Engineering Association; American Supply & Machinery Manufacturers' Association; National Association of Manufacturers of the U. S. A.; National Association of Purchasing Agents; National Machine Tool Builders Association; and Southern Supply & Machinery Dealers' Association.

Approved Report on Shafting Sizes

On January 14 the committee submitted to the council a report in which it recommended the approval and adoption of the following lists of sizes as standard for the society:

Transmission Shafting—15/16, 1 3/16, 1 7/16, 1 11/16, 1 15/16, 2 3/16, 2 7/16, 2 15/16, 3 7/16, 3 15/16, 4 7/16, 4 15/16, 5 7/16, and 5 15/16 inches.

Machinery Shafting—Size intervals extending to 2½ inches, by sixteenth inches; from 2½ to 4 inches inclusive, by eighth inches; and from 4 to 6 inches by quarter inches.

The council approved the report and accepted the recommendations.

* * *

"We have proved in many places that the doctrine of service which has been preached in the churches as religion is not only good economics and eminently practical, but because of the increased production of goods obtained by it, promises to lead us safely through the maze of confusion into which we seem to be headed and to give us that industrial democracy which alone can afford a basis for industrial peace."—*H. L. Gantt, in "Organizing for Work"*

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW AMERICAN METAL-WORKING MACHINERY

Gray Thread Milling Machines. Gray Machine Tool Co., Inc., 2649-2653 Main St., Buffalo, N. Y. 875
American Broaching Machine. American Broach & Machine Co., Ann Arbor, Mich. 876
Rogers Adjustable Limit Gage. John M. Rogers Works, Inc., Gloucester City, N. J. 876
Colburn Motor-driven Drilling Machines. Colburn Machine Tool Co., Franklin, Pa. 877
Rieker Precision Levels. Rieker Instrument Co., 1919-1921 Fairmount Ave., Philadelphia, Pa. 878
Brown Expanding Ring Clutch. Brown Engineering Co., 133 N. 3rd St., Reading, Pa. 878
Armstrong-Blum Punch, Shear, and Bender. Armstrong-Blum Mfg. Co., 343 N. Francisco Ave., Chicago, Ill. 878
Cutler-Hammer Automatic Motor Controller. Cutler-Hammer Mfg. Co., Milwaukee, Wis. 879
GTD Opening Die-stock. Greenfield Tap & Die Corporation, Greenfield, Mass. 879
Planing Attachment for Elgin Bench Lathes. Elgin Tool Works, Inc., Elgin, Ill. 879
Pittsburg Hardness Testing Machine and Indentation Micrometer. Pittsburg Instrument & Machine Co., 40 Water St., Pittsburg, Pa. 880
Grand Rapids Tap Grinding Machine. Grand Rapids Grinding Machine Co., Grand Rapids, Mich. 880
Titan Quick-change Drill Chuck. Titan Tool Co., P. O. Box 295, Erie, Pa. 881
Scully-Jones Index-centers. Scully-Jones & Co., 647 Railway Exchange Bldg., Chicago, Ill. 881
Betts-Bridgeford Lathe. Betts Machine Co., Rochester, N. Y. 881
Thomas Power Presses. Thomas Spacing Machine Co., Pittsburg, Pa. 882
Wiesman Punch Press Safeguard. William A. Wiesman, 14 N. Canal St., Dayton, Ohio 883

Gray Thread Milling Machines

THE Gray Machine Tool Co., Inc., 2649-2653 Main St., Buffalo, N. Y., is manufacturing a new line of thread milling machines which are thoroughly universal in type and adapted for use on either tool-room or standard production work. The aim has been to produce a line of thread millers that, while being able to handle a wide range, yet are particularly adapted for production work on one or more parts, and to combine in a compact and simple machine, ample strength and capacity. These thread millers will handle bar work, work held in a chuck, or work held between centers. On work held in a chuck, internal threads can be cut as well as external, and where the only work required to be milled is of the class that is cut with a multiple hob, a plain heavy cutter-head is used; but where the machine is required to use a single cutter, it is equipped with a swivel cutter-head so that the cutter may be held on an angle when cutting worms and threads with steep leads. The work-spindle, which has a hole through it for handling bar work, is driven through mechanism in the head from a three-step cone pulley at the head of the machine, allowing for three different speeds in revolving the work, with an opportunity for varying these speeds.

In developing this line of thread millers, the purpose has been to produce machines that are adapted for a wide range of work and yet well suited for the performance of special manufacturing operations. Provision is made for operating on pieces held in a chuck or between centers, and a hollow spindle enables threads to be milled on long bars. Either a multiple hob type of cutter or a single cutter can be employed, and when using a single cutter the carriage may be moved along the bed for milling a thread over a considerable length on the work. When the work is held in the chuck, either external or internal thread milling operations can be performed.

The carriage, which is moved along the bed by means of a shaft shown in front of the machine, supports the cutter-head mounted on a cross-slide. On the smallest sized machine, there are no change-gears between the carriage and the work-spindle, the lead being acquired through a threaded sleeve and nut on the lead-screw shaft, which is directly geared to the work-spindle. The threaded sleeve can be set at any point on its shaft, by means of an adjusting screw and handwheel at the rear of the machine, which also permits the setting and adjusting of the cutter. Power is transmitted to the cutter-spindle through spur, bevel, and spiral gears by a three-step cone pulley, placed on a shaft at the back of the machine. The shaft on which the cone pulley is mounted extends the full length of the machine, and is splined, allowing the head to be moved to any position along the bed without shifting any belts.

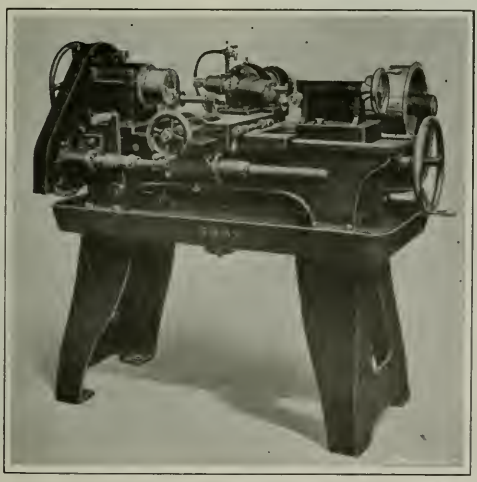


Fig. 1. Smallest Size of the Gray Machine Tool Co.'s Thread Miller equipped with a Swivel Head

Ball thrust bearings are used in the construction of the cutter-head. The cutter-spindle is made of high-carbon steel, hardened and ground, and carried in tapered bronze bearings which allow all wear to be taken up. The hole through the work-spindle makes it possible to introduce work from either end of the spindle, and if so desired, the machines can be equipped with air chucks. Ample lubrication is provided throughout the machines, and they are equipped with oil-pans and oil-pumps, and all cutting compound is strained before it is again delivered to the work. All standard machines are furnished complete with a countershaft with ring oiling bearings.

When cutting threads with a multiple hob, a thread can be milled with one revolution of the work, plus a slight over-travel. The hob is first set to the proper depth by means of a micrometer dial on the cutter-head cross-slide. The feed is started by throwing the handle in front of the machine to the right, and after making one revolution, the feed is automatically tripped, an adjustable stop being provided where duplicate parts are to be milled in quantities. After the thread is milled, the handle referred to is thrown to the left, engaging a quick-return mechanism, which returns the

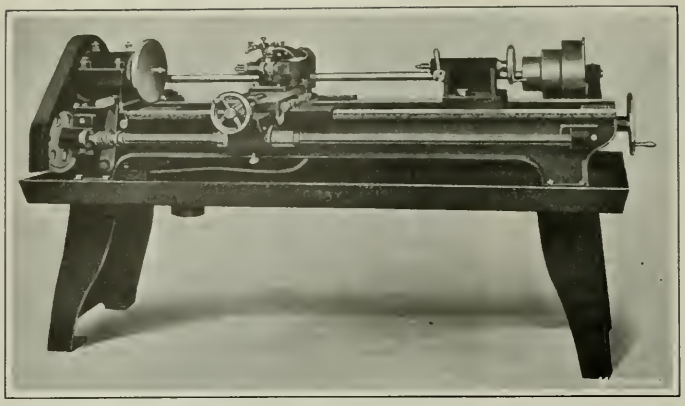


Fig. 2. Smallest Size of the Gray Machine Tool Co.'s Thread Miller equipped with a Swivel Head and a Long Bed

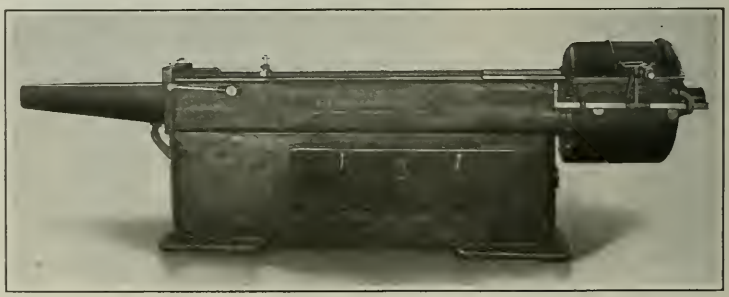
hob to the starting point. Another point is that the quick-return mechanism can be so utilized that parts may be faced and trued up with the thread. When milling lead-screws, worms, or other parts of considerable length with the single cutter, where more than one revolution is required for doing the work, a tripping device may be attached. For handling work on centers, a tailstock of rigid design is supplied, and for cutting multiple threads on worms or other parts, a special indexing faceplate is provided. The preceding description of the smallest sized machine covers the larger sizes, with the exception that various leads of threads are obtained by means of change-gears in place of threaded sleeves and nuts, and the larger sizes of machines are mounted on pedestals or box type beds. While these machines are designed for belt drive, a direct motor drive can be furnished when it is required.

AMERICAN BROACHING MACHINE

The No. 3 broaching machine which forms the subject of the following description is a recent product of the American Broach & Machine Co., Ann Arbor, Mich. It will be seen that a single belt drive is employed, power being transmitted through a steel driving pinion and two steel idler gears. The main driving gear is of the internal type, which was adopted to provide the balanced effect that is obtained with this type of transmission. All of the gears are enclosed and do not run when the machine is on its reverse stroke, which is made at a high ratio as compared with the cutting stroke. A quickly removable nut is provided, that can be taken off with very little loss of time and without the necessity of removing the screw; also, the nut can be removed regardless of the position, which is important, as it is claimed to save considerable time when it is necessary to replace a worn out nut. A large roller thrust bearing and the nut are mounted in a compartment so that they run in an oil bath, and are well protected from injury caused by grit and other foreign matter.

On the front of the column there is a finished face with two T-slots for bolting in place a work-holding fixture, oil-pan, or supporting table, according to the requirements of the work. A large oil-pump, which is driven directly from the countershaft and always runs in one direction, affords a constant supply of lubricant. There is a tool cupboard provided in the base for storing broaches and other accessories used on the machine. This cupboard is provided with shelves, and so arranged that when the door is open it rests in a horizontal position and serves as a shelf. Two hard wood sills across the inside of the door enable tools to be laid down without danger of damaging them.

The operating handle is of the ball control type, which allows easy operation from any position of the operator. This handle can be placed in any position horizontally, vertically, or in any other location around a complete circle. A hardened and ground spindle is provided on the machine, and it drives the nut directly at its front end, the spindle being hollow to allow the screw to pass through and afford a well balanced construction. The screw passes through the spindle and the gearing mounted centrally around the spindle. The sliding head is fitted with hardened steel shoes which slide in box-shaped ways. The screw is of the buttress thread type, which affords ample strength, as the load is all in one direction. The screw is locked to the sliding head by a square key and lock-nut, which provides for easy assembling or disassembling.

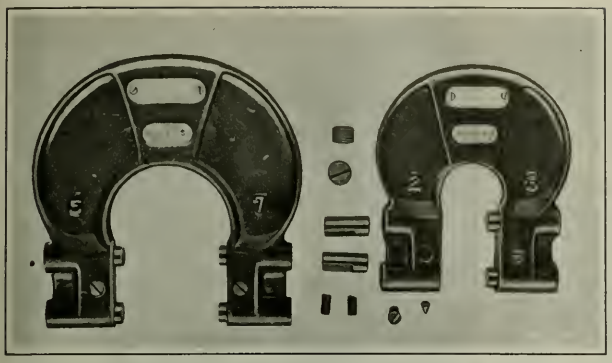


No. 3 Broaching Machine built by the American Broach & Machine Co.

ROGERS ADJUSTABLE LIMIT GAGE

One of the latest products of the John M. Rogers Works, Inc., Gloucester City, N. J., is the adjustable limit snap gage which is here illustrated and described. Gages of this type are made in twenty-two different sizes, the smallest of which has a range of from 0 to ¼ inch while the largest has a range of from 8 to 8½ inches. The frame of the gage is double-ribbed to afford extreme rigidity, which is obviously a most important feature in a tool of this type; and the anvils are made of alloy steel hardened, ground, and lapped to afford durability and accuracy. Marking tags showing the sizes are made in the form of separate brass plates screwed to the frames of the gages, and extra tags may be furnished when they are required.

Having made a general statement of the features of these tools, it will be of interest to learn of some of the points of their construction which are considered important by the manufacturers. Before being machined, the malleable iron castings are well seasoned to guard against danger of their warping after the gages have been finished. All of the gage plugs are carefully lapped, both on their diameters and gaging surfaces. This accuracy in sizing the diameters of the plugs enables them to fit snugly into the holes in the frame which are line-reamed to assure parallelism. The plugs are



Adjustable Limit Snap Gage made by the John M. Rogers Works, Inc.

so designed that they cannot turn in the frame. The adjusting screws have a fine-pitch thread, which permits of making accurate adjustments. The Rogers master locking device, in addition to firmly setting both anvils with one master screw, can also be set to hold a slight tension equally on the anvils while adjustments are being made. When the master locking screw is firmly set, the space provided over the head may be sealed, making the gage proof against tampering.

It is an easy matter to set the plugs to any dimension within the range of the gage by using any standard measuring plug, block, or disk. Either standard reference disks of nominal size or disks of specified accuracy can be furnished for setting the gages. When the plugs become worn and require repairing, it is only necessary to grind the ends on a wheel and lap the surfaces down perfectly square. Used in this manner, the plugs may be kept in service indefinitely, as they are made of ample length. Adjustable limit gages of this type are especially useful to manufacturers whose product is subject to changes in design, but must be held within specified limits of accuracy, as the adjustment takes care of changes in dimensions, thus avoiding the necessity of scrapping expensive gages.

COLBURN MOTOR-DRIVEN DRILLING MACHINES

The accompanying illustrations show two motor-driven heavy-duty drilling machines, built by the Colburn Machine Tool Co., Franklin, Pa., one of which is equipped with a Cutler-Hammer alternating-current electrical control and the other with an Electric Controller & Mfg. Co.'s direct control for reversing the spindle for performing tapping operations. These machines have been arranged for reversing the spindle with direct-current motors for some time, but it is only recently that any equipment has been available which would accomplish this result with alternating-current motors. As shown in Fig. 1, the alternating-current equipment consists of an automatic motor starter and a reversing switch. The automatic starter is contained in a metal box which may be mounted directly on the machine or fastened to the wall, the latter arrangement being illustrated. A reversing switch is mounted on the column of the machine directly above the feed-gear box, and is connected to the operating lever by sprockets and a chain. It has three positions, namely, forward, neutral, and reverse. When tapping a hole, the operator simply throws the lever to the forward position, and when the tap reaches the desired depth, he throws it to the extreme opposite (reverse) position, which reverses the spindle instantly and withdraws the tap. To stop the machine, the lever is thrown to the neutral position.



Fig. 1. Heavy-duty Drilling Machine built by the Colburn Machine Tool Co. and equipped with an Automatic Alternating-current Motor Starter and a Reversing Switch

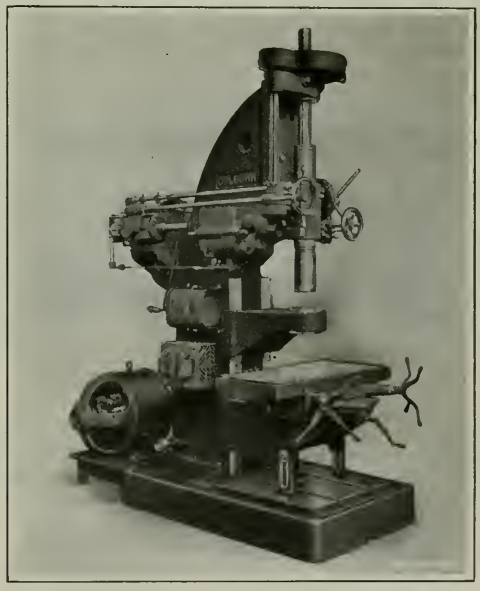


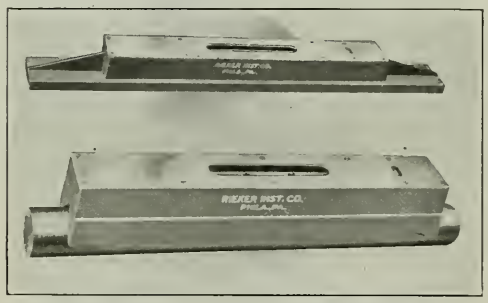
Fig. 2. Heavy-duty Drilling Machine built by the Colburn Machine Tool Co. and equipped with an Automatic Direct-current Motor Starter and a Reversing Switch

As illustrated in Fig. 2, the direct-current equipment also consists of an automatic motor starter and reversing switch, but it differs somewhat in mechanical detail from the alternating-current equipment. In this illustration, the starter and reversing switch are shown mounted directly on the column of the machine. This reversing switch also has three positions, namely, forward, neutral, and reverse; and control is carried to the operating lever at the front by means of a lever and link. In operation, this mechanism acts similarly to the alternating-current control. Throwing the lever to its forward position, starts the spindle; throwing it to the extreme opposite position, reverses the spindle; and throwing it to neutral, stops the spindle immediately. Colburn heavy-duty drilling machines are built in three styles and several sizes, and although the illustrations show reversing

alternating- and direct-current motor control as applied to the larger machines, either style of control is readily adaptable to the smaller sizes of drilling machines. The use of electrical control for reversing the spindle of either an alternating- or direct-current motor-driven drilling machine eliminates all shock and jar. Moreover, it reduces the wear and tear on the machine and increases its term of service.

RIEKER PRECISION LEVELS

Many users of machine tools do not exercise sufficient care in leveling up their equipment. Doubtless this is due to a lack of knowledge concerning the way in which attention paid to this subject will often increase the efficiency with which machinery is able to operate. The Rieker Instrument Co., 1919-1921 Fairmount Ave., Philadelphia, Pa., has recently developed a new line of precision levels which are adapted for use in setting up the equipment in machine shops. These instruments are furnished with a level vial that is ground on its inner surface so that when a plane is out of level 0.001 inch per foot, it deflects the air space or bubble 0.1 inch under the graduated face of the vial. In other words, if a 12-inch level is placed on a surface and the level bubble is found to be one of the 0.1-inch graduations off center, the plane is out of level 0.001 inch per foot, or the corresponding number of thousandths for any length of the plane expressed in feet. Level tubes of this type are mounted in frames of various forms to adapt them for use

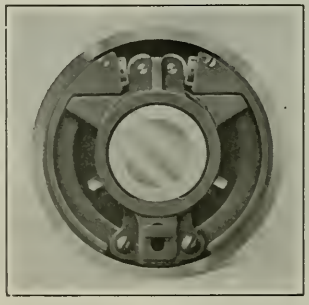


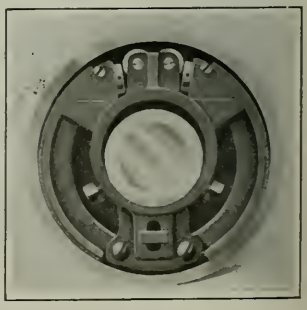
Two Types of Precision Levels made by the Rieker Instrument Co.

in the installation and maintenance of planers, shapers, lathes, millers, grinders, boring machines, shafting, and for various other purposes. While the instruments carried in stock deflect the bubble as stated, levels of other degrees of sensitiveness can be provided.

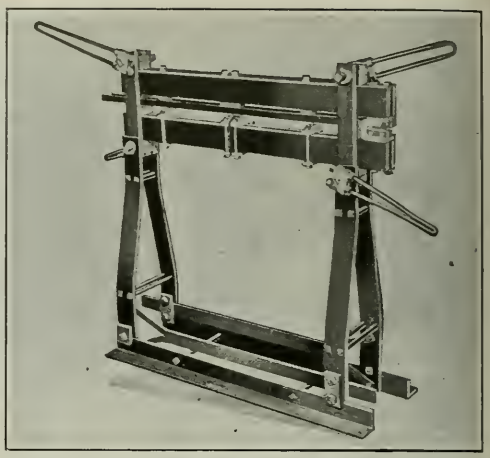
BROWN EXPANDING RING CLUTCH

The Brown Engineering Co., 133 N. 3rd St., Reading, Pa., is now manufacturing an expanding ring friction clutch, which is designated as the Type ER "Mule-pull" clutch. It is intended for use where a small compact clutch of simple design is required, as on crowded line-shafts and for installation in machinery where it is necessary to have a clutch with interchangeable parts. All of the parts of these clutches are made in large quantities, and all holes are jig-drilled. The friction surfaces are faced with thermoid brake lining, and the adjusting screws on which the rolls track, are made of 100-point carbon tool steel. Each clutch is supplied with a fitted key, shifter yoke, and fulcrum; and two hardened set-screws, placed at 90 degrees, are used, one to hold the key in place and the other to prevent the clutch from moving on its shaft. Clutches of this design are manufactured in both the extended sleeve type and the cut-off coupling type.





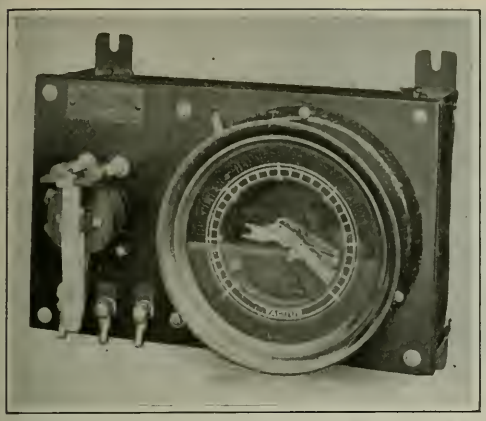
Figs. 1 and 2. Type ER "Mule-pull" Expanding Ring Friction Clutch manufactured by the Brown Engineering Co.



Combination Punching, Shearing and Bending Machine built by the Armstrong-Blum Mfg. Co.

ARMSTRONG-BLUM PUNCH, SHEAR AND BENDER

A No. 23 combination punching, shearing, and bending machine which is here illustrated and described has recently been added to the line of products of the Armstrong-Blum Mfg. Co., 343 N. Francisco Ave., Chicago, Ill. It will be seen that the machine is built almost entirely of bar steel, with the horizontal tool-holding bars spaced ¾ inch apart to form bolt slots for clamping various tools. Pressure is applied to these members by an eccentric and link arrangement at both ends. Several punches and dies may be placed between the links and spaced according to the requirements of the work, to provide for simultaneously punching a row of holes. A punch and die, a V-block bender, a shear, a notcher, and other similar tools may be set in the machine at the same time, so that all of them can be used at a single downward stroke. The tool-holding bars have a capacity of 40 inches between the links, and the links are slidably mounted on an angle-iron base, so that they may be shifted to give a deep throat on one or both ends of the machine; also, the levers may be worked from one or both ends at the same time. Various combinations of tools may be arranged to suit the requirements of different jobs. On this machine, ⅝-inch holes may be punched in ¾-inch stock with a 2-inch throat, or ¼-inch holes may be punched in ¼-inch stock with a 9-inch throat. The machine will shear ½- by 2-inch bars, notch 1½- by 1½- by ¼-inch angle-iron, bend 1½- by 1½- by ¼-inch angle-iron to 90 degrees, slit ¼-inch sheets lengthwise, and perform other similar operations. Vertical travel of the bars with one lever is 7/16 inch, and with two levers, ⅞ inch; space between upper and lower bars is 3¼ inches.



Automatic Controller made by the Cutler-Hammer Mfg. Co., for Use with Motors employed to drive Pumps and Compressors

CUTLER-HAMMER AUTOMATIC MOTOR CONTROLLER

A new gage type pressure regulator made by the Cutler-Hammer Mfg. Co., Milwaukee, Wis., is shown in the accompanying illustration. This regulator is intended to replace the alternating-current and direct-current gage type regulators formerly manufactured by this company. It consists of a pressure gage and relay mounted on a slate panel carried on a wall type frame, and may be used on either alternating-current or direct-current circuits. It is claimed that this regulator is more durable and less expensive than the types formerly manufactured. In operation, it automatically controls the pilot circuits of the automatic motor starters connected to the motors which drive the pumps or compressors.

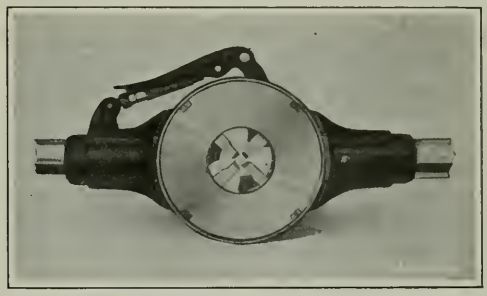
This controller can be used on pressure systems operating either above or below atmospheric pressure. As the pressure falls or rises, the needle indicator of the pressure gage makes contact with one of two adjustable contact points, thereby starting or stopping the motor when the pressure falls or rises to the points at which the contacts are set. The two contact points can be set so close together that a change of only 5 per cent of the total reading shown on the gage is sufficient to stop or start the motor. The contact points are made accessible for adjustment by simply unscrewing the glass cover of the dial.

The pressure inlet hole in the gage cover is tapped for a ¾-inch pipe. The gage can be supplied with dials reading in various capacities, the smallest being 0 to 25, and the largest 0 to 10,000, all readings being in pounds per square inch. Dials reading from 0 to 30 inches of mercury below atmospheric pressure can also be provided. This type of gage can also be furnished for ammonia service reading from 0 to 300, and for this purpose the operating mechanism is constructed from material which readily resists ammonia fumes. The relay used in connection with the gage has solid copper contacts, and operates on either direct or alternating circuits. Pressure regulators of this type must always be mounted in a vertical position, and should be connected to an independent pipe from the pressure tank or to the discharge line from the pump, with an air chamber interposed to prevent fluctuation in pressure produced at each stroke of the pump from seriously affecting the gage needle.

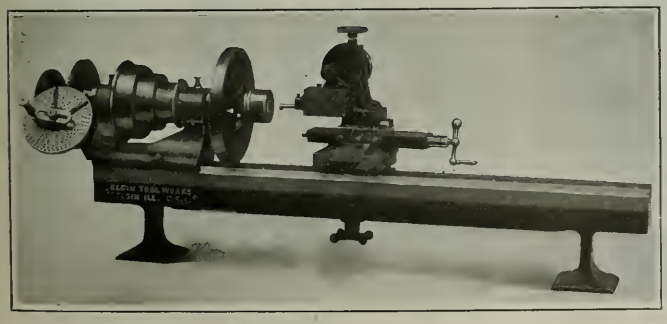
GTD OPENING DIE-STOCK

The opening die-stock shown in the accompanying illustration is a recent product of the Greenfield Tap & Die Corporation, Greenfield, Mass. When cutting threads, this die-stock is used just as an ordinary solid die-stock would be operated. After the desired length of thread has been cut, however, a simple movement of the clamping lever withdraws the chasers from contact with the work, thus permitting the die-stock to be removed. The die is then reset by simply pushing the lever toward the body of the stock.

To remove the chasers, the clamping lever is opened part way, and at the same time the round-head pin at the end of the lever is pressed down. This movement disconnects the clamping lever from the cam-lever, which projects from the body. The cam-lever is next swung as far as it will go toward the clamping lever, and the chasers are then free and can be removed for resharpening or replacement with another size. If another size of thread is to be cut, the proper chasers are slid into their respective slots, as designated by the numbers on the ends of the chasers. When the scratch on the chasers comes flush with the outside of the body, the cam-lever is moved toward its closed position, and at the same time the clamping lever is engaged. The die is now ready for use. Adjustment for the exact size of threads is marked on the side of the body, but by turning the sleeve on the knurled turnbuckle, the die can be set to cut threads either larger or smaller than standard.



Opening Die-stock manufactured by the Greenfield Tap & Die Corporation



Elgin Tool Works Bench Lathe eqnipped with a Planing Attachment

PLANING ATTACHMENT FOR ELGIN LATHES

For use in the performance of precision planing and slotting operations on a bench lathe, and for such work as cutting keyways, small internal gears, openings in dies, etc., the Elgin Tool Works, Inc., Elgin, Ill., recently developed an attachment for use on one of the bench lathes of its manufacture. This device was originally intended for handling work in the shops of the Elgin Tool Works, but it proved so successful in operation that a decision was later reached to

manufacture the attachment for the market. It is somewhat similar in construction to the No. 14 geared miller, except that the hardened spindle is provided with a crankpin and roller working in a slot in the hardened steel ram, with provision for regulating the stroke to either ½, ¾, or 1 inch. All slides on the machines are provided with gibs and gib screws, and the feed has a large knurled steel handwheel which is graduated to 0.001 inch. The ram housing is graduated to read in degrees and may be set to cut the proper clearance inside of a die. A clapper is provided on the toolpost to afford clearance on the return stroke, and either round or square tools may be used. There are two slots placed at right angles in the base, which match the one in the slide-rest, and the attachment may be placed in any of the four positions that make it best suited for the requirements of the work.

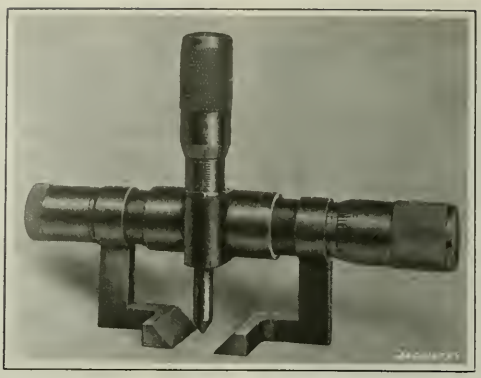


Fig. 2. Indentation Micrometer for Use with the Hardness Testing Machine shown in Fig. 1

PITTSBURG HARDNESS TESTING MACHINE AND INDENTATION MICROMETER

For use in making hardness tests by the Brinell method, the Pittsburg Instrument & Machine Co., 40 Water St., Pittsburg, Pa., has recently added to its line a Style C machine. Since the practicability of the Brinell method of testing was clearly demonstrated, a number of sizes of machines have been built to meet the requirements of various classes of work, and it was with a view of developing a Brinell tester suitable for the requirements of laboratories and tool-rooms that the Pittsburg Instrument & Machine Co.'s Style C tester was developed. There is a slight difference in the construction of this machine from the standard type of this concern's manufacture, inasmuch as the oil reservoir is attached to the side of the supporting frame and arranged in such a manner that the overflow of oil from the cylinder will circulate back to the reservoir. The maximum distance between the 10-millimeter steel ball and the table is 3 inches. An idea of the construction of the machine will be obtained by reference to Fig. 1. Fig. 2 shows an instrument known as an indentation micrometer, which has been developed for use with the testing machine in conducting hardness tests by the Brinell method. It consists of horizontally and vertically working micrometers, and can be used to read the diameter and depth of impressions up to 0.01 millimeter.



Fig. 1. Brinell Hardness Testing Machine built by the Pittsburg Instrument & Machine Co.

GRAND RAPIDS TAP GRINDING MACHINE

In the April number of MACHINERY, a description was published of a machine developed by the Grand Rapids Grinding Machine Co., 29 Ottawa Ave., N. W., Grand Rapids, Mich., for use in grinding the taper at the end of a tap and the clearance back of its cutting edges. This machine had a capacity for handling taps ranging from ⅜ inch up to 3 inches in diameter. To provide for handling smaller sizes, a No. 1 machine has been developed, as shown in the accompanying illustration, which is adapted for performing the same grinding operations on taps ranging from No. 6 machine screw up to a maximum of 1 inch plug taps; it will also grind tapered taps, where the length of the taper does not exceed 1½ inches. When grinding taps with centers, the work is mounted between the centers, as on the larger sized machine previously described. In the case of small taps that do not have centers, the shank is held in a Jacobs drill chuck and the point in a female center, the chuck and center being interchangeable with standard centers.

To facilitate the handling of very small taps, the tap-holder is mounted in a horizontal position and the grinding is done on the periphery of a straight wheel. The principle of operation is that the axis on which the tap is swung while performing the grinding operation is offset from the axis of the tap by an amount that is sufficient to provide the desired degree of clearance, the amount of offset being adjustable, with provision for having this offset at either the right or left of the



Machine built by the Grand Rapids Grinding Machine Co. for grinding Small Sized Taps

center for grinding right- or left-hand taps. The angle of taper or lead is also adjustable to handle anything from very blunt plug taps up to long tapered taps. Ring-oiled bronze bearings support the spindle. The housing is bored on a taper, and the bronze bushings are turned to a corresponding taper and furnished with adjusting collars for taking up wear. These collars have felt rings to provide for excluding dust. A diamond wheel-truing device provided with a diamond is part of the regular equipment.

TITAN QUICK-CHANGE DRILL CHUCK

For use in driving straight-shank drills, the Titan Tool Co., P. O. Box 295, Erie, Pa., is now manufacturing a quick-change, positive-drive chuck, which is claimed to eliminate all chance of the drill slipping. This chuck is especially adapted for use on multiple-spindle drilling machines where a number of holes are to be drilled within a relatively small area, it being possible to drill on 7/8-inch centers when using chucks of this type. The largest size of straight-shank drill which can be used on 7/8-inch centers is 5/16 inch in diameter, but larger sizes of straight-shank drills can be used on proportionately greater centers. Another claim made for this chuck is that it eliminates all torn or mutilated shanks due to slipping. Drills can be removed from these chucks for grinding or for any other purpose without requiring the spindles to be stopped.

SCULLY-JONES INDEX-CENTERS

Scully-Jones & Co., 647 Railway Exchange Bldg., Chicago, Ill., are now manufacturing multiple index-centers of the type here illustrated and described. These tools were designed by T. L. Maisch, works manager of the company, and they were originally developed for use in manufacturing Scully-Jones Woodruff keyway cutters and end-mills. It will be seen that there are eight spindles, all of which are geared together so that indexing of all centers is accomplished by a single index-plate and pin. The mechanism is completely enclosed, making it impossible for dirt to find its way into the working parts or for the operator's hands or clothing to get caught in the gears, etc. Index-centers of this general type will be made to suit the requirements of different classes of work. The equipment shown in the accompanying illustrations has the spindles spaced on 1½-inch centers, but the design can be modified to give a considerable range of center distances; also, the number of spindles can be varied. Accuracy in indexing is obtained by making the diameter

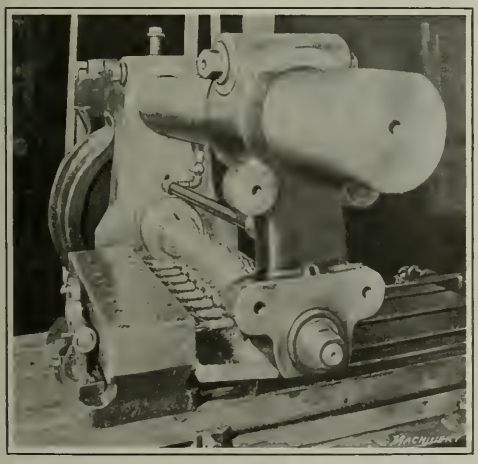


Fig. 1. Eight-spindle Index-centers recently developed by Scully-Jones & Co.



Fig. 2. Opposite End of the Scully-Jones Index-centers

of the index-plate several times larger than the diameter of the work.

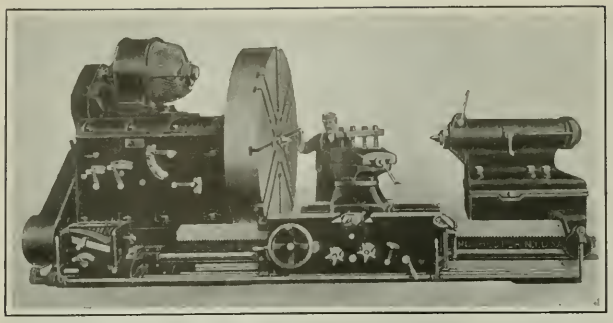
These index-centers are well adapted for use in cutting the teeth of gears and sprocket wheels, milling splined shafts, etc.; and if mounted on an angle-plate, they could be readily employed for cutting the teeth of bevel gears and pinions. The master shaft forms one of the centers and all shafts are geared together so that they rotate in unison. To provide for milling helical cutters and gears, a simple device is made to actuate the master shaft without depending upon the accuracy of the transmission in the milling machine. It consists of a sine bar, a rack, and a gear on the master shaft of the index-centers. A bracket for attaching this device is fastened to the column of the milling machine.

BETTS-BRIDGEFORD LATHE

An all-geared-head lathe to swing 60 inches and 72 inches has been designed by the Betts Machine Co., Rochester, N. Y. The headstock is of the all-geared, enclosed type and is driven through an expanding ring friction clutch which is operated from the apron, a position which is always convenient for the operator. The same movement which disengages the clutch automatically applies a friction brake, thereby stopping the machine almost instantly. There are twelve spindle speeds in geometrical progression, any one of which can be instantly obtained. These speeds are controlled by means of conveniently located levers at the front of the headstock.

All speed changes are obtained through hardened steel sliding gears and positive clutches running in oil, with the edges of the gear teeth rounded to allow for instant and easy engagement. No two speeds can be engaged at the same time. All shafts and gears are located in the lower half or base of the headstock, thereby allowing easy access to all of the parts, it being necessary only to remove the cover. All shaft bearings are bronze-bushed, and all bearings are lubricated by means of chain oilers. When this machine is motor driven, the motor is mounted on top of the headstock cover and directly connected through gearing to the main driving shaft.

There are thirty-two changes of feeds and leads obtainable through quadrant gearing and a quick-change gear-box to the lead-screw. The feeds are driven from a spline in the lead-screw to the rack on the bed through all-steel gearing and amply proportioned frictions. No two feeds can be engaged at the same time, and the feeds and leads are interlocking, so that only one can be in use at one time. The apron is of the double-wall unit casting construction, there being no overhanging studs. All shafts have a bearing on each side and the gearing runs in oil. Power angular feed to the compound slide is driven from the cross-feed friction,



All-geared-head Lathe built in 60- and 72-inch Swings by the Betts Machine Co.

a slip gear being provided for cross-feeding or power angular feeding, and such movements are reversed at the apron. Both feeds and leads may also be reversed at the headstock. Power rapid traverse is obtained by means of a friction clutch on the lower shaft in the quick-change box, which is driven from the constant-speed headstock driving shaft by means of a Morse silent chain at the head end of the lathe. The rapid traverse is operated by a lever at the apron, and the movement which engages the rapid traverse clutch first automatically disengages the feed and lead, making it impossible to have both engaged at the same time. The rapid traverse is applicable to the longitudinal, cross or power angular feed.

THOMAS POWER PRESSES

In the accompanying illustrations there are shown some interesting comparisons between two power presses recently shipped by the Thomas Spacing Machine Co., Pittsburg, Pa., from its Glenshaw plant. These machines may well be called "David" and "Goliath," in view of the fact that the large double-crank drawing press, which has a capacity of 250 tons with 14-inch stroke of the crankshaft, represents a ram capacity of approximately 7 pounds per pound of weight of the machine, while the small open-back inclinable press, which has a capacity of 5 tons with 1½-inch stroke of the crankshaft, represents a ram capacity of 16 pounds per pound of weight of the machine. Moreover, the smaller machine makes 140 strokes per minute, while the speed of the larger is only 17 strokes per minute.

This large double-crank drawing press has some interesting features of design, and the small press is not without its noteworthy points, irrespective of the foregoing comparisons as to capacity. A familiar type of tie-rod construction is used in the large press, with the top, bottom, and side members made of semi-steel, the top tie-piece being cast as a unit and keyed into position on the side housings. The bottom tie-piece or bed casting is aligned by means of finished bolts in reamed holes, and the four threaded tie-rods are heated before finally putting them in place. After screwing down the holding nuts, the rods are tightened further by shrinkage. The height of the ram is adjusted by a motor-driven elevating and lowering attachment. The worm and shaft, gearing, motor, etc., of this attachment are shown in the illustration directly above the upper kick-out bracket.

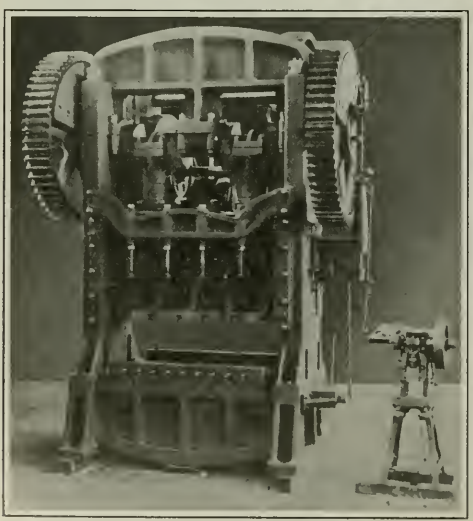


Fig. 1. Two-hundred-fifty-ton Double-crank Drawing Press built by the Thomas Spacing Machine Co.

The direct-geared main driving motor is mounted on a bracket at the rear of the machine, and the reducing gearing with the flywheel shaft, friction clutch, etc., are so laid out as to give a compact and rigid construction with a maximum amount of clear space on all sides of the machine. The arrangement of the clutch knock-out mechanism with provision for auxiliary hand operation may be seen on the right-hand side of the press. The bolster plate, which is made of cast steel, is arranged for holding the lower die in place by means of set-screws as shown, and the upper die is held in place by means of T-head bolts, hung in the T-slots on the face of the ram. This construction provides for quickly changing die set-ups. An adjustable "kick-off" mechanism is provided for both the bed and ram, for loosening the material from the dies after the operation has been completed.

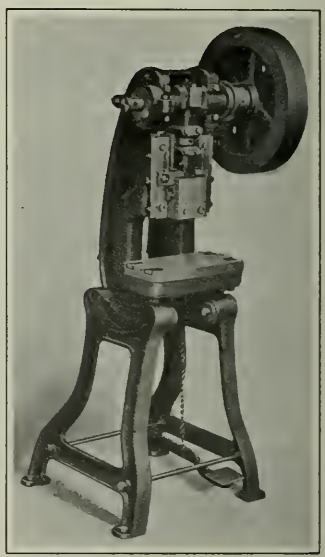


Fig. 2. Five-ton Inclinable Power Press built by the Thomas Spacing Machine Co.

All gears of this press are made of cast steel and are machine cut, which gives a smooth running action. The main driving gears have cast-iron counterweights attached to them, these weights being so proportioned as to insure the ram coming to rest in the "up" position when the clutch is thrown out. The crankshaft main bearings and crank bearings in the cam pintles are all bronze-bushed. The crankshaft, gearing, etc., are of such proportions that if this same design of machine were equipped for operation as a punch, that is, with a camshaft for short strokes, it would have a ram capacity as high as 1000 tons. Another large double-crank press of the same rating as this machine is now being completed on the same contract, but the second machine is of the throat type instead of being built with a central ram and straight side housings, the housings in this case being made of cast steel. On this second machine the clearance

between the housings is 92 inches, or 20 inches greater than that of the press here illustrated. With a stroke of crankshaft of 6 inches, this second press has a rated capacity of 500 tons.

The small open-back inclinable press is of quite standard construction, with a heat-treated, high-carbon, open-hearth steel crankshaft, and it is furnished either with or without bronze-bushed bearings, according to the purchaser's requirements. Perhaps the most noteworthy feature of this press is the patented "non-repeat," automatic type of clutch, the mechanism of which is such that the operator has to release the foot-lever after each stroke of the ram before the clutch can throw in and make another stroke. By the removal of a pin fastened into the clutch collar, the clutch is readily converted into a repeating type.

WIESMAN PUNCH PRESS SAFEGUARD

The punch press safeguard shown in the accompanying illustration was recently placed on the market by William A. Wiesman, of 14 N. Canal St., Dayton, Ohio. This guard was developed in the Wiesman plant for the protection of its own employes. Factory inspectors and insurance examiners who noticed the guard in action suggested that it be placed upon the market, and after two years of successful operation in various plants, it is now offered to the trade in six sizes. As will be seen in the illustration, it consists principally of brackets carrying an adjustable fulcrum pin on which the guard proper is mounted; and a pin attached to the crankshaft bearing-cap which transmits motion to the guard when the press is in operation.

When the press is tripped, the eccentric movement of the pin attached to the crankshaft bearing-cap causes the guard or swinging arm to sweep directly across the mouth of the press, brushing away the operator's hand when necessary. The device is so attached that the arm sweeps three-quarters of the way across the opening and well past the danger point during the first quarter of the stroke of the ram; and it sweeps back four-fifths of the way on the third quarter of the stroke. Some of the notable features are that the guard possesses but two moving parts, and consequently there is but little wear or need for frequent adjustment. It is positively automatic, does not interfere with the operator's work, and does not touch him in any way, unless his hand is allowed to remain on the die when the punch begins its downward stroke. His hand is then brushed quickly but gently to one side. This guard can be quickly attached to any press without boring holes; it is not in the way for any class of work where required; and when not desired, the swinging arm can be removed from the press in a minute's time. The guard is also reversible for either left- or right-hand operators and it can be easily changed from one press to another.



Safeguard made by William A. Wiesman to protect Punch Press Operators

CORRECTION

In the description of a milling machine built by the Gabrielson Mfg. Corporation, 318 First Trust and Deposit Co. Bldg., Syracuse, N. Y., published in the March number of MACHINERY, it was stated that in making the vertical cutter adjustment, a tumbler gear that connects the gearing with the spindle driving gear is dropped down out of mesh by releasing a lever at the front of the machine beneath the spindle-carrier. This part of the description was incorrect, as it is not necessary to drop the gear meshing with the spindle gear out of mesh. In fact, the mechanism is so arranged that these gears positively cannot get out of mesh. The construction and mounting of the rocker holding the gear that meshes with the spindle gear is such that the free end of the rocker is in contact with a cam surface on the spindle carrying the sleeve. This cam is cut so that the gear is always in correct mesh with the spindle gear, regardless of the vertical position of the spindle.

NEW MACHINERY AND TOOLS NOTES

Rail-bending Press: Hydraulic Press Mfg. Co., Mount Gilead, Ohio. A hydraulic rail-bending press which has a capacity of 35 tons. It is of the horizontal type, and mounted on wheels so that the press can be readily moved into the position where it is to be used.

Self-starter for Slip-ring Motors: Cutler-Hammer Mfg. Co., Milwaukee, Wis. An automatic starter with a speed-regulating handle for use in slip-ring motors of various sizes up to 15 horsepower, which are engaged in driving printing, folding, and paper box making machines, etc.

Power Press: Toledo Machine & Tool Co., Toledo, Ohio. A power press which is believed to be one of the largest machines of the deep-gap double-crank type that has ever been built. This machine stands 18 feet 7 inches above the floor line and weighs 175,000 pounds.

Knurling Tool: New Britain Tool & Mfg. Co., New Britain, Conn. A multiple knurling tool provided with three pairs of knurls for accomplishing fine, medium, and coarse knurling. By having a selective set of knurls mounted on the tool, it is unnecessary to change knurls.

Hydraulic Press: Metalwood Mfg. Co., Detroit, Mich. A press for use in operating sizing punches or broaches used for finishing the tappet guide holes in motor cylinder blocks. It is claimed that this machine performs the equivalent of a broaching operation at a lower cost.

Tool Sleeve: J. C. Glenzer Co., Fort St. W. and 14th St., Detroit, Mich. A "Utility" tool sleeve which is intended for use with straight-shank drills, reamers, etc. It is made of 3½ per cent nickel steel, and provides for setting up straight-shank tools in the spindle of a machine with a tapered socket.

Gang Drilling Machine: Dauber-Kratsch Co., Oshkosh, Wis. An all-geared machine on which the upper structure is similar to the Wisconsin 20-inch gear-driven drilling machines of this company's manufacture, while the base is so designed that the machines can be built up in units of two or more spindles.

Plate-bending Roll: Southwark Foundry & Machine Co., Philadelphia, Pa. A plate-bending roll built for the Mare Island Navy Yard, which is believed to be the largest equipment of this type ever constructed. This machine is especially adapted for bending keel plates or other work where a sharp radius is required.

Electric Rivet Heater: American Car & Foundry Co., 165 Broadway, New York City. An electric rivet heater employing the step-down transformer principle which is claimed

to reduce the percentage of spoiled rivets. It is also stated that in the operation of a furnace of this type there is no discomfort caused by smoke or heat and very little fire risk.

Electric Metal Melting Furnace: Industrial Electric Furnace Co., Chicago, Ill. An electric furnace of small capacity, which was designed to meet requirements in making castings. Furnaces of this type are built for capacities up to 1½ tons, and are especially adapted for making castings of special composition where only a moderate amount of metal is to be melted.

Tiering Machine: Revolvator Co., 336 Garfield Ave., Jersey City, N. J. A tiering machine for elevating and piling cases, bales, etc., which is of improved design and provided with dual control so that it may be hand- or motor-operated, the same crank being employed in either case. Other features of similar machines built by this company are incorporated in the present instance.

Cartridge Fuse Remover: Bush Electric Co., Cleveland, Ohio. A tool for use in removing and replacing cartridge fuses. It is made entirely of a special insulating compound with the parts held together by small rivets. A small movement of the handles as compared with a large movement of the gripping jaws, makes the tool easy to operate when working around live circuits.

Cold Saw: Higley Machine Co., South Norwalk, Conn. A new model known as the No. 11½ B, which has capacity for cutting work up to 3 inches on either square or round stock. The work clamps are so constructed that four 1½-inch rods may be cut off simultaneously, or by shifting the V-plate of the clamping mechanism one-quarter turn, two 3-inch rods may be cut off in like manner.

Gear-hobbing Machine: Hercules Machine & Tool Co., 404 Broome St., New York City. An improved design of the 8-inch gear hobbing machine of this company's manufacture. It is furnished with a special device providing means for exact adjustment in centering the hob. For generating spiral gears, a differential is employed, which simplifies adjustment and assures precise machine operation.

Hot Swaging Machine: Langelier Mfg. Co., Providence, R. I. A machine especially designed for use in forming a U-shaped joint uniting a pair of pipes, although its application is not limited to a single class of work. It can be employed for swaging straight pieces with satisfactory results. The design employs standard Langelier features of construction combined with a number of new features.

Metal Strip Cutting Machine: Yoder Co., Cleveland, Ohio. A machine for use in cutting sheet metal into strips suitable for various purposes. It is claimed that this equipment provides a rapid means of performing the operation and that the work is done in a way that insures parallelism of the edges. Machines of this type are made in several sizes to accommodate various widths and thicknesses of metal.

Duplex Air-operated Chucks: Logansport Machine Co., Logansport, Ind. Air chucks of similar design to the ones illustrated and described in MACHINERY for April and June, 1919, except that a duplex control mechanism is provided to adapt the chucks for use on double-spindle turret lathes built by the Jones & Lamson Machine Co., of Springfield, Vt. Frank G. Payson Co., 9 S. Clinton St., Chicago, Ill., is the selling agent.

Sheet Tinning Machine: Aetna Foundry & Machine Co., Warren, Ohio. A machine designed for use in tinning heavy sheets used in the manufacture of milk-can bodies. There are three pairs of rolls, the lower pair acting as feed-rolls, the second pair, which run in a bath of tin, acting as spreaders, and the upper pair of rolls, which run in an oil bath, removing the excess tin, and leaving the sheets with the desired coating and finish.

Portable Graphoscope Projector: Graphoscope Development Co., 50 E. 42nd St., New York City. A moving picture apparatus especially designed for the use of salesmen. This complete unit, ready for operation, is packed in a case of about the same size as an ordinary suitcase. It is equipped with a motor drive and is of simple construction. The machine uses standard films and will project a picture 10 feet square at a distance of 35 feet.

Turret Chuck: Scully-Jones & Co., 647 Railway Exchange Bldg., Chicago, Ill. A "Wear-ever" turret chuck, which is of the same general construction as other chucks of this company's manufacture, but is designed to hold square-end tap shanks or other tools with shanks of the same form. Various sizes of chucks are made to fit different diameters of tap shanks, and standard bushings may be furnished to allow a chuck to be used in large turret holes.

Maximum Demand Meter: Westinghouse Electric & Mfg. Co., East Pittsburg, Pa. A new type of maximum demand meter which employs the principle of thermal storage and indicates what has been termed the logarithmic average demand. A new line of instruments has been developed on this principle which includes indicating watt demand meters for alternating-current circuit, and ampere demand meters for alternating- and direct-current circuits.

Oil-fired Furnace: Gaskill Furnace Co., 155 N. Market St., Chicago, Ill. An oil-fired furnace built in several different designs to meet the requirements of foundries, forge shops, and heat-treating plants. Provision is made for preheating the air and oil before they enter the combustion chamber, and it is stated that this not only gives more complete combustion, but also protects the crucible and furnace lining from the destructive effect of damp cold air.

Duplex Lathe: Greenlee Bros. Co., Rockford, Ill. A double-end lathe with a center drive which provides for simultaneously performing two operations with tools provided at either side of the driving head, which is located at the center of the machine. This lathe was originally designed for simultaneously turning both ends of automobile axles, but it is now being applied with equal success on bar and shaft work where only the ends have to be turned.

Precision Bench Lathe: Package Machinery Co., Springfield, Mass. A precision bench lathe known as the "P.M.C.", having all its parts made to master standards, thereby insuring their interchangeability. The spindle bearings are adjustable for wear, and a ball thrust bearing is provided to take the end thrust. The compound rest has large bearing surfaces, which are adjustable for wear. Provision is also made for taking up the wear in the feed-screw threads. The feed-screws are graduated in divisions of 0.001 inch, and the compound rest is graduated in degrees.

Switch Panel for Remote Control: Cutler-Hammer Mfg. Co., Milwaukee, Wis. This equipment consists of the necessary circuit-breakers, switches, relays, fuses, and recording instruments mounted on slate panels on a floor type of frame. The primary equipment of the control panel includes a hand-operated oil circuit-breaker provided with inverse time overload attachments, a phase failure and phase reversal relay, and an automatic starter of the auto-transformer type. This switch panel is for use with induction motors, but with slight changes it could be used with synchronous motors.

Centerless Grinding Machine: Russell, Holbrook & Henderson, Inc., 30 Church St., New York City. A centerless grinding machine built by F. C. Sanford Mfg. Co., Bridgeport, Conn., which is intended for the performance of precision grinding operations on rolls and other work of uniform diameter. The essential members consist of a grinding wheel, with a feed-wheel opposed to it, this feed-wheel being of smaller diameter and inclined in relation to the grinding wheel. By changing this angle of inclination, the rate at which the work is fed past the grinding wheel may be varied.

Slotter: Alfred Herbert, Ltd., 54 Dey St., New York City. A 6½-inch cone-driven slotter which is built by Harry F. Atkins, Old-Fletton, Petersborough, England. This machine is equipped with automatic feed mechanisms for both slides and for the circular table. The table is of unusually large diameter and is graduated in degrees; it has a locking device with twelve divisions. Provision is made for swiveling the ram to cut tapered keyways or to handle other tapered work. The stroke of the ram is 6 inches, and the machine is capable of making 26 to 77 strokes per minute, while the range of feeds is from 0.004 to 0.024 inch.

Grinding Machine: Marschke Mfg. Co., Indianapolis, Ind. A motor-driven grinding machine termed the "Economy." This machine consists essentially of a motor mounted on a cast-iron column; the starting mechanism contained inside the column; and arbors and suitable guards for two grinding wheels located at the sides of the motor. The motor is controlled by a foot-treadle in front of the base. This treadle can be locked in its running position until released by the operator, or it will work automatically to stop the motor when the foot pressure is released. The wheel guards can be set in different positions for grinding a variety of work.

Automatic Milling Machine: Brown & Sharpe Mfg. Co., Providence, R. I. An automatic milling machine developed for use in the production of duplicate parts in large quantities. This is essentially a manufacturing machine, and is heavily constructed to meet the requirements of severe service. The general features of design of Brown & Sharpe column and knee type machines have been retained. The noteworthy feature of the new machine, which is known as a No. 21 automatic miller, lies in the application of automatic control of the spindle and table, supplemented by important features and refinements to adapt the machine for its peculiar line of work.

Portable Air Compressor: Sullivan Machinery Co., Chicago, Ill. A "Class WK 31 compressor," which consists of a specially designed two-cylinder vertical air compressor driven by a Buda four-cylinder, four-cycle, heavy-duty tractor gasoline engine. This equipment is mounted on a truck body provided with heavy steel wheels, or if desired, it can be mounted on a flat car. The compressor has a displacement of 150 cubic feet of free air per minute and requires 32 horsepower for operation against 100 pounds pressure. Power economy is effected by an unloading device and pilot valve connected with the air receiver, which raises the inlet valves from their seats when the demand for air temporarily ceases.

Electrically Controlled Planer: John Stirk & Sons, Ltd., Halifax, England. A machine known as a "Hiloplane," which is equipped with a reversing motor drive having current supplied through a special generator set that is part of the equipment; magnetic feeds; a graduated dial that provides a simple method of setting the table stroke, no table dogs being employed; and provision for the performance of cross-planing operations. Probably the most striking feature of this machine is its flexibility and ease of control through a special system of driving which incorporates the Ward-Leonard system of employing a special motor-generator to supply current to the individual motor. Alfred Herbert, Ltd., 54 Dey St., New York City is sales agent for this planer.

Bar Straightening Machine: Whitney Metal Tool Co., 109 Forbes St., Rockford, Ill. Ball bearing truing machine designed for straightening bar stock. This machine embodies the company's patented ball bearing spindle which is claimed to give a pressure of over 40,000 pounds per square inch. Round bars can be straightened quickly, as it is not necessary to take the bar from the straightening blocks until the operation is completed. Small rollers on the outside of the V-blocks, equipped with ball bearings, automatically raise the bar from the V-blocks when pressure is removed so that the bar can be rotated by hand. This permits the high spot to be located so that pressure can be applied at the proper position. The machine has a capacity for bars 2 inches in diameter.

Self-opening Die-head: Alfred Herbert, Ltd., Coventry, England, with branch offices at 54 Dey St., New York City. A self-opening die-head equipped with dies made of high-speed steel cut by a milling cutter. It is claimed that the form of the die is such that a keen cutting edge is obtained at the front, with a non-cutting guiding portion farther back that acts as a guiding nut. The straight-cut dies can all be ground at the same operation and to definite angles without requiring any special skill or experience, as a grinding fixture is provided for that purpose. The die-head will cut right- or left-hand threads and is adapted for use on screw machines. It is made in seven sizes with capacities ranging from 5/16 to 3 inches in diameter, and provision is made for cutting threads either above or below the standard sizes.

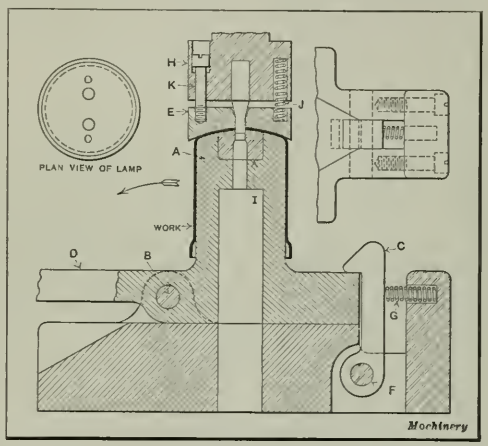
Punch, Shear, and Bending Machine: Armstrong-Blum Mfg. Co., 343 N. Francisco Ave., Chicago, Ill. A machine known as the No. 22 "Marvel," which is built almost entirely of bar steel and is intended for the performance of light punching, bending, and shearing operations. Pressure is applied by two levers to upper and lower eccentrics connected by link mechanism. The lower parallel bars remain stationary, all the motion being confined to the upper bars. The capacity of the machine for punching is a $\frac{3}{8}$-inch hole in 5/16-inch steel with a 2-inch throat, or a $\frac{1}{4}$-inch hole in $\frac{1}{4}$-inch steel with a 6-inch throat, and the shearing capacity is for $\frac{3}{8}$- by 2-inch bars. The maximum vertical movement of the jaw is $\frac{7}{8}$ inch, and the total jaw opening is $3\frac{1}{4}$ inches. The machine is 48 inches high, 24 inches long, 10 inches wide, and weighs 260 pounds.

Selective-head Lathes: Joseph T. Ryerson & Son, Chicago, Ill. A line of Ryerson-Conradson selective-head lathes which are built by the Conradson Machine Tool Co. These machines are made in five different sizes with lengths of beds to suit the purchaser's requirements. Either single pulley or direct reversing motor drive can be furnished. Practically the entire control of the machine is centralized in the apron. For belt drive, the pulley is mounted on ball bearings, which are carried on a stud, thus relieving the shaft from the belt pull. The gearing of the reversing mechanism is of the planetary type, but this is omitted from the machines driven by reversing motors. Twelve spindle speeds are obtainable through change-gears and back-gears controlled by two levers which can be shifted while the lathe is in operation. The handwheel and lever on the front of the headstock, when turned to the indicated feed rate, automatically select the desired feed. Two sets of cone gears provide twenty-eight feeds, and provision is made for transposing and compounding gears, thus permitting the cutting of almost any desired lead of thread. The longitudinal and cross feeds are operated through independent sets of worm-gears which are driven by large friction cones.

HINGED PIERCING DIE

By J. BINOHAM

The die employed in piercing four holes through the back of an automobile lamp on a short-stroke punch press is shown in the accompanying illustration. A novel feature of this die is that the die-block *A* is pivoted on pin *B* in such a manner that when latch *C* is pulled back from contact with the base of the die-block, the latter can be tilted forward in the direction indicated by the arrow. This is accomplished by pressing down on lever *D*. The purpose of this arrangement is to bring the die-block into such a position that work can be readily placed on it or removed without interfering with stripper *E* when punch-holder *H* has been raised its maximum height. If this feature were not employed, it would be necessary to use a punch press having a comparatively long stroke or have the die designed in such a way that it could be swung sidewise from under the punch in order to remove or mount work on die-block *A*. Latch *C* is pivoted on pin *F* and is held in contact with the die-block by the expansion coil spring *G*. While this spring is of such size and strength that it will readily snap latch *C* forward when die-block *A* is lowered to its working position, it can be easily held back by one hand while operating lever *D* with the other hand in tilting the die-block.



Tilting Piercing Die used in Operation on a Short-stroke Punch Press

In the operation of this die, stripper *E* first comes in contact with the work as punch-holder *H* descends on the downward stroke of the press ram. The holes are next pierced in the work by punches mounted in the punch-holder as they are forced through the stripper and work into corresponding holes in die *I*. On the return stroke of the press ram, stripper *E* is held in contact with the work by means of expansion coil springs *J*, until the punches are entirely removed from the work. When this has occurred, the bottoms of the counterbored holes in which the fillister-head machine screws *K* which secure stripper *E* to the punch-holder *H* are contained, come in contact with the heads of these screws. This causes screws *K* and stripper *E* to be raised as the punch continues to ascend.

* * *

Automobile manufacturers state that there is a growing tendency on the part of motor car users to favor the pressed-steel disk wheel. The wheel used for passenger cars is a single disk. In most designs, the thickness of the metal is greater at the center than at the rim, thus proportioning the section to the strain coming upon it. A master hub made from a steel casting is fastened to the axle, and the steel disk is attached to this by four nuts which screw on studs in the permanent hub flange.

Modern Lubrication Methods

By E. N. PERCY

Lubrication seems to be an empirical rather than a scientific study. Science has been applied to the solution of lubrication problems with but slight success. Supposed laws of friction have been laid down, but in practice they are so modified by the character of the surfaces and complicated action of the forces actually involved as to nullify their application. Formulas have been developed which are based on film thickness, bearing pressures, and viscosity, but in most cases these have proved impractical because it has been found that the film thickness changes with temperature and mechanical adjustment, that journals reciprocate and oscillate in their bearings, that bearing pressures are affected by features of the bearing design such as oil-grooves, etc., and that bearings act as pumps. However, interesting information on the complicated action of oil films in motion has been obtained experimentally, and made use of in some instances. This article reviews some of the important points in connection with lubrication.

VISCOSITY is the most deceptive and changeable of all the physical characteristics of lubricants. In fact, it is not a true characteristic, like the temperature characteristics, but rather an arbitrary peculiarity directly related to mobility. It varies with temperature and capillarity. Actually, it consists of first, the ability of the lubricant molecules to cling together, and second, of their ability to cling to the tube through which the lubricant flows. How much of either ability is possessed by an oil is a matter of pure conjecture. The tube may be of one temperature and the lubricant of another; the surface of the tube may vary, or other conditions may affect the viscosity.

Although science makes it possible to obtain a fairly accurate knowledge of the composition, flash point, etc., of various lubricants, it is difficult to deduce by any mental process, the lubricant that may be applied to a totally new use. It has been found better to make careful experiments, until a satisfactory lubricant is found. In practical use, a lubricant becomes not only a separating film for moving parts, but a cooling medium as well, a certain amount of energy being lost in every bearing or sliding surface which is absorbed by the oil in the form of heat.

An engine having a mechanical efficiency of 90 per cent, for instance, loses 10 per cent of its power in the form of heat. It is evident that 10 per cent of the power of a 1000-horsepower engine is equivalent to a good deal of heat, and represents considerable wasted energy. Water-cooled bearings and guides require surprisingly small amounts of lubricant, and frequently more oil runs off such bearings than is actually used for lubrication purposes.

Development of Oiling Systems

In the early days of slow-moving machinery, it was an easy matter to go about with an oil-can, lubricate the various parts, and watch them while in operation. This inefficient method is still in use on many marine engines and on slow-moving stationary engines. Modern lubrication was first developed in the automobile engine—a high-speed delicate mechanism which is required to run for hours, if not days, absolutely without attention or inspection. It must lubricate itself reliably, but in such a way that no excess oil is carried up into the cylinder by the piston. It is unfortunate that many designers pay so little attention to lubrication, but the fact is that they do not thoroughly understand or appreciate the importance of this subject.

The writer has seen a ten million dollar battleship come in a failure from its trial trip with expensive bearings badly damaged simply because the lubrication system did not work properly. Steam turbines have been ruined because they were equipped with a lubricating system that "ought" to have worked but didn't. A Diesel engine compressor has been known to explode because it received an oversupply of lubricating oil. Otherwise finely constructed automobiles are not infrequently condemned because they are equipped with freak lubrication systems. Many other machines might be mentioned which have failed through inefficient oiling systems, yet some mechanical engineers and machine building firms continue to neglect the improvement of lubricating systems.

As machines of larger size and greater power came into use, it was found necessary to supplement the regular oiling systems with a water cooling system for the purpose of carrying away excess heat. It therefore became customary to water-jacket large bearings, guides, and other parts having friction surfaces. On crank-pins and wrist-pins where water jackets could not be used, water was applied directly, when necessary, and saponifying oils used which would mix with the water instead of being washed off by it.

With the continued development of machines of greater power operated at higher speeds it became imperative to eliminate the personal equation of uncertainty that was present when the hand-oiling system was employed. That system was therefore superseded by the drip system. The early drip systems employed wicks, and this practice is still in general use for isolated bearings. The drip system, in turn, was superseded by the gravity system equipped with adjustable droppers or "sight-feeds."

It was soon found that the amount of oil fed by sight-feed oilers varied with the temperature of the oil which was affected by the temperature of the room, and also that the feed varied with the kind of oil used. In the case of cylinder lubricators of this type, great trouble was experienced and, as a result, forced lubrication was developed which was accomplished by the use of a common pump supplying all bearings, or an individual pump for each point requiring lubrication. As more costly high-speed machinery was developed it became increasingly dangerous to cut the oil consumption down to the minimum, because of the correspondingly decreasing margin of safety. Suitable oils also became more expensive and only oils of higher grade could meet the more exacting requirements. Engineers were expected to operate more equipment per capita, and in fact one of the most important duties of the engineer became that of maintaining proper lubrication.

The highly successful splash system of oiling applied to the automobile was gradually adapted to blower engines, small steam engines and Diesel engines. In this connection it is interesting to note that European steam and internal combustion engines were made of the enclosed type and lubricated by the splash system twenty years before the practice was taken up in this country. It was found that in steam and combustion engines of the trunk piston type, water, carbon, sulphur dioxide and debris were deposited in the crankcase. This necessitated frequent changes of the oil in the case of small engines, and made it necessary to return to the individual system of lubrication in the case of large engines. These troubles also resulted in the development of the piston type internal combustion engines with separate enclosed crankcases, and the bulkhead high-speed steam engine with splash lubrication in the separate crankcase.

Force-feed Lubrication

The development of high-grade automobile engines was responsible for the evolution of the full force-feed pressure system of lubrication. It consists primarily of a pump which takes the oil dralnage from a reservoir at the bottom of the crankcase. This is pumped at a pressure exceeding the bearing pressure, or from 30 to 60 pounds per square inch, to the main bearings. From the main bearings, the oil passes through a hollow crankshaft to the crankpins, then through hollow connecting-rods to the wrist-pins, and through hollow wrist-pins to the cylinder walls, from where it falls back to the crankcase sump.

Only a few cars are equipped with this system in its entirety, but most present-day cars are equipped with various modifications or plain splash systems. Ordinarily cars equipped with splash systems run 10,000 to 15,000 miles before a general overhauling is advisable, while cars equipped with a full force-feed system may run 50,000 or 75,000 miles before a general overhauling is in order. Of course, much depends on the treatment that a car receives, the frequency with which it is supplied with clean oil, and how often the crankcase is carefully washed out.

The development of the airplane engine, with its tremendous power, light weight, and high speed, was largely a problem of providing suitable lubrication. The most highly developed lubricating systems for airplane engines employed during the war included the full force-feed circulating system, which had in the oil circuit an oil filter, cooler, and heater. The oil was heated just before entering the filter and cooled afterward. Later and more practical motors depended on ground apparatus at the landing field to filter and cool the oil, and the engine cooler consisted merely of fins on the crankcase reservoir.

The most highly developed oiling systems in use at the present time are the circulating systems used on steam turbines, crosshead-type Diesel engines, and reduction gears. These systems are of the full force-feed pressure type, equipped with filters, coolers, settling tanks, and considerable storage space. Several types of filters are now in use, of which, some remove the dirt by forcing the oil through a layer of hot water. Such a filter, obviously, cannot be used for a saponifying oil. Others strain the oil through toweling or wicking, while still others use a centrifugal separator to clear the oil of dirt, etc. Each type has its limitations and advantages, but none is in a state of perfection.

It is customary to provide a by-pass in a circulation system so that only a small percentage of the oil circulated will pass through the filter, because the filter would have to be of an enormous size to filter all the oil circulated; furthermore, it is not necessary to filter lubricating oil every time it makes a circuit. Enough oil is carried in the system to circulate once every five to twenty minutes, according to the kind of machine, its speed, etc. Frequently, instead of connecting the filter with the circulating system, two oil reservoirs are used, so that the oil contained by one may be filtered while that in the other is in use. Care in designing lubricating systems makes safe and possible, increased bearing pressures, higher speeds, lighter machinery, and less attention from the operator. A modern turbine plant or Diesel engine plant could, except for the attention which boilers and pumps require, be put in operation and locked up for a week without attention from the operator. This is made possible by the efficiency and reliability of modern lubrication systems.

The really important points of lubrication are practical rather than academic, and the design of a lubricating system must provide: (1) Means of supplying the lubricant; (2) means of removing the heat; and (3) means of restoring used oil. The selection of a lubricant involves the following requirements: (1) An oil that will flow; (2) an oil that will stand the conditions; and (3) an oil that can be cleaned and restored. To meet these conditions, conclusions must be based either on experience or experiment, as no theoretical procedure has yet been devised which will forecast reliably what is the most suitable lubricant to employ under different conditions of service.

Comparison of Paraffin- and Asphalt-base Oils

There has been considerable discussion relative to the comparative values of paraffin- and asphalt-base lubricating oils. Most oils used at the present time come from stocks containing both bases, and it is doubtful if the average engineer could tell which he is using, if it came to him without a label. Paraffin oils stand warming slightly better than asphalt-base oils, but freeze solid when subjected to temperatures at which the latter remain liquid and capable of giving good service. There is no perceptible difference in their chemical stability, both breaking up and depositing heavy tars at about the same temperatures. The most stable hydrocarbons, such as kerosene, benzol and benzol-oils are not good lubricants, while the least stable, or heavier hydrocarbons are the best lubricants. It is claimed by several of our best chemists that the quality of oiliness or slipperiness comes from the very fact that the oil is not stable, but composed of unstable or unsaturated compounds. Therefore an oil cannot be both stable and a good lubricant, which is apparent from the fact that no hydrocarbon whose composition is definitely known to be stable is a good lubricant.

This is the reason why it is difficult to obtain good lubricants for high temperatures. An oil that will stand the temperature is not as "oily" as some of the less stable oils used at lower temperatures. Viscosity means nothing in terms of lubrication; otherwise pure asphalt or pure paraffin wax would be the best lubricants, which is not the case. Emulsification with water and other substances is a subject worthy of the practical man's attention. There are two kinds of emulsions, namely, water in oil and oil in water. A small quantity of water finely emulsified in an oil matrix forms heavy clots which cannot be pumped, filtered or strained. It does no good to mix in more water, because additional water cannot reach the fine drops in the oil and such clots are best removed. If a large amount of valuable oil is so clotted, the clots can be separated and thinned out with a little sulphuric acid, which must afterward be washed out of the oil with lime water.

Persistent emulsification indicates the presence of water and the use of an unsuitable oil. If water absolutely cannot be prevented from entering the oil, a saponifiable or "marine" oil should be used, deliberately adding to the oil an amount of water equal to 25 per cent of the oil, in order to prevent clotting. If there is less than 15 per cent of water in a heavy oil used in a circulating system, clots will form; if considerably more than 15 per cent, the clots will not form because the emulsion reverses and becomes an oil-in-water emulsion, which is a thin, milky emulsion. Automobile and other internal combustion engines having trunk pistons tend to throw the water of combustion into the crankcase oil. Also, practically all such engines permit vapor to leak into the crankcase and such vapor always carries a small amount of water.

The combustion of gasoline or oil forms from 1 to 1½ pounds of water for every pound of fuel burned. In other words, the water formed is more than equal to the fuel burned, and it is a common occurrence for water to drip from the exhaust pipe of an automobile on a cold day. Such being the case, it is easy to account for some of the lubrication difficulties encountered in a trunk-piston type of internal combustion or steam engine.

The really important points of lubrication are practical rather than academic, and the design of a lubricating system must provide: (1) Means of supplying lubricant; (2) means of removing heat; and (3) means of restoring used oil.

Proposed Patent Legislation

Review of a Report of a Patent Committee of the National Research Council

THE Patent Committee of the National Research Council, of which L. H. Baekeland (address, National Research Council, National Academy of Sciences, Smithsonian Institution, Washington, D. C.) is acting chairman, has made a number of recommendations for future patent legislation that are well worth considering.

A Single Court of Patent Appeals

The first proposal made by the committee is the establishment of a single Court of Patent Appeals that will have jurisdiction of appeals in patent cases from all the United States District Courts throughout the country, in place of the nine independent Circuit Courts of Appeal in which appellate jurisdiction is now vested. Until 1891 the Supreme Court of the United States was the appellate court in patent cases for all the lower courts. At that time the right of appeal to the Supreme Court in patent cases was taken away, and that court now hears patent cases only when very unusual conditions exist.

The existence of nine appellate courts of concurrent jurisdiction in patent cases works serious hardships. While, theoretically, the law is the same in all of these courts, there has been an irresistible tendency to drift apart in the application of the law. It has even happened in a substantial number of cases that two of the appellate courts have taken a different view of the same patent. It is very important that the questions which always exist as to the validity and scope of a patent should be settled once and for all at the earliest possible date in the life of the patent, for, as a practical matter, seventeen years (the term of a patent) is a comparatively short time in which to reduce the invention to a thoroughly commercial form, to prepare for its manufacture, and to introduce it on the market, and it is usually necessary to determine the validity and scope of the patent in order to tell what amount of money it is safe to invest in exploiting the invention. As things are now, whichever party succeeds in the first suit that is tried on the patent, the other party is likely to feel that in a second trial before another court he might have better luck. He is therefore inclined to insist upon a second litigation. Meantime, he advertises that the questions involved were not settled in the first case. This means uncertainty on the part of the owners of the patent as to their rights, and uncertainty on the part of the public as to its rights to use the invention or to determine what it must avoid in working in the same field—a really intolerable situation.

Moreover, we shall never have a uniform and definite patent law, consistently applied, until we have a single Court of Patent Appeals, independent of local sentiment, realizing a responsibility to fix the principles of the law and enforcing a harmonious application of these principles in the lower courts. It would be of the utmost value to those in the United States who are engaged in industry if the present confused condition could be corrected and a single tribunal devote itself to crystallizing the fundamentals of the patent law and to educating the courts throughout the land to uniformity in applying these principles in special cases.

The Patent Office a Separate Institution, Independent of the Department of the Interior

The second proposal of the committee is that the Patent Office be made a separate institution, independent of the Department of the Interior or any other department. The Patent Office was originally in the State Department, but on the formation of the Department of the Interior in 1849, it was made a bureau of that department.

The experience of many commissioners over a period of several generations has shown that, no matter how pleasant the personal relations may be, the Commissioner of Patents cannot expect any real benefit to accrue to the Patent Office from its connection with the Department of the Interior. There is nothing in common between the interests of these departments, and consequently no advantage will result from the amalgamation of the Patent Office and the Department of the Interior. The committee believes that to make the Patent Office an independent bureau would greatly increase the respect of the public, as well as of Congress and the courts for it, and would make it easier to procure enlarged appropriations and better salaries.

As to appropriations, under present conditions the demands of the Patent Office for equipment, personnel, and salaries are necessarily subjected to comparison, both by the Secretary of the Interior and by Congress, with those of several other unrelated bureaus, each pressing its own demands and criticizing any apparent preference. In the opinion of the committee, this operates as a severe handicap. As an independent institution, the needs of the Patent Office would be judged on their necessity, and the appropriation determined by consideration of general policy. As to personnel, the enhanced dignity and independence of the Patent Office would render all positions of importance in it more attractive, and particularly make it easier to secure and retain in office men of the necessary qualifications to fill the difficult office of Commissioner of Patents.

Increase in Force and Salaries of the Patent Office

The third recommendation of the committee is a substantial increase in the force and salaries of the Patent Office. The patents granted by the United States Patent Office are of less average probable validity than formerly, because the number of applications for patents and the field of search are constantly increasing, while the examining force for many years has been insufficiently large and has not been increased proportionately. The inducements are so unattractive that 25 per cent of the examining force has resigned within the past three years. The committee finds that the Patent Office is suffering both from lack of examiners and from inadequate compensation. The salaries of the Patent Office examiners have been increased only 10 per cent since they were fixed in 1848, when they were approximately the same as those of members of Congress. At the time the salaries of the examiners-in-chief were fixed, they were the same as those of federal district judges. During the past seventy years, the compensation for technical service in almost all other directions has been increased very largely. Congress, in creating new positions, is willing to pay technical men salaries more nearly approximating the usual compensation of such men in private service, but, having started a position at a given salary, is loath to increase the salary. A principal examiner, to pass the entrance examination for the Patent Office, must himself have an education equivalent to that of a college graduate, and yet his salary is so low ($2700 a year) that it is practically impossible for him to give his own sons a college education. The committee believes that salaries should be paid to the examiners proportionate to those paid for equally high technical work in other departments created recently, as, for example, in the Army and Navy and in the office of the Attorney General.

Compensation for Infringement of Patents

While an injunction can ordinarily be obtained against an infringer in a case where a patent is adjudged valid, except

where it would interfere with government work, a money recovery has not heretofore been generally possible except under most favorable circumstances. In a case where it cannot be said that the entire salability of the article depends upon the invention, it has been necessary to show just how much of the price of the article is attributable to the invention, but it is ordinarily impossible to make such a separation, and most patent cases are ones in which it cannot be said that the whole salability of the article depends upon the invention, so the result has been that recovery of money is seldom obtained in a patent suit.

Recently there have been two or three decisions in which the courts have taken a more liberal attitude, holding, in effect, that where an invention has been used by an infringer a reasonable royalty may be awarded to the patentee based on a mere estimation or on opinion evidence, even though no exact computation can be made. This is analogous to the attitude of the courts in personal injury cases, and is entirely just and reasonable. While, as stated, there have been two or three decisions to this effect, it may take a generation to induce United States courts generally to adopt this position, if it can be done at all, and the committee therefore proposes that the law be amended to provide that as damages to the complainant, the court, on due proceedings, may adjudge and decree to the owner payment of a reasonable royalty or other form of general damages.

There are some cases in which it seems to many who are familiar with such matters, as though the courts were inclined to go to the other extreme and award damages out of all proportion. Where a complainant has shown that profits have been made by the use of an article patented as an entirety, the infringer is liable for all the profits unless he can show—and the burden of the proof is on him to show—that a portion is a result of some other invention used by him. If the infringer cannot show what proportion of the profits is due to such other invention, then all his profits must go to the complainant. Any rule by which the entire profits are given to a patentee in the absence of proof that they are not all due to the invention of the patent sued upon, is unfortunate and sometimes very unjust. The proposed amendment to the statute would permit a court under these circumstances to do substantial justice, even though it could not be mathematically exact. In other words, the amendment to the statute would enable a court to avoid awarding either too much or too little.

* * *

MILLING GREASE GROOVES IN DRIVING-BOX SHELLS

By NORMAN McCLEOD

In order to distribute the grease on locomotive journal bearings properly, it is necessary to cut grooves on the internal or bearing surfaces of the journal-box shells. In the case of driving-box shells, it has been found to be the best practice to cut these grooves after the shells have been forced into place and bored. This is accomplished on a drilling machine in a certain locomotive repair shop by the use of the device shown in Fig. 1. This device is mounted on a wrought-iron base *A*, 1⅝ inches thick by 21 inches square, upon which is erected a vertical hollow post *B*, 9⅛ inches in diameter by 20⅜ inches long. To this cylinder is attached a templet *C* such as shown in Fig. 2, which acts as a guide for the milling head carried inside the post.

The cross-slots in the templet are made to correspond with the grooves desired in the shell. After the shell in which the grooves are to be cut is clamped in place over the post, the milling cutter which is held at right angles with the drilling machine spindle is fed down by the feed mechanism employed for ordinary drilling operations. As will be seen by referring to Fig. 1, rotation of arbor *E* is accomplished by means of bevel gears *F* and *G*, and shaft *M*, the end of which fits into the drilling machine spindle socket. Before taking a downward cut, tool *L* is fed to the required depth

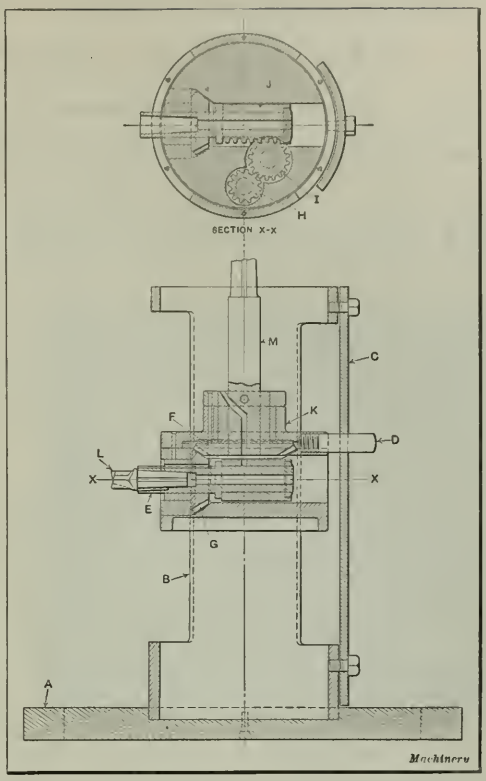


Fig. 1. Device for milling Grease Grooves in Driving-box Shells

by means of pinion *H* and gear *I*, which mesh with the rack teeth on the sleeve *J* secured to spindle *E*. A ratchet device located on top of flange *K* (not shown in the illustration) locks pinion *H* when the tool has been fed to the required depth. As the guide pin *D*, following in the crossed templet slots, causes the milling cutter to reproduce grooves similar to those in the templet, it is evident that in order to accommodate bearing boxes of any size within the capacity of the machine, it is only necessary to provide suitable templets and a milling cutter of the required size.

* * *

To produce clean, smooth castings from molds made with metal patterns, it is essential that there be no sticking of molding sand to the patterns upon removal from the sand. The collection of moisture largely responsible for this difficulty can be prevented by heating the pattern. To accomplish this purpose the Westinghouse Electric & Mfg. Co., East Pittsburg, Pa., has applied its standard steel-clad heater in a large number of cases, with satisfactory results.

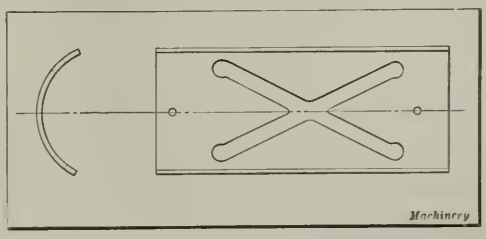


Fig. 2. End and Plan Views of Templet C, Fig. 1

The British Machine Tool Industry

From MACHINERY'S Special Correspondent

London, April 13

MACHINE tool manufacturers throughout the country are experiencing demands which carry them forward in most cases for several months ahead. Only in one instance has a firm reported any falling off in business, and this result, rightly or wrongly, has been attributed to the extensive sales of government machine tool stock which have taken place in the vicinity of the firm in question. The motor car industry, railway shops, and shipyards are among the most insistent buyers, plate-edge planers for shipyards being particularly in demand, while Henry Berry & Sons, Leeds are receiving many inquiries for heavy type extrusion presses.

Imports and Exports

To get going and produce, outweighs most other considerations; if the machine tools cannot be obtained in the country within a short period an imported one is purchased, the price, affected as it is enormously by the prevailing exchange rate is a poor second consideration to delivery. How long such conditions will remain it is very difficult to estimate. It is easy to say that price considerations will again take full effect when demands are satisfied, but with the state of mind to which, not only labor but the world has grown, satisfied demands do not open up a prospect altogether attractive.

Contrary to pre-war experience, we continue to import far more in value of machine tools than we export but the returns show a steady tendency to a reversal of this condition. For January and February of this year the value of machine tool exports amounted to £275,068 whereas the imports reached £549,768 in value. It is of interest to note that the export value represented 2228 tons, whereas the much greater import value only represented 2448 tons.

Labor Conditions

As regards labor in this country, one of the most significant signs is the probability of the engineering trades accepting the principle of payment by results, and the effect of such conditions would be remarkable, according to those best able to judge.

Despite the disastrous molders' strike of last year which ate into the heart of the machine tool industry, the rapidity with which the great majority of firms not only laid but followed their plans for reconstruction has surprised even the optimist. Sheffield, for example, has in the last twelve months made extraordinary strides, the only exceptions here being the armor plate and gun plants, although it would be more correct to say that these plants have been devoted to other and at this time more important work. One of the largest demands is for heavy rolling mill plant which is now made in this country on lines that enable the American and continental standard of output to be at least attained.

Manufacture of Small Tools

The number of concerns that are manufacturing small and proprietary small tools is great, and at least one large firm, the Birmingham Small Arms Co., Ltd., has arranged for the manufacture of such tools on a very large scale. For this purpose, a subsidiary company, the B.S.A. Small Tools, Ltd., has been formed, and the undertaking will probably be the largest of its kind in the world; Burton Griffiths & Co., Ltd., Ludgate Square, London, are the selling agents. The parent company made all the tools used in the manufacture of the Lewis guns used by our troops during the war.

Use of Molding Machines

The mechanical output of castings by the jolt ram and similar systems is making great headway, and firms providing machinery for this type of plant are booked up with orders, both for home and continental use, for a considerable time ahead; this condition is accentuated by the uncertainty in the delivery of castings which has induced several firms to install their own foundries. One very large lead melting furnace for feeding cable and pipe presses is going to Charleroi.

Gear Cutting

Gear cutting in all its branches continues to attract the attention of many engineers in this country, and firms specializing in this work are still experiencing a heavy demand for their machines. One firm is undertaking the manufacture of a gear-cutting machine on the lines of the Gleason machine.

Steel Belt Conveyors

The steel belt method of conveyance which has been used with success for some time in Scandinavian countries is being increasingly used here. The belts, as made by Steel Belt Conveyors, Ltd., Birmingham, are in one-piece lengths up to 300 feet, and the rollers for support can, if necessary, be as far apart as 12 feet.

Demonstration Shop

On the selling side, many concerns have adopted a far more helpful attitude toward purchasers. Buck & Hickman of London, for example, who for many years have been the selling agents here for such well-known American concerns as the Brown & Sharpe Mfg. Co. and the Pratt & Whitney Co. run a demonstration shop devoted to the execution of samples of customers' work on automatics and other machines manufactured by these firms.

Foreign Trade

The demand for small tools, such as taps and dies, twist drills, and milling cutters, in foreign and colonial countries is very heavy, and France in particular is absorbing many of the highest class precision machine tools. With regard to imports, the view is gaining ground that "dumping" should be defined as the importation of goods into the country at a price below the cost of manufacture in the country of origin and not below the selling price in that country, but the difficulty of establishing the cost in a foreign country may be well nigh insuperable. Switzerland and Sweden are in particular very active in the English market, and the latter country is laying the foundation for greatly increased trade in machine tools here through its selling organization the Swedish Machine Tool Makers Export Co., Ltd., while importations from Switzerland such as automatic screw machines and small precision lathes made by Bechler, are fine products of modern toolmaking in design and workmanship and equal to anything previously seen over here in these lines.

New Tools

Many firms are engaged upon new designs of machines which will be available for the machine tool exhibition to be held at Olympia in September, and in the meantime it is not possible to draw attention to many new models. Among British makers the desire to supply tool-room equipment from home sources is finding expression in several new ventures which promise among other things, a new development in measuring machines. The 7-inch center lathe made

by Croft & Naylor, Keighley, has been redesigned, while the new 8½-inch center lathe manufactured by Dean Smith & Grace, Ltd., Keighley, is experiencing a very good demand, and the manufacturing equipment for these machines is now nearly complete. J. Buckton & Co., Ltd., Leeds, are extending their works, and are placing on the market a new tire turning and boring mill, while a new universal grinding machine of 12-inch centers and 48-inch bed has been produced by James J. Guest & Co., Coventry. In the design of the latter machine, particular attention has been devoted to dustproof features, and convenience of control, while the arrangement of the wheel-slide suspension weight allows the wheel to be set to any desired angle without interfering with the tension on the slide.

Several firms are now producing some fine examples of relieving lathes, and another maker will shortly be added to the number. A new 6-inch center lathe has been turned out by Precision Gages, Ltd., Birmingham, the bed being provided with V-guides. The British Abrasive Wheel Co., Ltd., Sheffield, which has been paying especial attention to the physical properties of abrasive wheels, is producing a grinding wheel which shows remarkably good results in the amount of metal removed as compared to wheel loss, and at the same time a non-glazed surface is maintained on the wheel.

Prices of Machine Tools and Materials

Castings, the position of which is slowly recuperating after the molders' strike, continue to be the crux in most works. In the case of small castings, there is a tendency for a price per piece to be quoted in place of the well established price per unit weight; this condition reacts unfavorably on small intricate castings to such an extent that, in many instances, it is found cheaper to use gun-metal castings for small work. For a medium weight casting the prices ruling are about 40s per hundredweight, but the price shows a distinct tendency to rise from 3 to 5s. Steel has risen considerably in price, generally bringing for bar £3 per ton more today than one month ago.

The prices for machine tools made in this country have not undergone much change during the last month, and the following prices give some indication of current values. A tool-room lathe suitable for precision work having 6-inch centers and a four-change gear-box costs £160 to £170, while a heavy-duty shaping machine of 16-inch stroke, back-geared and equipped with vise and countershaft, costs about £250.

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NATIONAL SCREW THREAD COMMISSION

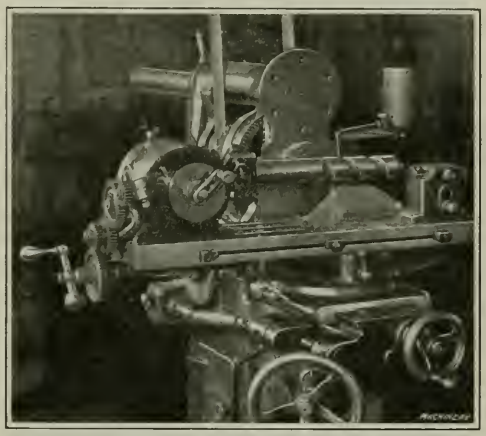
The work of the National Screw Thread Commission, appointed in 1918 to investigate, formulate test, and upon approval, promulgate standards of commercial screw thread practice, has been practically completed, but the commission, which is composed of two representatives of the Army, two of the Navy, and four civilians, and which is headed by Dr. S. W. Stratton, director of the Bureau of Standards, has been authorized by Act of Congress to continue in existence for two years from March 21, 1920. A tentative report has been made accessible to the engineering and manufacturing industries.

* * *

Zirconium and zirconium alloys are said to dissolve completely when added to molten steel. The ferro-zirconium thus obtained is very strong and is especially useful for the manufacture of armor plate, or sheet metal used for general defensive purposes. Armor plate made of nickel-zirconium steel having a thickness of 0.4 inch shows the same resistance to bullets as either nickel-molybdenum steel of 0.5 inch thickness or chromium steel of 0.6 inch thickness. Zirconium steel which has given the best results has an analysis as follows: 0.42 per cent carbon, 1 per cent manganese, 1.50 per cent silicon, 3 per cent nickel, and 0.34 per cent zirconium. The tensile strength of this steel is stated to be 250,000 pounds per square inch.

MILLING A LONG-LEAD TAILSTOCK SLEEVE

At the plant of the Rockford Milling Machine Co., Rockford, Ill., a No. 2-B Rockford universal miller, built by this firm, is equipped as shown in the accompanying illustration for use in cutting the spiral groove in a long-lead tailstock sleeve for a lathe. The groove to be cut is ⅜ inch deep by ⅝ inch wide, and the lead of the spiral is 2½ inches. The cut is taken by an end-mill running at 224 revolutions per minute, with a feed of 0.110 inch per revolution, and one roughing and two finishing cuts are required to complete the operation. In order to obtain the required lead for the spiral groove, it will be apparent that it is necessary to em-



Milling a Long-lead Tailstock Sleeve

ploy a rate of longitudinal table feed and gearing for the dividing head that will afford the proper ratio between longitudinal and rotary movements of the work past the cutter. On this job the time taken to complete the milling operation is twenty-four minutes.

* * *

TURNING A LARGE DRIVING SHAFT

A repair problem encountered in the machine shop of the Delaware & Hudson Railroad Co., Watervliet, N. Y., was successfully handled in the following interesting manner: The driving shaft of a locomotive axle lathe had been forged, and in arranging to machine it to the finished length of 18 feet 8 inches, no adequate equipment was available in the shop for handling large work such as this. Although at first it was thought that the job would have to be done in an outside shop having the necessary equipment, an arrangement was finally devised in which an ordinary 36-inch Lodge & Shipley lathe was employed in conjunction with a Niles-Bement-Pond 20-inch lathe. The two machines happened to be situated in such a manner in the shop that with very little difficulty the Niles lathe was turned end for end and aligned with the 36-inch machine. This brought the machines with the headstocks at opposite ends so that the tailstock of the 20-inch machine, when properly blocked up to come to the right height, could be used to center one end of the shaft, the opposite end of which was held in the headstock center of the Lodge & Shipley lathe. In order to obtain the required finished length, it was necessary to forge the shaft 19 feet 2 inches long, the extra ends being cropped off after machining. The shaft was turned up as far as required, and was then turned around and the journal on the opposite end machined. No difficulty was experienced by this method of handling the shafting, the job being done satisfactorily and at a considerable saving in cost.

CONVENTION NEWS

AUTOMOTIVE ENGINEERS' SUMMER CONVENTION

The Society of Automotive Engineers will hold its summer meeting at Ottawa Beach, Mich., June 21 to 25. There will be one professional session each day, dealing with some one specific side of the automotive industry. On Monday, June 21, a standards and business session will be held. On the following four days, one day each will be devoted to a fuel session, a transportation session, a farm power session, and a production session, respectively. In addition to the professional sessions, there will be a one-hour lecture every evening immediately after dinner on a popular subject of instructive value.

CONFERENCE OF THE NATIONAL SAFETY COUNCIL

The spring conference of the engineering section of the National Safety Council was held in the Engineering Societies Bldg., 29 W. 39th St., New York City, April 27. The purpose of the conference was to bring the safety movement and the engineering world more closely together. At the morning session the topics discussed were the relationship of the safety movement and engineering efficiency, and safety education in technical schools. The afternoon session was devoted to safety standards, consideration being given to the present movement for uniform standards, and the National Safety Council's part in this movement. C. P. Tolman of the National Lead Co., who is chairman of the engineering section, presided.

CONVENTION OF THE AMERICAN STEEL TREATERS' SOCIETY

The second annual convention and exhibit of the American Steel Treaters' Society of Chicago, Ill., in conjunction with the Steel Treating Research Society of Detroit, Mich., will be held in the Commercial Museum, Philadelphia, Pa., on September 14 to 18. The exhibits will include tool steels, high-speed steels, and alloy steels; processes of mechanical heat-treating, hardening, casehardening, tempering, annealing, welding, etc.; hardening, pickling, and hoisting equipment, and ventilating systems; carburizing, and casehardening materials, cements, quenching oils and mediums, rust preventives, etc.; laboratory equipment; first-aid equipment; inspection bureau equipment; periodicals, trade journals, and text-books.

AMERICAN GEAR MANUFACTURERS ASSOCIATION'S MEETING

Standardization in the manufacture of gears was one of the important subjects discussed at the fourth annual meeting of the American Gear Manufacturers Association, which was held in the Hotel Statler, Detroit, Mich., April 29 to May 1. An entire day of the convention was devoted to the various angles of this subject, and reports were presented by committees which have had it under consideration for months. An interesting program was arranged which included papers on such subjects as "Gears from a Purchaser's Standpoint," by D. G. Stanbrough, of the Packard Motor Car Co.; "Routing of Gears and Machine Parts through the Factory," by J. A. Urquhart, of the Brown & Sharpe Mfg. Co.; "The Science of Manufacturing," by Henry M. Leland, president of the Lincoln Motors Co.; "Problems of the Gear User"; "Mill Gearing from the User's Standpoint," and other phases of gear manufacturing. A visit to the plant of the Ford Motor Co. was an interesting event of the convention. The annual banquet was held on Friday evening April 30. The principal speakers were Edgar A. Guest of the Detroit Free Press, and Henry M. Leland, president of the Lincoln Motors Co. A complete report of the convention, with abstracts of the papers read, will be published in the June number of MACHINERY.

THE NATIONAL FOREIGN TRADE CONVENTION IN SAN FRANCISCO

The National Foreign Trade Convention, which meets in San Francisco May 12 to 15, will have for its general convention theme "The Effect of Being a Creditor Nation," and will discuss the following main topics during the various sessions: Fundamentals of our foreign trade; exports and imports; foreign trade policies; the merchant marine; and the national program for foreign trade. In addition, there will be group sessions that will deal with the following subjects: Education for foreign trade; financing foreign trade; transportation and communication; foreign trade advertising; direct selling abroad; banking service to foreign trade; sources of imports; foreign trade and the press; foreign trade credits and credit information; American trade with Russia; practical problems of the export manager; Webb law in operation; and Pacific problems. At each general group and session, addresses will be made by men who are especially fitted to speak upon the subject under discussion. Each group session will, in addition, provide an opportunity for discussion upon the subject by those present, so that all the members may have an opportunity to benefit by the experience and opinions of others.

CONVENTION OF THE INDUSTRIAL RELATIONS ASSOCIATION OF AMERICA

The second annual convention of the Industrial Relations Association of America, will be held in the Auditorium Theater, Chicago, Ill., May 19 to 21. This association, which was first organized in 1918, is composed of those in charge of the employment, personnel, and industrial relations work in industrial and mercantile enterprises, as well as executives and others interested in the relations between employer and employe. The original name of the organization was National Association of Employment Managers, but the broadening of the scope of the society led to the adoption of the present name in January, 1920. The purpose of the association is to assist its members in selecting, placing and training employes, by keeping them informed of the best experiences, theory, and literature in employment and personal lines through conventions, conferences, committee studies, reports, and other literature. No attempt is made to enforce standards or policies upon any of the members, the endeavor being to educate through the presentation of the experiences of others in such form as to allow the selection of the methods best fitted to a particular concern or industry.

Some of the subjects to be discussed at the coming convention are as follows: Americanization; Shop and Works Committees; Industrial Relations Department Costs; Insurance and Bonus Plans; Job Specification and Job Analysis; Employment Office Methods; Incentives and Production; Community Conditions Affecting Labor Stability; Public Opinion and Labor Policies; Wage Levels; Radicalism; Apprentice Training; Shortage of Labor; the Foreman of the Present and Future; Thrift Plans; Relations of Employment Office and Foremen; What Management Wants; and What the Workingman Wants. George D. Halsey, employment manager of the Cincinnati Milling Machine Co., Cincinnati, Ohio, will be chairman of the discussion on employment office methods. M. C. Turpin, assistant manager of the publicity department of the Westinghouse Electric & Mfg. Co., East Pittsburg, Pa., will be chairman of the discussion on plant papers. Roger Babson, president of Babson's Statistical Organization, Wellesley Hills, Mass., will have charge of the discussion on wage levels; Franklin T. Jones, assistant employment supervisor of the Warner & Swasey Co., Cleveland, Ohio, will lead the discussion on apprentice training. E. J. Cole, superintendent of the Acheson Graphite Co., Niagara Falls, N. Y., will be chairman of the discussion on the relations of employment office and foremen. Representatives from a wide variety of industries will take part in the program.

NATIONAL METAL TRADES CONVENTION

On April 21 and 22, the twenty-second annual convention of the National Metal Trades Association was held in the Hotel Astor, New York City. After the usual opening ceremonies, and reading of the minutes and the officers' reports, the committee on industrial education submitted its report. Following the general discussion of this report, M. W. Alexander, managing director of the National Industrial Conference Board, presented in graphical form data which have been gathered by his organization, showing the relationship between advances in the cost of living and advances in the wages of operatives in the metal trades, boot and shoe, silk, cotton and woolen industries; similar charts were presented showing the causes and the seriousness of absence on the part of factory employes. Following the usual custom, a buffet luncheon was served to members and guests in attendance at the convention.

At the afternoon session, addresses were presented by George E. Roberts of the National City Bank, New York City, on "Business Conditions"; Richard H. Waldo of the Inter-Racial Council, New York City, on "Immigration and Labor"; and E. N. McCone, General Manager of the *Buffalo Commercial*, Buffalo, N. Y., on "The Closed Shop Press." Following the presentation of these discussions the convention banquet was held in the evening. Samuel O. Dunn of the *Railway Age Gazette*, New York City, spoke on "The Railroad Situation and American Business."

On the morning of the second day of the convention, a discussion of the subject "What is Shop Representation?" was led by A. H. Young, International Harvester Co., Chicago, Ill.; L. R. Clausen, Deere & Co., Moline, Ill.; C. S. Ching, United States Rubber Co., New York City; Robert E. Newcomb, Worthington Pump & Machinery Corporation, Holyoke, Mass.; R. G. A. Phillips, American Multigraph Co., Cleveland, Ohio. Following the expression of opinion by these authorities, there was a general discussion of the subject.

The afternoon session was devoted to an analysis of the report of the President's Second Industrial Conference, led by Walter H. Drew, counsel, National Erectors' Association, New York City, which was followed by a general discussion. The reports of the convention committees and of the nominating committee were then heard, followed by the election and installation of officers. The officers for the following year are: President, A. E. Newton, Reed-Prentice Co., Worcester, Mass.; first vice-president, George O. Rockwood, the Rockwood Mfg. Co., Indianapolis, Ind.; second vice-president, W. W. Coleman, the Bucyrus Co., South Milwaukee, Wis.; treasurer, F. C. Caldwell, H. W. Caldwell & Son Co., Chicago, Ill.

PROGRAM FOR THE CONVENTION OF THE AMERICAN DROP FORGE ASSOCIATION

Announcement has been made by the secretary of the American Drop Forge Association that the following papers will be read at the annual convention to be held at the Marlborough-Blenheim Hotel, Atlantic City, N. J., June 17 to 19: "Relative Cost of Operation of Steam and Board Hammers," by R. T. Herdegen, Dominion Forge & Stamping Co.; "Forge Shop Lubricating System," by Harry Johnson, Ingalls-Shepard Forging Co.; "Use of Forging Press and Upsetters," by Mr. Hopkins, Atlas Drop Forge Co.; "Powdered Fuel"; "Apprenticeship in the Die Room," by Mr. Saylis, Billings & Spencer Co.; "Necessary Chemical and Physical Characteristics of Die-blocks," by W. C. Peterson, Packard Motor Car Co.; "Forge Shop Finances," by Lee Wellington, Scoville-Wellington Co.; "The Place of Laboratory and Testing in the Forging Business," by Professor Nelson, Wyman-Gordon Co.; "The Company Store," by Edgar E. Adams, Cleveland Hardware Co.; "Heat Control in Furnaces," by Dr. W. N. Best; and "Accident Prevention in the Forge Shop," by G. A. Kuechenmeister, Dominion Forge & Stamping Co. Further information can be obtained from the president, E. J. Frost of the Frost Gear & Forge Co., Jackson, Mich.

INCREASED PRODUCTION CONVENTION

On April 26 to 29 the Chamber of Commerce of the United States held a meeting at Atlantic City, N. J., designated as an "Increased Production Convention" to consider the subject of increasing production throughout the country. The topics discussed at the convention were as follows: "Transportation in Relation to Production"—this subject was divided into three parts, treating of railways, highways and merchant marine; "Industrial Production"; "Labor in Relation to Production"; and "Immigration in Relation to Production." The topics discussed under the heading "Industrial Production" were "Standardization of Products," "Increased Use of Labor-saving Machinery as Aids to Increased Production," "Industrial Relations from an International Viewpoint," and "Increased Production to Decrease the Cost of Living." Secretary of Agriculture Meredith discussed the subject "Agriculture in its Relation to Production."

CONVENTION OF TAYLOR SOCIETY

The Taylor Society, which is devoted to scientific management, will hold its spring meeting in Rochester, N. Y., May 6 to 8. The subjects which are planned for this meeting are: "The Necessity of Planning in Administration"; "Balance of Work"; "The Promulgation of Standards by the Taylor Society"; "The Necessity of Standards of the Relation between Illumination and Output"; "Can Industrial Democracy be Efficient?—The Rochester Plan"; "The Workers' Reaction to Scientific Management"; and "The Industrial Problem." Additional information relating to the convention can be obtained from B. M. Taylor, secretary to the managing director, 29 W. 39th St., New York City.

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THE CONFERENCE NOONDAY LUNCH

A rather novel scheme is in use at the Ludlum Steel Co.'s plant at Watervliet, N. Y., in which representatives from the various departments of the steel mill are brought together once a day. In the executive building of the company there has been fitted up a dining room where the noonday lunch is served to the executives of the company and to the engineers, foremen, etc., representing every department and phase of the industry. The men are the guests of the company, and an opportunity is presented during the course of the regular noonday lunch for discussing questions of a business nature, thereby creating a spirit of cooperation and complete understanding. This arrangement also provides an ideal means of introducing visitors and friends to the various department representatives. It so happens that the Ludlum Steel Co.'s plant is not conveniently located as regards lunch facilities; consequently, the idea which is now a regular thing, started in a much smaller way, the object being simply to accommodate the executives and thus enable them to give closer attention to the daily business.

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IMPORTANCE OF ELEMENTARY PRINCIPLES IN OXY-ACETYLENE WELDING

In a recent number of the *Journal of the American Welding Society*, M. K. Dunham emphasizes the need of fundamental knowledge of the principles of oxy-acetylene welding. It is pointed out that an understanding of the importance of fusion, and the principles of expansion and contraction should be thoroughly understood by the engineer as well as by the welder. It would seem that the proper instructor for the welder is a man who has had both practical and technical experience, and practice is more desirable than theory. If no attention is paid to the law of expansion and contraction, failure will result, except in the simplest welding jobs. There have recently appeared many technical articles dealing with what takes place in the weld; such research work is of utmost value to the industry, but the real need of the practical welder and engineer is simple principles, simply explained.

INDUSTRIAL NOTES AND COMMENT

Chuck manufacturers report large domestic and foreign business, and state that notwithstanding the fact that the exchange is against the foreign buyer, large orders are being placed from abroad and payments are made promptly. The domestic dealers show an apparent willingness to stock up, as their supply of accessories was exhausted at the end of the war and in many lines has not yet been replenished. Manufacturing costs still show a tendency to increase.

In the saw manufacturing field, business is very brisk but the price situation is not satisfactory, because the prices quoted are too low to meet present costs of material and labor. Saws are still being sold at the 1916 prices, and some manufacturers state that it will be necessary for them to raise prices shortly, expecting that other saw manufacturers will follow. It is believed that there will be an increase in saw prices until a price level has been reached comparable with that now quoted for other machine accessories. Twist drill prices have also been advanced slightly, and in some cases prices of milling cutters; but other small tools appear to remain at former price levels.

The automobile industries appear to be fairly well supplied with machine tools for present requirements, though some of the larger companies are still buying. Gear manufacturers are exceedingly active, and a large percentage—in some cases from 75 to 80 per cent—of their product goes to the automobile and truck industries. It is estimated that the output of the automobile and truck builders for this year will amount to 2,250,000 cars. It may not be possible for all the automobile builders to complete as many cars as planned on account of the decided shortage of certain classes of material. Sheet steel is scarce, and cold-rolled stock of some sizes can be had only in small quantities. This is a serious drawback in the metal-working industries.

While the various sales offices of the machine tool section of the department of sales of the War Department still list a large number of government machine tools, it appears that most of the standard machine tools have been ordered by the technical and trade schools under the provisions in effect whereby these machines may be bought at a greatly reduced price. In fact, the supply of the types of machines most generally required by these schools has already been exhausted, and several trade schools have placed orders with machine tool dealers for new machines to supplement those that they are obtaining from the Government.

As a specific example of how some of the foreign trade in machine tools is encouraged in the face of the present exchange situation, it may be mentioned that one firm, in selling to French manufacturers, receives part payment in cash equivalent to the full amount in francs if the exchange were six francs to the dollar. The remainder of the purchase price, as figured at the present exchange, is paid in trade acceptances running for two years, which read in dollars. If at the end of two years the exchange has receded to nearly normal, it is evident that the buyer will pay less than one-half the number of francs that he would have to pay if he were to settle in full at the present time. The seller, again, can borrow on these trade acceptances, and so finds the arrangement satisfactory.

A plan that has been proposed to overcome the obstructive influence of the present foreign exchange to international trade, and one that possibly could be worked to advantage if it had big enough interests to back it, is to create a large, international financing company which would operate somewhat along the same lines as the Farm Loan Bank or as a large mortgage insurance company. This bank would take what would practically amount to a mortgage on manufacturing plants abroad and would issue credits to these plants, making it possible for them to buy on a credit basis, awaiting the re-establishment of normal exchange and stabilized industrial conditions. In effect, this corporation would extend credits to all firms whose resources would warrant it.

Canadian buyers seem to be especially dissatisfied with the present exchange situation and appear to be inclined to blame the American manufacturer for his unwillingness to accept Canadian dollars in payment for machinery quoted in American dollars. With the value of the Canadian dollar 8 per cent below that of the American dollar, it is evident that the American manufacturer cannot afford to stand the loss incident to accepting payment in Canadian funds, but Canadian dealers and manufacturers buying machine tools do not appear to appreciate this fact, and many manufacturers complain of the difficulties they have had in trying to satisfy their Canadian customers.

The efficiency of labor, generally speaking, is much lower than before the war. In many instances, there is an aversion to working over-time, and wages, especially for unskilled labor, are very high. As an example of the decrease in production due partly to decreased efficiency and partly to the scarcity of help, the experience of one factory may be quoted: The output of this factory today is only about 65 per cent of what it was in 1915. The reason is that only 80 per cent of the machine capacity of the plant is running, because it is impossible to obtain operators for the remainder, and the output per hour per man for the machines running is only 80 per cent of the man-hour output in 1915, so that the total output of the plant is less than 65 per cent. Such conditions cause prices to rise, and the cost of living will increase as long as production is kept down.

Consul Frederick Simpich reports from Berlin, Germany, under date of March 8, that the plan proposed in German economic and industrial circles to send a commission to Russia for the purpose of studying the economic conditions in that country has been approved by the German government and will receive its assistance. It is believed that German interests are planning to reconstruct the Russian railroads and telegraph systems and to export to Russia certain types of agricultural machinery. The German commission to Russia is a purely commercial one, the greater part of its members consisting of representatives of various branches of business.

An interesting development at the present stage of the metric controversy is reported. It is stated that some large manufacturers, whose managements are favorably inclined toward the adoption of the metric system, in signing contracts with subsidiary concerns or those manufacturing parts or equipment for them specify that the material and equipment that is supplied must be manufactured to the metric system. Through this requirement, if insisted upon by a few of the larger buyers of materials and equipment, it would be possible to exert such a pressure upon the smaller manufacturers selling to them that there would be practically a compulsory adoption of the metric system. We must presume that the manufacturers who formulate such requirements have sufficient reason for their demand, but in view of the experience of the large number of manufacturers who oppose any change at this time, it would be necessary to have a more detailed statement as to the advantages that are expected to be gained before it would be possible to say anything positive as to the justification for such a request.

COOPERATIVE INDUSTRIAL COURSE OF HARVARD ENGINEERING SCHOOL

The Harvard Engineering School has adopted a new plan of instruction for the junior year of the engineering course, whereby students will hereafter be given an opportunity to combine classroom work with six months of active engineering practice and industrial training. According to the new plan, which will be inaugurated in June and will apply to the instruction in mechanical, electrical, civil, sanitary, and municipal engineering, every student who wishes to take the industrial training work will spend half his time during his junior year working in industrial or engineering plants within easy reach of Cambridge. A schedule has been arranged which will enable these men to secure the full amount of regular classroom instruction and also to spend three separate periods of two months each in the industrial work. The plan has received the support and encouragement of the Associated Industries of Massachusetts, comprising about 1400 industrial and engineering concerns, and these industries have indicated their willingness to take on as many students as the Engineering School desires to place. It is expected that the men who go into this work will be paid current wages for the periods in which they work in the plants and that they will be able to earn sufficient money to pay their expenses during these periods. The new plan will be entirely optional on the part of the student, but the indications are that the great majority of students will welcome the opportunity to undertake it.

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NEW PLAN FOR RAILROAD REPAIR SHOPS

The Erie Railroad Co. is making an interesting experiment at its mechanical shops at Hornell, N. Y. It is reported that the railroad company is leasing the works to local interests, who will maintain and conduct the plant for engine and car repairs for the road. The Hornell Repair & Construction Co. has been organized for this purpose. This company will handle all features of operation, providing the present payroll, which totals about $200,000 a month, and invoicing the jobs handled to the railroad on an established basis. The change has been made to bring about closer contact between the employes and the officials who are actually engaging and paying them; with this local management plan, there is also a chance of keeping a watchful eye on plant production, and introducing economies where necessary. The basis as arranged is also far more economical for the railroad. The experiment is being watched with interest by a number of other railroad lines, and the Erie Railroad Co. is so impressed with the success up to the present time that it is said to be planning to place its repair shops at Susquehanna, Pa., on a similar operating basis.

PERSONALS

Louis E. Peck, formerly associated with the J. N. Lapointe Co., New London, Conn., has become treasurer of the Euclid Broach & Machine Co., Cleveland, Ohio.

Charles S. Amadon, formerly general manager of the J. N. Lapointe Co., New London, Conn., is now president of the Euclid Broach & Machine Co., Cleveland, Ohio.

Lyle B. Marcy, formerly superintendent of the Hart & Cooley Co., Inc., New Britain, Conn., has become connected with the Chase Companies, Inc., Waterbury, Conn., in the capacity of research engineer.

Maxwell C. Maxwell, formerly assistant general superintendent of the Yale & Towne Mfg. Co., 9 E. 40th St., New York City, has been appointed general superintendent, with headquarters at Stamford, Conn.

George Baily, formerly manager of the supply division of the Cincinnati office of the Westinghouse Electric & Mfg. Co., has been appointed industrial assistant to the manager of the supply department at East Pittsburg, Pa.

T. J. Pace, formerly industrial assistant to the manager of the supply department of the Westinghouse Electric & Mfg. Co., East Pittsburg, Pa., has recently been appointed assistant manager of the supply department.

James B. Dillard, formerly chief of the Engineering Division of the Ordnance Department, has resigned his commission in the Army and is now a member of the executive staff of the Cleveland Twist Drill Co., Cleveland, Ohio.

A. F. Orcutt was elected president and general manager of the Rivett Lathe & Grinder Co., Brighton District, Boston, Mass., at a recent meeting of the directors. Mr. Orcutt formerly served as vice-president and general manager.

C. C. McDermott has assumed charge of the Chicago office of the Brown Instrument Co., Philadelphia, Pa., succeeding J. W. Lazear. Mr. McDermott has been transferred from the Philadelphia office where he was district manager.

J. H. Malone has purchased the business of the Precision & Thread Grinder Mfg. Co., 1932 Arch St., Philadelphia, Pa., manufacturer of the multi-graduated precision grinder. F. Rodger Imhoff will continue as field engineer, with headquarters in Detroit.

William Ochse, formerly tool supervisor of the Gould & Eberhardt plants, Newark, N. J., has become associated with Manning, Maxwell & Moore, Inc., 119 W. 40th St., New York City, as a representative in the company's Chicago office at 27-29 N. Jefferson St.

L. A. S. Wood, who has been active in illuminating engineering circles both in this country and in Europe, has been made manager of the illuminating section of the supply department of the Westinghouse Electric & Mfg. Co., with headquarters at South Bend, Ind.

D. Ramon Casals, author of the article "American Machine Tools in Spain," published in the December, 1919, number of Machinery, has been appointed manager of the newly established branch office of Fenwick Freres & Co. in Barcelona, Spain, at Calle Consejo de Ciento, 421.

William S. Bloomer has been appointed Chicago district manager of the Quaker City Rubber Co., 182 W. Lake St., Chicago, Ill. Mr. Bloomer has been connected with the rubber business for many years, and was previously located in Chicago, so that he is well acquainted in that locality.

A. C. Johnston, formerly chief engineer of the Chicago works of the Link-Belt Co., has been elected vice-president of the company and resident general manager of the Chicago plant. Mr. Johnston succeeds Prentiss L. Coonley who is devoting his entire time to his duties as president of the Iske Mfg. Co.

Harry A. Hey, who has been connected with the Singer Mfg. Co., Elizabethport, N. J., for five years, has been appointed manager of sales in the eastern territory for the Illinois Tool Works, Chicago, Ill., manufacturer of milling cutters, hobs, and reamers. Mr. Hey's headquarters will be at 127 Water St., New York City.

A. L. DeLeeuw has become associated in an advisory capacity with the Illinois Tool Works, Chicago, Ill., and will be located at the New York branch, 127 Water St. Mr. De Leeuw will handle the cutter and milling problems in the eastern district. A complete stock of high-speed steel tools will be carried in the new, enlarged quarters.

Arthur Kirkland, formerly sales engineer with the Detroit Tool Co., is now manager of the Cleveland office, 548 Leader News Bldg., of Russell, Holbrook & Henderson, Inc., 30 Church St., New York City. This office has been established for the purpose of handling the sales of the Sanford precision centerless cylindrical grinding machine.

C. A. Severin has been appointed manager of the Cleveland branch of the Becker Milling Machine Co., which is located at 408 Frankfort St. This branch handles the company's full line of milling machines and milling cutters. Mr. Severin will be assisted by Charles Brandhill, who has been in the employ of the company for a number of years.

Robert S. Alter, vice-president of the American Tool Works Co., Cincinnati, Ohio, has been appointed trade adviser to the machine tool interests of foreign countries, by the National Foreign Trade Conference, and will conduct a bureau for the information of foreign buyers of machine tools at the annual foreign trade convention to be held at San Francisco, May 12 to 14.

Ernest W. Duston, a contributor to Machinery and for the past ten years mechanical engineer with the Blake & Johnson Co., Waterbury, Conn., has entered the employ of the Lake Erie Bolt & Nut Co., Cleveland, Ohio, in a similar capacity. Mr. Duston's associates at the Blake & Johnson Co. presented him with a gold watch at a farewell dinner that was tendered in his honor.

Clifford H. Peters has opened consulting engineering offices at 226 Superior Ave. W., Cleveland, Ohio. Until recently Mr. Peters was captain in the United States Army, attached to the Engineering Division of the Ordnance Department. His engineering practice includes the design and construction of various types of automatic and semi-automatic machines as well as plant lay-outs, production systems, and similar engineering service.

Charles F. Overly has recently been appointed general manager of sales of the Structural Tool Co., Cleveland, Ohio, manufacturer of rivet sets, chisel blanks, punches, dies, and pneumatic tool parts. Mr. Overly was connected with the manufacture of pneumatic tools for many years, after which he formed the Overly Industrial Tool Co., of which he was

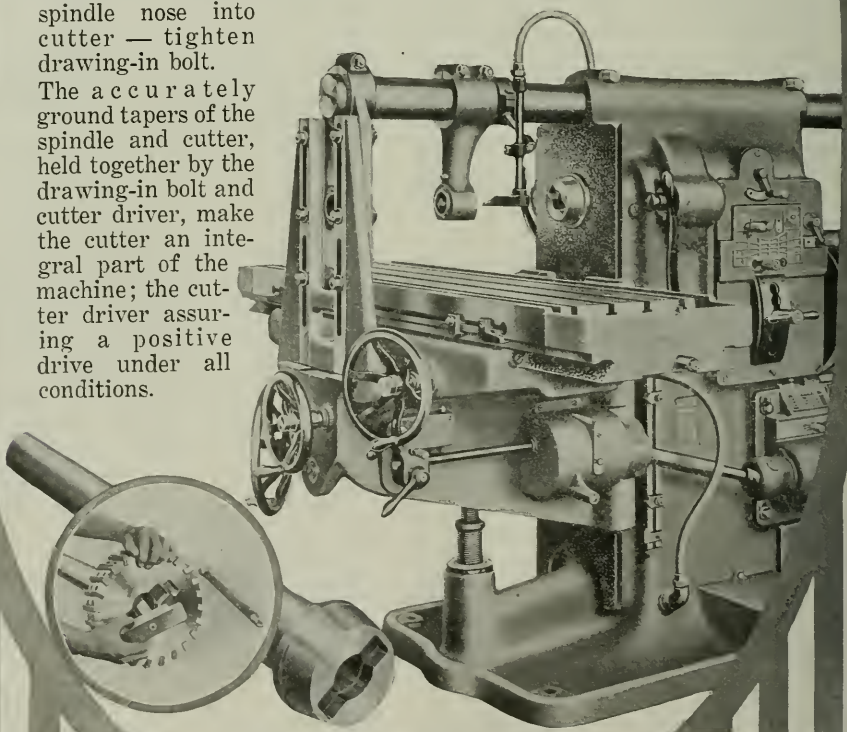
BROWN & SHARPE

Potential Points for High

The Taper Nose Spindle

The front end of the spindle is tapered, hardened and ground and has a recess to receive cutter driver and clutch on arbors and collets. Face milling cutters are quickly and easily removed and replaced. On the Vertical Spindle Machines it is especially easy to attach heavy cutters as insert on opposite page shows: simply place cutter on table — lower spindle nose into cutter — tighten drawing-in bolt.

The accurately ground tapers of the spindle and cutter, held together by the drawing-in bolt and cutter driver, make the cutter an integral part of the machine; the cutter driver assuring a positive drive under all conditions.



BROWN & SHARPE
MFG. CO.

MILLING MACHINES

Production and Accuracy

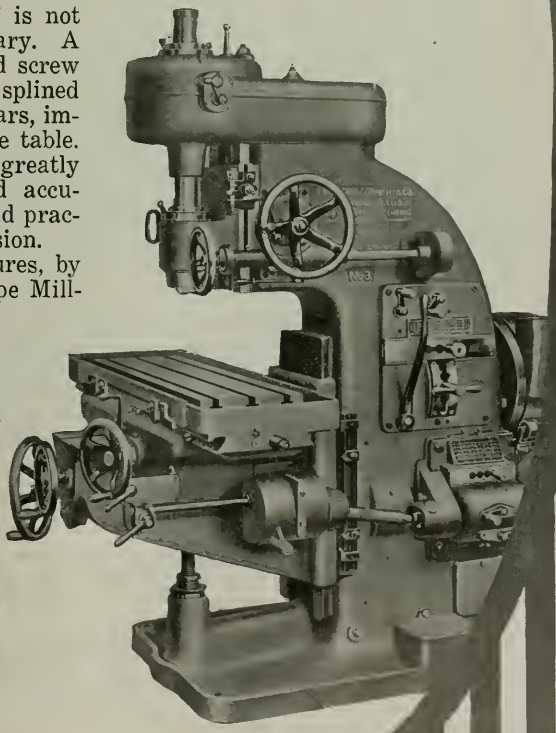
Feed and Speed Changes

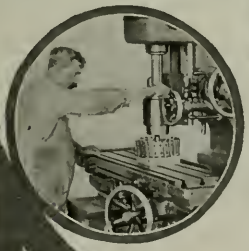
All changes are easily made by adjustment of index slide and levers. Correct positions of levers and slide for each speed or feed pictorially shown by direct reading index plate. Gears have teeth of special form permitting instant engagement.

Table Feed Screw

The feed screw itself is not splined and is stationary. A revolving nut for feed screw driven by an auxiliary splined shaft through spur gears, imparts movement to the table. This construction greatly prolongs the life and accuracy of the threads and practically eliminates torsion.

These and other features, by which Brown & Sharpe Milling Machines maintain their High Standards are described in our Milling Machine Book, a copy of which awaits your request.





PROVIDENCE, R. I.
U. S. A.

president. He has now combined forces with the Structural Tool Co. The company is located in its new plant at 3160 W. 106th St.

VANCE MCCARTY, general sales manager of Edward R. Ladew Co., Inc., 50 Union Square, New York City, manufacturer of Ladew leather belting, has been made vice-president of the company. Mr. McCarty has been associated with the company for the last twenty years, and his experience embraces every phase of the leather belting business, including manufacture, sale, branch management, and general sales direction. He will continue in direct control of Ladew sales policies, and has retained as assistant general sales manager, Russell B. Reid.

C. L. SONEN, formerly production engineer of the Teetor-Hartley Motor Corporation, Hagerstown, Ind., and the Ansted Engineering Co., Connersville, Ind., has organized the C. L. Sonen Co., Indianapolis, Ind., industrial manufacturing engineers for metal-processing plants. Mr. Sonen has been actively engaged as an executive and engineer for a period of twenty-four years, having been associated with the Heald Machine Co., Worcester, Mass., the Square D Co., Detroit, Mich., and L. V. Estes, Chicago, Ill., industrial engineers.

GEORGE C. BOA has recently become representative in the Chicago territory for C. E. Johansson, Inc., Poughkeepsie, N. Y., manufacturer and distributor of Johansson gages. Mr. Boa has had thirteen years practical experience in toolmaking and designing, having been employed by the Northern Electric & Mfg. Co., Montreal, Canada, the Ford Motor Car Co., Detroit, Mich., the Western Electric Co., Hawthorne, Ill., and the Wahl Adding Machine Co., Chicago, Ill. C. C. POUCHER, formerly representative of C. E. Johansson, Inc., in the Chicago territory, has purchased an interest in the Star Tool & Mfg. Co., Chicago, Ill., and is president of that concern.

RALPH G. MACY has been elected vice-president of the Engineering & Appraisal Co., Inc., 103 Park Ave., New York City. Mr. Macy, previous to becoming connected with this company, was chief engineer of the construction department with the Walter Kidde Co., where he organized the local working forces and carried on important factory construction simultaneously in various cities. When the United States entered the war, he was in charge of the operation of five plants making liquid oxygen and nitrogen by the French Claude liquid-air process, but at once obtained a commission in the United States Army and constructed for the Government the first helium gas plant. He also served as ordnance proof officer and as armament officer in the Coast Defense. His experience has covered the construction and operation of gas works, power plants, underground caisson work and high-tension electrical distrihuting systems and sub-stations.

OBITUARIES

JOHN A. BRASHEAR

JOHN A. BRASHEAR, known throughout the world as a scientist and manufacturer of astronomical instruments of precision, died in Pittsburg, April 8. Dr. Brashear was born in 1840 in Brownsville, Pa. He learned the machinist's trade, and was employed for many years in the rolling mills of Pittsburg. The study of astronomy was his hobby, and he devoted all his spare time to it. His work in this line attracted the attention of Professor Langley, head of the Allegheny Observatory, and in 1870, with the aid of one of the patrons of the observatory, he set up a shop in Allegheny for the manufacture of astronomical instruments, soon becoming widely known as an expert. Perhaps his most important achievement was in connection with the design and development of the spectroscope for astronomical uses. In 1888 he completed the spectroscope for the 36-inch telescope of the Lick Observatory. He was acting director of the Allegheny Observatory from 1898 to 1900. He received the degree of LL.D from Washington and Jefferson College, Wooster University, and the University of Pittsburg. Princeton University and the Western University of Pennsylvania conferred the degree of Sc.D. on him, and Stevens Institute of Technology, the degree of Doctor of Engineering. He was president of the American Society of Mechanical Engineers in 1915, and was also president of the Engineers' Society of Western Pennsylvania and the Pittsburg Academy of Arts and Sciences. For many years Dr. Brashear was trustee of the Carnegie Institute of Technology and of the University of Pittsburg.



COMING EVENTS

May 12-15—Seventh national foreign trade convention in San Francisco, Cal. Secretary of the National Foreign Trade Council, O. K. Davis, 1 Hanover Square, New York City.

May 17-19—Annual convention of the National Association of Manufacturers in New York City; headquarters, Hotel Waldorf Astoria.

May 17-19—Joint meeting of the American Supply & Machinery Manufacturers' Association, the Southern Supply & Machinery Dealers' Association, and the National Supply & Machinery Dealers' Association at Atlantic City, N. J.; headquarters, Hotel Marlborough-Blenheim; address of secretary, National Supply & Machinery Dealers' Association, Philadelphia, Pa.

May 19-21—Second annual convention of the Industrial Relations Association of America in the Auditorium Theater, Chicago, Ill. Assistant Secretary, E. A. Shay, Orange, N. J.

May 20-21—Spring convention of the National Machine Tool Builders' Association at Atlantic City, N. J.; headquarters, Hotel Traymore, Secretary, Charles E. Hildreth, Worcester, Mass.

May 24-27—Spring convention of the American Society of Mechanical Engineers at St. Louis, Mo.; headquarters, Hotel Statler. Secretary, Calvin W. Rice, 29 W. 39th St., New York City.

May 27—Monthly meeting of the Rochester Society of Technical Draftsmen, in Rooms 131-137 Sibley Block, 328 Main St., E., Rochester, N. Y. Secretary, O. L. Angevine, Jr., 547 Arnett Blvd., Rochester, N. Y.

May 28—Spring meeting of the American Iron and Steel Institute at New York City; headquarters, Hotel Commodore.

June 9-16—Annual convention of the American Railroad Association at Atlantic City, N. J. Secretary of Section III—Mechanical (formerly American Railway Master Mechanics' and Master Car Builders' Association), V. R. Hawthorne, 431 S. Dearborn St., Chicago, Ill.

June 17-19—Meeting of the American Drop Forge Association at Atlantic City, N. J.; headquarters, Hotel Marlborough-Blenheim. President, E. J. Frost, Frost Gear & Forge Co., Jackson, Mich.

June 21-25—Summer meeting of the Society of Automotive Engineers at Ottawa Beach, Mich. Secretary, Coker F. Clarkson, 29 W. 39th St., New York City.

June 21-26—Annual meeting of the American Society for Testing Materials, at Asbury Park, N. J.; headquarters, New Monterey Hotel. Secretary and treasurer, C. L. Warwick, 1315 Spruce St., Philadelphia, Pa.

September 14-18—Second annual convention and exhibit of the American Steel Treaters' Society of Chicago, Ill., and the Steel Treating Research Society of Detroit, Mich., in the Commercial Museum, Philadelphia, Pa. Department of Exhibits, 208 N. Wabash Ave., Chicago, Ill.

October 4-9—Annual convention and exhibit of the American Foundrymen's Association at Columbus, Ohio.

SOCIETIES, SCHOOLS AND COLLEGES

Lowell Textile School, Lowell, Mass. Bulletin for 1920-1921, containing calendar for 1919-1920 and courses of study.

BOOKS AND PAMPHLETS

Metallographic Features Revealed by the Deep Etching of Steel. By H. S. Rawdon and Samuel Epstein. 24 pages, 7 by 10 inches. Published by the Department of Commerce, Washington, D. C., as Technologic Paper No. 156 of the Bureau of Standards. Price, 10 cents.

Problems of Labor. Compiled and edited by Daniel Bloomfield. 436 pages, 5 by 7½ inches. Published by the H. W. Wilson Co., 958 University Ave., New York City. Price, $1.80.

The purpose of this volume is to save the time of the busy executive, industrial worker, or student of labor problems by assembling and reprinting the best of what has been published on the following subjects: Causes of Friction and Unrest; Cost of Living; Methods of Compensation; Hours of Work; Tenure of Employment; Trade Unionism; Labor Disputes and Adjustment; Methods of Promoting Industrial Peace; Limitation of Output; Industrial Insurance; Occupational Hygiene; and Women in Industry. The book contains a bibliography classified according to the subjects covered by the reprinted articles, as well as a complete index. A number of the authors whose articles are included are: Louis F. Post, John P. Frey, Frank W. Taussig, W. F. Ogburn, John A. Fitch, George W. Perkins, Charles W. Eliot, Lord Leverhulme, Royal Meeker, J. A. Hobson, Louis D. Brandeis, Samuel Gompers, and others.

Electrician's Handy Book. By T. O'Conor Sloane. 825 pages, 4½ by 6 inches. Published by the Norman W. Henley Publishing Co., 2 W. 45th St., New York City. Price, $4.

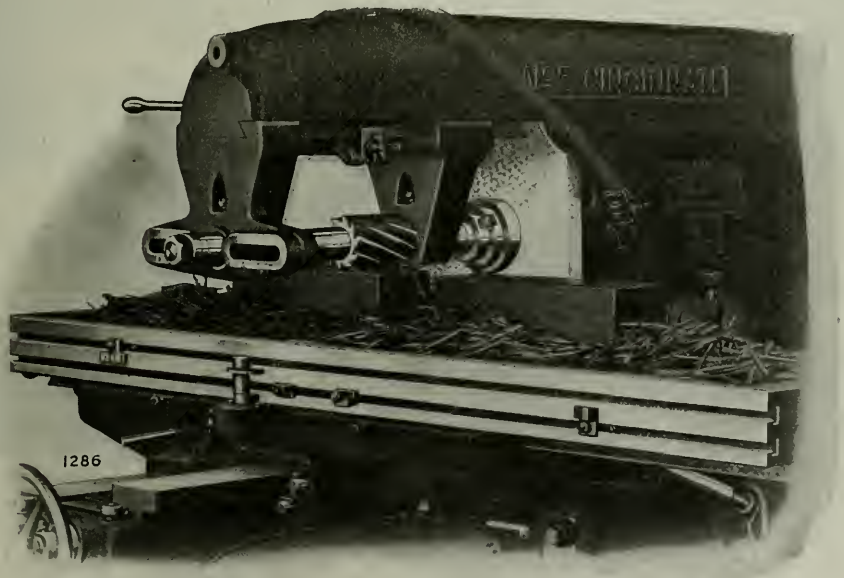
This reference book for electricians has been revised and enlarged, and is now in its fifth edition. It comprises a condensed encyclopedia of electricity, treating of the elementary principles

24 Cubic Inches of Steel Removed Without Braces

THE CINCINNATI RECTANGULAR OVERARM

(PATENTED)

enables the new No. 5 machine to take cuts up to its normal rated capacity without the use of braces.



Material, machinery steel, cutter, 4½-in. diameter Cincinnati design spiral mill, 2 in. arbor

Cut, ¼-in. deep, 5 in. wide. Feed, 19 in. per minute

Removing 23¾ cubic inches of steel per minute— without the use of braces.

THE CINCINNATI MILLING MACHINE CO.

CINCINNATI OHIO, U. S. A.

of the subject. The aim has been to make the present work practical rather than theoretical, abstruse theories having been avoided. There are forty-six chapters containing over 600 engravings. An idea of the scope of the work will be obtained by the following list of chapter heads: Mathematics; Electric Quantity and Current; the Electric Circuit; Ohm's Law; Electro-chemistry; Primary Batteries; Storage Batteries; the Field of Force; Magnets; Induction Direct-current Generators and Motors; Direct-current Armature Winding; the Direct-current Generator; Armature Reactions; Characteristic Curves; the Direct-current Motor; Open-coil Generators; Generator and Motor Construction; the Alternating Current; Alternating-current Generators; Alternating-current Motors; Transformers; Management of Motors and Dynamos; Care of Dynamos and Motors; Station Notes; Switchboards; Voltmeters and Ammeters; Distribution; Electric Meters; Lightning Arresters; the Incandescent Lamp; the Arc Lamp; Photometry; Electric Railroads; Electrical Measuring Instruments; Electrical Engineering Measurements; Electroplating; Telephony; Bell Wiring; Electric Heating; Wireless Telegraphy; Metallic Filament Incandescent Lamps; Vacuum Tube Lamps, Frame Arc Lamps, Notes on Illumination and Photometry; Electric Furnaces; Electric Bleaching; and Pupin's Coils—Lifting Magnets.

Inventions—Their Purchase and Sale. By William E. Baff. 230 pages, 5 by 7½ inches. Published by the D. Van Nostrand Co., 8 Warren St., New York City. Price, $2.

This book is essentially a manual on the marketing of inventions, but in its broader aspect it is a book on business policy, the purpose being to give to inventors and others information concerning plans by which inventions may be profitably exploited. It is intended for people in every line who are desirous of understanding the nature of patent property in inventions. Problems discussed are the manufacturers' problems as well as those of the individual inventor seeking to enlist capital or to start a business founded upon a new and useful invention. The aim of the book, as stated by the author, is "to standardize the best way, the best thing, the best thought, and see that all inventors know, practice, and use them." The book is divided into twenty-four chapters headed as follows: Value and Price of Patents; Gaging the Merits of an Invention; Types of Inventions (The Commercial Side); Gleaning the Talking Points of Inventions; How Patents Exclude—Practical Examples; Developing Inventions; Success in Inventing; The Demand for Inventions; the Market for Inventions; Patents as Property; Inventions and Investors; Inventor and Capitalist; Opportunities for Investment and Facts about Investors; the Presentation of the Inventor's Proposition; Methods of Making Sales; Closing with Inventors; Raising Funds—the Right Way vs. the Wrong Way—What Plans to Adopt; Advertising for Capital Leading up to a Partnership or Corporation; Salesmanship and Business—General Consideration; Sizing Yourself up as a Business Man; Elementary Contract Laws; Mistakes of Inventors; the Safety Valves of Marketing Inventions; and Suggestions from the Author on Every Phase of Selling Inventions.

Thomas' Register of American Manufacturers. 4500 pages, 10 by 12 inches. Published by the Thomas Publishing Co., 129 Lafayette St., New York City. Price, $15.

The eleventh edition of this well-known purchasing guide and directory here reviewed contains a considerable amount of additional material not found in previous editions, so that while the arrangement is the same as in past editions, the present volume contains 300 additional pages. The first main section of the directory contains a finding list and index of the various classes of machines, devices, products, and materials listed. This section, in order to facilitate easy reference, is printed on yellow paper. The second and by far the largest section of the work is devoted to a list of names and addresses of manufacturers classified according to their business. This list is thoroughly subdivided so that reference can be made to a specific class of manufacturers with little difficulty, and in addition the indexing in the first section of the book has so many cross-references that by always making use of the index first, the particular line of manufacturers to be found can be readily located. This section of the work is printed on white paper. The third section contains an alphabetical list of manufacturers in the United States, giving home offices, branches, names of officers, sales managers, purchasing agents, etc. This section is printed on blue paper. The fourth section contains an alphabetical list of trade names and brands, giving the names and addresses of the manufacturers. Immediately following this section is the fifth division which lists the representatives of prominent manufacturers. The alphabetical list of trade names and the manufacturers' representatives are printed on pink paper. The usual appendix is included, which gives a list of representative banks, boards of trade, and other commercial organizations, as well as a list of leading trade journals. Another feature of the work is the list of export and import houses, steamship lines, forwarding agents, foreign banks, etc., and an international trade section is also included which contains the names of some of the leading overseas importers and merchants. This list, it is stated, contains only responsible concerns, and should therefore be of considerable value to American merchants and manufacturers who desire direct overseas connections. Buyers and purchasing agents in all industries will find this work useful in answering the many questions that come up in their daily work, and in locating the sources of supply for the products or the manufacturers of the machinery and devices which they have to buy. It will also prove useful to the sales manager and the sales promotion department in determining the possible customers for any given product, and it is therefore a work that may be recommended to any manufacturer as a reference book and a directory.

NEW CATALOGUES AND CIRCULARS

Cincinnati Ball Crank Co., Oakley, Cincinnati, Ohio. Circular giving dimensions and prices of the company's line of finished steel washers.

E. F. Decker Saw Works, Albany, N. Y. Catalogue 64 of circular saws, bandsaws, circular knives, cross-cut saws, and other mill accessories.

Cleveland Punch & Shear Works Co., Cleveland, Ohio. Circular entitled "Penny Wise," advertising the company's line of punches, dies, rivet sets, and chisel blanks.

Electrolabs Co., 2635 Penn Ave., Pittsburg, Pa. Circular treating of Lectio oxygen and hydrogen cells for generating oxygen and hydrogen, and showing installations of these cells in a number of large plants.

Peter A. Frasse & Co., Inc., 417-421 Canal St., New York City. Pamphlet containing stock list of Shelby cold-drawn seamless steel tubing in round, square, and oval form. Circular descriptive of Britton priming cups and drain cocks.

Silver Mfg. Co., Salem, Ohio. Pamphlet entitled "Silver Drills in Service," containing a story of the work done by Silver drilling machines in the Army during the war. Copies of the booklet will be sent free upon request.

U. S. Gutta Percha Paint Co., Providence, R. I. Pamphlet entitled, "Which is Which?" advertising paint products for industrial plants, and showing their application for distinguishing pipes and service lines by the use of different colors.

Cincinnati Shaper Co., Elam St. and Garrard Ave., Cincinnati, Ohio. Circulars illustrating and describing Cincinnati line of heavy-duty back-geared crank shapers, which are made in sizes of 16-inch, 20-inch, 24-inch, and 32-inch stroke, respectively.

Frank G. Payson Co., 9 S. Clinton St., Chicago, Ill. Circular of "Logan" two- and three-jaw air-operated chucks and air-operated compensating collet chucks. Circular descriptive of Logan air-operated chucking equipments for the Jones & Lamson double-spindle flat turret lathe.

Cincinnati Gear Cutting Machine Co., Cincinnati, Ohio. Circulars illustrating and describing Cincinnati 16-inch spur and spiral gear-hobbers for quantity production, and Cincinnati 3A, 4A, and 6A automatic gear-cutting machines, in sizes of 36 by 10 inches, 48 by 12 inches, and 72 by 20 inches, respectively.

Lewis-Shepard Co., E. First St., Boston, Mass. Circular illustrating the application of "Jacklift" trucks for lifting and transporting loads in factories, foundries, freight terminals, etc. These trucks have capacities of from 2000 to 8000 pounds.

National Tube Co., Pittsburg, Pa. Circular containing a reprint of an article in the "Scientific American," entitled "Anti-corrosion Engineering," which deals with a method for preventing the destruction of steam and hot water pipes by corrosion.

Independent Pneumatic Tool Co., 600 W. Jackson Blvd., Chicago, Ill. Circular of "Thor" pneumatic motor hoists, describing the safety features, control, lubrication, etc., and giving general instructions for assembling the hoist and motor. Price lists of repair parts for Thor hoists are also given.

Cowan Truck Co., 16 Water St., Holyoke, Mass. Catalogue entitled "Transveyor Picture Book," showing a collection of views of the Cowan transveyor in operation in machine shops, printing plants, stock-rooms, warehouses, freight terminals, express terminals, automobile factories, textile factories, and many other industries.

C. J. Root Co., Bristol, Conn. Circular entitled "Chidsey's Challenge," describing the wide field of application of Root automatic counters, which will count or measure in single units, pairs, dozens, or any other desired unit, and should be of considerable value in keeping production records. A copy of the booklet will be sent free upon request.

Smalley-General Co., Inc., Bay City, Mich. Circular describing the application of Smalley-General thread milling machines in the manufacture of automobile parts, flanges, valves, oil and gas well supplies, pipe and pipe couplings, taps and dies, or in general, in the production of internal or external, right- or left-hand, straight or tapered threads.

Gisholt Machine Co., 9 S. Baldwin St., Madison, Wis. Circular showing the Gisholt 20-inch automatic turret lathe machining a steel commutator cap, which is completed in two operations, the total time consumed being thirty-five minutes.

Circular advertising the use of the periodograph for factories in keeping cost records and setting proper piece and premium rates.

Cincinnati Milling Machine Co., Cincinnati, Ohio. Catalogue covering the Cincinnati line of horizontal and vertical milling machines. A complete description of the machines is given, each part being described in detail. The different styles—plain, universal, and vertical high-power machines—are illustrated and specifications are given for the various sizes. These machines can be equipped for either belt or motor drive.

Sibley Machine Co., 8 Tutt St., South Bend, Ind. Circular illustrating and describing Sibley 26-inch and 28-inch heavy-pattern sliding-head drilling machines which have been especially designed to meet the requirements of rapid production. These machines were previously built in but one size—the 24-inch swing. The speeds and feeds are selective and have an unusually wide range, the spindle speeds varying from 26 to 403 revolutions per minute.

Griscom-Russell Co., 90 West St., New York City. Leaflet 6, covering the line of apparatus manufactured by the company, which includes water heaters, oil coolers, oil heaters, evaporators, expansion joints, grease extractors, and steam, oil, and air separators. Bulletin 1140, describing construction and operation of the Stratton steam separator. The pamphlet also contains tables giving the approximate dimensions of cast-iron and wrought-steel separators.

General Electric Co., Schenectady, N. Y. Circulars 61509, 61510, 61511, and 61512, illustrating four sizes of fractional horsepower constant-speed motors, and showing their applications on various types of machines and devices. These motors are made in capacities of 1/12 to 3/4 horsepower, 1/30 to 1/4 horsepower, 1/30 to 3/4 horsepower, and 1/200 to 1/15 horsepower, respectively. Bulletin 48029, illustrating and describing a reversing motor drive for planers, slotters, and other machine tools.

David Maydole Hammer Co., Norwich, N. Y. Catalogue of Maydole hammers for machine shops, pattern shops, and general use. Booklet entitled "A Captain of Industry," containing the story of David Maydole, inventor of the "Adz-eye" hammer, and presenting dimensions and other data for the line of machinists', blacksmiths', and special hammers made by the company. This little book also contains useful tables, such as board and plank measurements, speed of circular saws, weights of square and round bars of wrought iron, and other general information.

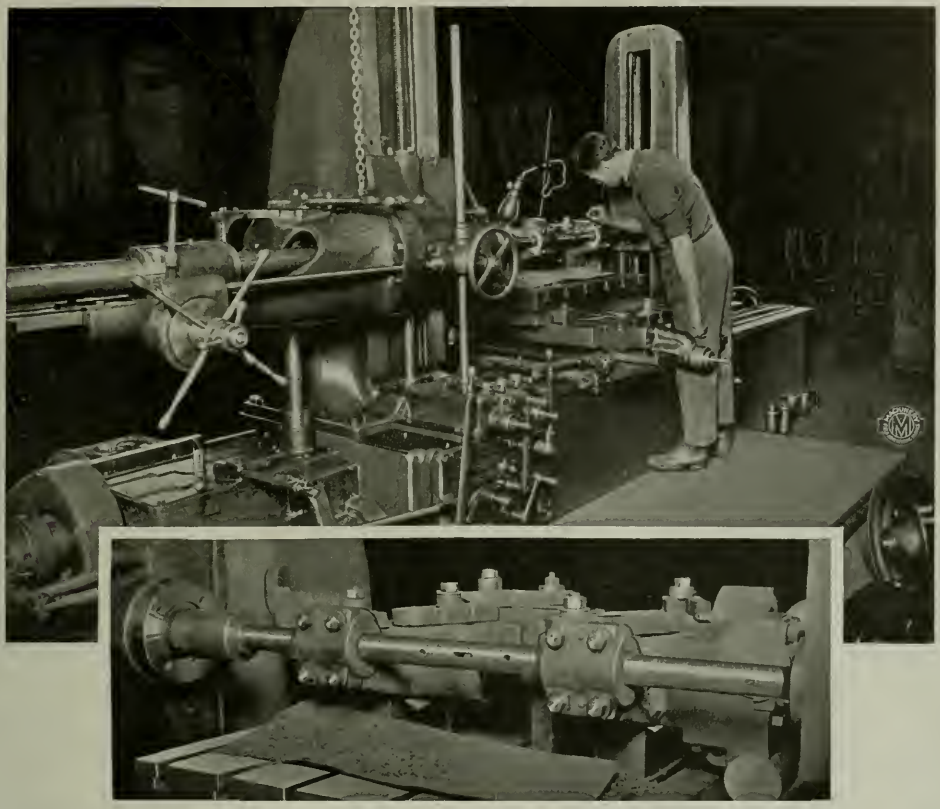
Allied Machinery Co. of America, 51 Chambers St., New York City. Catalogues illustrating and describing drilling machines made by the Western Machine Tool Works, Holland, Mich.; grinding machines, made by the Wilmarth & Morman Co., Grand Rapids, Mich.; shaping machines, made by the Ideton Mfg. Co., Muskegon, Mich.; reliefing machines, made by the Cleveland Milling Machine Co., Cleveland, Ohio; flanging machines made by the Lovekin Pipe Expanding & Flanging Machine Co., Philadelphia, Pa.; and cutting-off machines made by the Espen-Lucas Machine Works, Philadelphia, Pa.

Air Reduction Sales Co., 120 Broadway, New York City. Catalogue describing "Airco" A and B welding torches. The principles of torch operation involved in the construction of the "Airco" apparatus are explained, and the pamphlet is illustrated with views showing the full line of torches, angles of heads, tips, etc. Tables are given showing the thicknesses of metal that can be welded by the different tips supplied with each torch, pressures required, speed of welding in feet per hour, gas consumption in cubic feet per hour, etc. The catalogue will be mailed upon request to those interested.

Leeds & Northrup Co., 4901 Stenton Ave., Philadelphia, Pa. Catalogue 90, entitled "The Hump Method for Heat-treatment of Steel," describing a new method of hardening steel, which utilizes the outward manifestation of changes in internal structure that take place when steel is heated past the critical or transformation point to indicate when the work should be withdrawn from the furnace. The transformation point is indicated by a hump on the chart. This method is being used for hardening tools and dies, and for the quantity production of automobile gears, races for ball bearings, etc.

Greenfield Tap & Die Corporation, Greenfield, Mass. Catalogue 43, of the GTD gages, which include plain plug and ring gages, thread limit gages, limit snap gages, pipe thread gages, screw pitch gages, and miscellaneous special gages. Screw thread diameter measuring machines, precision pitch and lead testing machines, and screw thread projectors are also illustrated and described. In addition, the book contains miscellaneous gage and screw thread information relating to the care of gages, screw threading terms and their definitions, the measurement of screw threads by means of wires, and a number of useful tables of standard screw thread data. Another valuable feature of the catalogue is the graphic tolerance charts which should be found of use in establishing manufacturing limits.

Brown & Sharpe Mfg. Co., Providence, R. I. General catalogue 137, containing 609 pages, 3½ by 5¾ inches, listing the entire line of machinery and machine tools made by the company, which includes milling machines, grinding machines, automatic gear-cutting machines, screw machines, cutters, accurate test tools, and ma-



Three Lucas "Precision" Horizontal Boring, Drilling and Milling Machines

Always Busy on Jigs and other Large Pieces Held to Close Limits

Photographs and data obtained at the Baird Machine Company's plant at Bridgeport, Conn., where these machines have seen several years of service.

THESE machines are used for milling, drilling and boring—the one in the foreground being engaged in boring shaft bearing holes in a slide for a wire forming machine. There are ten of these holes, not cored but bored from solid stock, and they must all be on the same center line —limits for alignment and diameters of the holes being plus and minus 0.001".

Faces of bearings and caps are first milled off and caps drilled and tapped in place; after which the bearing holes are drilled, bored and reamed. Diameters are $2\frac{3}{16}$" and the bearing on each one is $4\frac{1}{4}$" long.

Think this over and write for a description of the machine

LUCAS MACHINE TOOL CO. NOW AND ALWAYS OF **CLEVELAND, OHIO, U.S.A.**

FOREIGN AGENTS: Alfred Herbert, Ltd., Coventry. Societe Anonyme, Alfred Herbert, Paris. Societe Anonyme Belge, Alfred Herbert, Brussels. Allied Machinery Co., Turin, Barcelona, Zurich. Benson Bros., Sydney, Melbourne. V. Lowener, Copenhagen, Christiania, Stockholm. R. S. Stokvis & Zonen, Rotterdam. Andrews & George Co., Tokyo.

chinists' tools. The book contains a complete index which facilitates referring to any desired section. The general plan followed in the catalogue is to show the illustration of each machine on the left-hand page and present the data covering dimensions, feeds, attachments, capacities, etc., on the opposite right-hand page. The capacity of the machine is given under the number of each machine at the head of the page in order to make it possible to compare the capacities for different machines easily. There is considerable general information of value in this publication such as tables of cutting speeds, formulas for determining dimensions of gears, tables of decimal equivalents, etc.

TRADE NOTES

Martin Tool Holder Co., Jackson, Tenn, has changed its firm name to Martin Tool Holder & Machine Co.

Martin Machine Co., manufacturer of marking machines, has moved from Greenfield, Mass., to Turners Falls, Mass.

American Galco Co., Inc., New York City, has removed its offices from S W. 40th St., to the Grand Central Palace.

Arthur M. Watkins, machine tool dealer, has moved from 165 Broadway, New York City to larger offices in the City Investing Bldg., Suite 1107.

Davis-Bournonville Co., Jersey City, N. J., has removed its Boston sales office from 125 Pearl St. to 44 Federal St. George J. Strobel is the manager.

Spaulding Chain Corporation, Bloomfield, N. J., has been organized for the manufacture of roller chain and sprockets. The president of the concern is Fenton J. Spaulding.

Imperial Brass Mfg. Co., Chicago, Ill., announces that its New York office was moved May 1 from 51 E. 42nd St. to the Longacre Bldg., Suite 605, 42nd St. and Broadway.

Baldor Electric Co., 4015 Laclede Ave., St. Louis, Mo., has been formed by E. C. Ballman and E. Doerr, formerly with the St. Louis Electric Works, St. Louis, Mo., to engage in the manufacture of induction motors.

Relisnce Machinery Sales Co., Pittsburg, Pa., has purchased and remodeled the three-story building at 1407 Brighton Road, Pittsburg. This building will be used as a sales and store room for the company's new and used machinery business.

E. B. Stickley Machinery Co., Detroit, Mich., dealer in new and used metal-working machinery, has combined its office and warehouse in one building at 217-221 E. Congress St., and all communications should hereafter be sent to that address.

Wellman-Seaver-Morgan Co., Cleveland, Ohio, has moved its manufacturing sales department, which handles the company's sales of rubber equipment and machinery, from the Akron office to the general offices at 7000 Central Ave., Cleveland, Ohio. L. N. Ridenour is in charge of this department.

Midwest Forge & Steel Co., East St. Louis, Ill., manufacturer of cement mill and mine forgings, grinding plates and steel balls, elected the following officers at its annual meeting: J. W. Eschenbrenner, president and treasurer; C. T. Coates, vice-president and general manager; and E. A. Eschenbrenner, secretary.

W. B. Knight Machinery Co., 3920 W. Pine St., St. Louis, Mo., manufacturer of the Knight milling and drilling machines, has found it necessary, owing to the large demand for its machines, to duplicate its plant by the construction of an addition adjoining the present shop which will double the capacity of the plant.

Alfred Herbert, Ltd., 54 Dey St., New York City, has recently opened an office in Toronto, Canada, in the Board of Trade Building, 31 Yonge St., where the company's line of machine tools, small tools, steel, etc., will be sold to the Canadian trade. J. C. Blair is in charge of the new office, assisted by G. A. Keith.

Frevert Machinery Co., 38 Vesey St., New York City, has sold its entire stock of machinery and merchandise, as well as the good will of the company to Peter A. Frasse & Co., 417 Canal St., New York City. The salesmen and other employes of the Frevert Machinery Co. will continue with Peter A. Frasse & Co.

Brown Instrument Co., Philadelphia, Pa., is erecting two new buildiogs—one for the manufactnre of recording thermometers and the other for use as a research department—at a cost of $100,000. It is expected that these facilities will enable the company to increase materially its output of Brown pyrometers and recording thermometers.

Tacony Steel Co., Tacony, Philadelphia, Pa., has removed its general and Philadelphia district sales offices from the works to the Franklin Bank Bldg., 1417 Sansom St., Philadelphia. J. B. Warren, president, and George Satterthwaite, vice-president, as well as the other officials of the company, are making their headquarters at the new address.

Hanson Clutch & Machinery Co., Tiffin, Ohio, has recently increased its capitalization from $60,000 to $300,000, and is now building a large addition to its present factory. Modern machine tools will be installed to meet the increasing demands of the business, and the company contemplates substantially increasing the present foundry capacity.

Deming Indicator Co., Patterson Bldg., Dayton, Ohio, has taken over the manufacture and sale of the Deming indicator, which has been manufactured and sold for the last two years by the Sheffield Machine & Tool Co., Dayton, Ohio, and for fifteen years previous by the inventor, Charles M. Deming, under whose personal supervision the indicator will now be made.

Euclid Broach & Machine Co., Cleveland, Ohio, has been incorporated with a capitalization of $50,000 to specialize in the design and manufacture of broaching eqoipment. Charles S. Amadon, formerly general manager of the J. N. Lapointe Co., New London, Conn., is president, and Louis E. Peck, also formerly connected with the J. N. Lapointe Co., is treasurer.

Fenwick Freres & Co., 8 Rue de Rocroy, Paris, France, has established a branch office in Barcelona, Spain at Calle Consejo de Ciento, 421, where a line of American metal-working machines and tools will be carried. D. Ramon Casals, author of the article "American Machine Tools in Spain," in the December, 1919, number of MACHINERY, is the manager of the new office.

Mummert-Dixon Co., Hanover, Pa., manufacturer of portable radial grinders, oilstone grinders, facing heads, etc., is now occupying its new 60- by 112-foot brick pattern shop which, with the side wings affords 7000 square feet of working floor surface. The shop is fully equipped with machines to meet the needs of the great variety of jobbing work done by the company.

Lincoln Products Corporation, 320 Market St., Newark, N. J., has recently been formed to market transmission equipment in Newark and vicinity. T. P. Cunningham, president of the new corporation, was formerly sales manager of the transmission department of the Hyatt Roller Bearing Co., and Hyatt roller bearing hangers will be one of the special lines carried by the Lincoln Products Corporation.

Hydraulic Press Mfg. Co., Mount Gilead, Ohio, has found it desirable, owing to the increasing demand for hydraulic machinery that exists throughout the Buffalo territory, to establish a branch office in that city. The new office is located in the Mutual Life Bldg., and is in charge of R. K. Havlicek, who has for some time represented the company as sales engineer, working from the main office in Mount Gilead.

Baker R & L Co., Cleveland, Ohio, has expanded its business to allow for a greater production of Baker industrial trucks and Raulang bodies. The change includes the sale of the electric passenger car business to Rauch & Lang, Inc., Cbspe Point, Mass. The manufacturing space made available by the expansion will result in tripling the output of industrial trucks and doubling the production of car bodies.

Curtis & Curtis Co., 324 Garden St., Bridgeport, Conn., manufactnrer of the Forbes pipe threading and cutting machine, was awarded a certificate of merit from the War Department for making prompt deliveries and otherwise cooperating with the construction division of the Army. During the war, Forbes pipe threading and cutting machines were supplied for pipe fitting work in the cantonments, battleships, navy yards, etc.

Lehmann Machine Co., 514 S. Broadway, St. Lonis, Mo., manufacturer of engine lathes, is erecting a new factory at Grand and Chonteau Aves. The building will be of steel and brick construction, 250 by 230 feet, one-half of which will be two stories in height, and will be ready for occupancy about July 1. The company intends to purchase considerable additional equipment for the new plant.

C. L. Sonen Co., 506 Indiana Trust Bldg., Indianapolis, Ind., has been organized by C. L. Sonen, directing engineer, to engage in work as industrial manufacturing engineers for metal-working plants. The field covered by the company includes functional organization; modern management plans; industrial relations; equipment specifications, analysis and lay-ont; experimental development; machine and tool design, manufacturing and production methods; factory cost analysis; manufacturing budgets, etc.

Toledo Milling Machine Co., Toledo, Ohio, has recently been organized, and is erecting a new factory on its manufacturing location on Summit St. The building will be 80 by 200 feet, two stories high, and of fireproof construction, and will be ready for occupancy in July. The company will manufacture a line of vertical milling machines. The officers are as follows: J. A. Geismar, president; L. J. Hinde, vice-president; W. P. Bateman, secretary-treasnrer; Herman Saxon, general manager; and L. E. Waite, general superintendent.

Morse Chain Co., Ithaca, N. Y., announces that the offices of the company in North Carolina have been moved from Greensboro, N. C., to 404 Commercial Bank Bldg., Charlotte, N. C. This change was found advisable by George W. Pritchett, the southeastern manager, owing to the great increase in the use of the Morse silent chains in the textile industry which can be served in a better manner from Charlotte, where large and commodious quarters have been secured, which will permit a complete exhibit of chain drives in operating order.

Westinghouse, Church, Kerr & Co., Inc., 37 Wall St., New York City, engineers and constructors, announce the combination of the company with Dwight P. Robinson & Co., Inc., of New York, constructing and consulting engineers. The new company will be called Dwigbt P. Robinson & Co., Inc., and will occupy executive offices at 61 Broadway, New York City, and engineering and designing offices in the Grand Central Palace, 125 E. 46th St. The company will engage in construction and engineering work along the same lines as previously followed by these two organizations, and the personnel will remain the same.

Link-Belt Co., Chicago, Ill., owing to the increasing demand for its products, is carrying out an extensive program of expansion at its works in Chicago, Indianapolis, Philadelphia, Toronto, and Seattle. New manufacturing facilities have been added to the various plants and the personnel of both factory and sales offices has been increased. The company has purchased the Fairmount Foundry at Philadelphia, which it will use as an adjunct to its Philadelphia works to supply the plant with gray iron castings. A new administration building is under construction at the Philadelphia works, and plans are being made to erect a similar building at the Chicago works.

Cleveland Abrasive Wheel Co., 2629 E. 25th St., Cleveland, Ohio, has been formed to engage in the manufacture of abrasives, abrasive wheels, abrasive cloth, dressing tools, and grinding machinery. J. R. Wild, formerly sales manager and director of the Canadian Hart Wheels, Ltd., Hamilton, Canada, is president of the new corporation; N. C. Yarian is vice-president; H. S. Roberts, formerly secretary of Alfred M. Best Co., Inc., New York City, is secretary-treasurer; and T. C. Dunford, who has been connected for over twenty-five years with the largest grinding wheel manufacturer in Canada, is works manager. The silicate plant begins operation about May 1, and the vitrified plant will be ready about September 1.

Carborundum Co., is extending and improving its plant at Niagara Falls, N. Y., and its two large furnace plants—one at Niagara Falls, Canada, and the other at Shawinigan Falls, Quebec, Canada. The extension includes a three-story addition, 432 feet long and 81 feet wide, to the paper and cloth plant at Niagara Falls, N. Y., in which are manufactured carborundum paper and cloth, carborundum brand garnet paper and cloth, and aloxite cloth. Another addition is a two-story building, 96 feet long and 64 feet wide, which will increase the capacity of the wheel-making and kiln departments. The company also contemplates making additions to the crushing department in the furnace plant at Niagara Falls, Ont., and to fourteen different departments at the Niagara Falls, N. Y., plant of the company. These various additions and extensions, it is estimated, will cost a half million dollars.

Safety Equipment Service Co., 215 St. Clair Ave., N. E., Cleveland, Ohio, has purchased the safety department of the Strong-Scbmard & Nutt Co., of Cleveland. The new company will continue to furnish the same class of equipment and service as heretofore rendered, inasmuch as the entire safety organization of the old firm has been retained. It is the aim to broaden the scope of operation in such a way as to meet the constantly growing demands of the safety field. In addition to the service department, an organization department will be maintained, which will furnish information and instruction on safety organization, charting, and functioning, compile statistical data for records, and conduct research work, showing the results obtained by means of graphic charts and tabulations. The company is developing new articles of safety equipment and will continue its line of "Adjustoglas" goggles, gloves, leggings, etc., and safety supplies.

Napier Saw Works, Inc., 5 Napier St., and the Victor Saw Works, of Springfield, Mass., have been taken over and merged by New York banking interests and will hereafter manufacture hacksaws exclusively, discontinuing the production of band saws and band saw machinery. The machinery of the Napier Saw Works will be moved to the plant of the Victor Saw Works. The management of the combined Victor and Napier concerns is as follows: President, Winthrop Sargeant, Jr.; vice-president and general manager, George J. Sledier; treasurer, Louis J. Oswald; secretary, William P. Jeffrey. W. F. Pollock, former president of the Victor Saw Works, will be assistant manager of the firm in active charge of operations. Guy W. Dunbohne, former sales manager of the Victor Saw Works, and C. C. Jackman, former works manager, will continue in the same capacities. A. C. Whitefield, former sales manager of the Napier Saw Works, Inc., will continue under the New York management.

Fred T. Ley, former president of the Napier Saw Works, Inc., and Henry F. Blanchard, former treasurer and general manager of the company, have formed a new company, with a capitalization of $500,000, and will manufacture metal-cutting band saws and band saw machinery. The new company will be known as the Metal Saw & Machine Co., Inc., and will be located in the Springfield, Mass., plant heretofore occupied by the Napier Saw Works. Howard L. Washburn, former works manager of the Napier plant, and F. H. Rich, former assistant treasurer, will become associated with the new band saw company.

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FOREIGN MACHINERY MERCHANTS PAGES, 544-545—ADVERTISERS INDEX, 579-580—PRODUCT INDEX, 548-576

The Editor's Talk With MACHINERY'S Readers

THE report of the National Industrial Conference Board covering the extent to which workmen's representation committees and shop councils are now in operation in the United States shows that at the present time 225 factories have workmen's representation plans, 144 of these being in the metal-working trades. This plan has not as yet been tried to any large extent in the machine tool and small tool fields, the Greenfield Tap & Die Corporation, Greenfield, Mass., being one of the first, if not the first, large company in this field to inaugurate a complete plan for workmen's representation.

IT is believed that all the manufacturers in the machine tool and small tool field will be interested in a complete review of the details of this new plan for creating cooperation between employers and employes, especially as applied to a large plant in their own field. It is for this reason that MACHINERY has obtained a definite account of the Greenfield experiment—the plan, its operation and the results obtained—from the officers of the Greenfield Tap & Die Corporation, which appears as the leading article in this number of MACHINERY. The statements made in this article are based upon interviews with Francis G. Echols, Vice-President and General Manager; L. M. Lamb, Comptroller; and R. P. Dolan, Head of Industrial Relations Department, of the Greenfield Tap & Die Corporation.

TWO other articles of especial interest to managers of industrial plants appear in this number. Building a Permanent Organization, by William H. McGregor, President, National Twist Drill & Tool Co., Detroit, Mich., is one. In this article Mr. McGregor outlines the methods employed in the National Twist Drill & Tool Co.'s plant for furthering friendly relations between the company and its employes, and for the building up of a permanent organization to which the men and women employed will be attached by firmer bonds than those produced merely by employment in the plant. The other article, Reducing the Labor Turnover, is by William A. Rockenfield, General Manager of the Baldwin Chain & Mfg. Co., Worcester, Mass., and deals with some of the questions involved in labor management. Mr. Rockenfield points out the importance of taking active steps for the education of industrial workers in regard to their relation to the industries in which they are employed, and the relation of the industries to the community. He advocates teaching a correct use of the term "labor," and deals with some of the problems met with in handling both native and foreign-born workers. He makes some apt remarks on the subject of welfare work and paternalism, and deals with the subject forcefully and in a manner which will attract and hold the interest of the reader.

STANDARDIZATION is the present watchword of the industries. True, standardization can be carried too far, but our present danger is not that we shall carry it too far, but rather that we shall not carry it far enough. A great advance toward adequate standardization has been made through the work of the National Screw Thread Commission, and the digest of the Commission's report as presented in the article on allowances and tolerances for screw threads gives the valuable results of the conscientious and painstaking labor of some of the leading men in the machine-building field in the United States for two years past. Before this report was rendered, numerous meetings and hearings were held in all the large industrial cities of the United States, and the Commission even journeyed to France and England in order to determine the possibility of an agreement for an international standard, before standards were recommended for the United States. Well-known men in the machine and tool field served upon this committee; among others, James Hartness and F. O. Wells. The whole machine-building field is indebted to men of this type for the time and effort devoted to this work of standardization, for the benefits to be derived will but in a small measure accrue to them, while it will save untold effort, time and cost in the machine-building industry as a whole.

AFTER all, the greatest steps in the advance of our industries often have been made through such unselfish service as this, and it is a matter of pride to the mechanical industries that men in this field have perhaps shown a greater willingness to cooperate with their competitors and with men from other industries for the advancement of engineering science as a whole, than have the men in other branches of industrial activity. They have always been ready to give freely of their time and energies to any movement promising better facilities and greater efficiency in producing work of higher quality at lower cost; and very often when it was clear that as individuals, or as manufacturers, they would be likely to profit but little by the improvements accomplished.

JULY MACHINERY 1920



Workmen's Representation in a Tool Manufacturing Plant

An Account of the Methods Used and the Results Obtained by the Greenfield Tap & Die Corporation, Greenfield, Mass., in the Application of Workmen's Representation in the Plants of the Corporation

Based upon interviews with FRANCIS G. ECHOLS, Vice-president and General Manager, L. M. LAMB, Comptroller, and R. P. DOLAN, Head of Industrial Relations Department

THE general industrial conditions throughout the country caused by the war, the unrest among labor, and the many other difficulties that have tended to bring about a reduction in output and a consequent increase in prices, have made it necessary to investigate different plans for promoting greater cooperation between employer and employe with a view to securing greater efficiency. Some of the plans investigated by industrial corporations during the past two or three years were installed in isolated cases years ago, but the conditions created by the war intensified the interest in matters of this kind and made more general the adoption of various plans whereby it is endeavored to obtain a better mutual understanding between the management and the workmen in the industries.

Among the numerous ideas for promoting this cooperation, improving the relationship between employers and employes, increasing the efficiency of labor in production, and providing an equitable means for increasing the compensation of the workers, the plan which has received the greatest attention is the method which gives to employes a voice in the management of the plant in so far as this is concerned with the working conditions and the general welfare of the men and women in the industries. The opinions of the workers are expressed through representatives elected by them, and the movement as a whole is known by such names as the Shop Committee Plan, Workers' Council Plan, Employes' Representation, Workmen's Representation, and Industrial Democracy.

It is believed that the term "workmen's representation" best describes this idea of industrial management, because it is descriptive of the general plan. The workmen's representation plan has been defined as a form of industrial organization under which the employes of the factory, through representatives chosen by and from among themselves, share collectively in the adjustment of employment conditions in the plant. It serves as a means of satisfying the employe's natural desire for a share in the determination of the conditions under which he works. The plan further endeavors to increase production by the cooperation fostered between the management and the workmen, and to stimulate the interest of the workmen in the welfare of the company by sharing with them, in the form of an additional wage payment or dividend, that part of the profits due to this cooperation.

During the past year a great deal of attention has been given by manufacturers to the experiment of workmen's representation, which is being tried out in some of the industries. Few manufacturers of machine tools and small tools have taken active steps along this line, and the Greenfield Tap & Die Corporation, Greenfield, Mass., is one of the first, if not the first, in this field to inaugurate a complete plan for workmen's representation. As manufacturers are interested in any plan of management intended to improve industrial conditions and stimulate production, this first complete review of the workmen's representation idea, as applied in the machine tool field, is published in MACHINERY as a record of this plan, showing what the experience in one large organization has taught concerning it.

One of the first plants in the country among the tool manufacturers to apply this new principle of management is the Greenfield Tap & Die Corporation, which operates six plants in Greenfield, Mass., and employs about 2000 people. The purpose of this article is to state in detail the methods by which the principle of workmen's representation has been applied in the various plants of this corporation and to show the results during one year's application of the principle.

The Object of the Greenfield Tap & Die Corporation's Plan

The two fundamental principles upon which the plan adopted by the Greenfield Tap & Die Corporation is based relate, first, to the duties of the management and, second, to the duties of the employes. The management endeavors to give just returns for work performed and to provide an opportunity for the employes to learn and progress. It endeavors to establish clean, orderly, safe, and sanitary working conditions, satisfactory equipment and reasonable hours, with opportunities for recreation and rest. The workers, in turn, are expected to give honestly applied labor, constructive thought with a view to reduction of costs, and to endeavor to cooperate with the management in preserving and improving the quality of the product. The workmen further cooperate with the management by regular attendance and punctuality, and by discouraging indifference, restriction of output, or poor workmanship on the part of any of their fellow-workers. It is believed that if both the management and the workers observe these principles, a better mutual understanding will be effected, and the management and the employes alike will benefit by the cooperation.



Fig. 1. The Judiciary in Session at One of the Plants of the Greenfield Tap & Die Corporation. The Judiciary is composed of the Foremen of the Plant

The method by which the aims outlined are obtained is by creating an association among the employes through which questions relating to working conditions and living conditions affecting the welfare of the employes may be brought to the attention of the management, and be thoroughly discussed so that decisions may be reached by mutual agreement. The association of employes, through its representatives, also possesses a means for the equitable adjustment of any difference that may arise between individual employes and their foremen, or between the employes in general and the management. This reduces the cost and waste due to misunderstandings, and the saving obtained by the reduction of this waste is shared equally by the employe and the employer.

General Outline of the Representation Plan

The association of employes just referred to is known as the G T D Associates. Employes of any department in any capacity who have been in the employ of the corporation for a continuous period of one month are eligible to membership. The general routine of the association is handled by the industrial relations manager, who acts as a general secretary of all the activities involved in the workmen's representation plan. When an employe wishes to become a member of the association, he applies to the industrial relations manager for membership. Upon verification of his employment record, the applicant is entered as a member. Membership in the association entitles the employe to full consideration of any question that he may wish to bring up through the chosen representatives and entitles him to a vote at the annual meeting, which is held in May, for the election of representatives for the coming year, as well as a vote at any special meetings of the membership that may be called to fill vacancies among the representatives. When a member leaves the employ of the corporation, he automatically ceases to be a member of the association.

The general plan of management in as far as it relates to the employes' representation comprises a legislature, which is composed of representatives of all the skilled and unskilled workers in the plant, there being one representative for each twenty employes, or fraction thereof, in each department. If a department has less than twenty employes, it elects one representative. There is a second body known as the judiciary, which is composed of the foremen, assistant foremen, and department heads, and there is a third body known as the executive council, which is composed of the factory manager, the superintendents, and the general foremen. Finally, the whole organization is headed by the chief executive—in this case the general manager of the corporation's plants.

The Duties and Powers of the Legislature

As the corporation operates several different plants, there is a separate body of workmen's representatives in each of the three larger plants, while some of the smaller plants are grouped together for representation in one unit. For the purpose of this article, it will be sufficient to take as an example the organization and working of the representation in one of the plants only. Referring especially to the Wells Bros. Division of the corporation, it may be mentioned that the 350 employes of this division have 26 representatives, who meet once a month to discuss the questions or "bills" brought up by the different members.

The representatives to the legislature are elected for one year, and to be eligible for election, a representative must have been in the service of the corporation continually for at least one year immediately preceding election. The object

of this restriction is to prevent any worker from having a voice as a representative who has not been in the employ of the corporation for a period sufficiently long to make him thoroughly conversant with the conditions in the plant. Should this restriction, however, deprive any department of sufficient representatives, members of that department who have been in the continuous employ of the corporation for over six months immediately preceding election may be added to the list of eligible representatives. Both the nominations and the elections are conducted by secret ballot, and twice as many members are nominated by each department as the number allowed for representation. It is not necessary here to give all the details of the election system, but it should be mentioned that the methods and the supervision of the elections are worked out in great detail in order to prevent any possible chance of dissatisfaction with the results, or any coercive or fraudulent practices, and carefully drawn provisions are made for the guarding and recounting of the ballots in cases of disputes or doubts.

The newly elected legislature at its first meeting elects a president, a vice-president, and a recording secretary from its own numbers. The industrial relations manager announces the date, place, and time of the monthly meetings to be held. These meetings take place on the company's time, and representatives working on piece-work receive compensation in the form of an adjustment made to correspond to their lost earnings. The meetings seldom require more than one hour.

Special meetings of the legislature may be called upon the request of two-thirds of its members, who make a written appeal to that effect to the industrial relations manager at least one week in advance of the date of meeting. Attendance at the meetings of the legislature is restricted to members, but courtesy of attendance is extended to members of the judiciary and the executive council, and to the chief executive, who have the privilege of entering into the discussion but have no power to vote. The industrial relations manager is a member ex officio of every committee, attends all meetings, has the privilege of entering into the discussions, but no voting power. He is the connecting link between the management and the "Associates." When the legislature has passed upon the proposals made, it either refers them to the judiciary for action or to either one of the standing committees of which more will be told later.



Fig. 2. The Legislature in Session. The Legislature consists of the Elected Representatives of the Workers

Power and Duties of the Judiciary

The judiciary, which is composed of the foremen, assistant foremen, and department heads, sifts the suggestions made by the legislature and makes further recommendations, if necessary, to the executive council. Members of the judiciary may also introduce suggestions and recommendations for the consideration of that body and for further submission to the executive council. The judiciary elects a president, vice-president, and recording secretary at its first regular meeting in June, the same as does the legislature. The meetings of the judiciary are held twice a month, except if a special meeting is called by a two-thirds vote of its members. Attendance at the meetings is restricted to the members of the judiciary body, but the chief executive or members of the executive council may be present with privilege of taking part in the discussion, but with no power to vote. The industrial relations manager is a member of all committees of the judiciary, the same as in the legislature; he attends all meetings, and has the privilege of taking part in all discussions but is not given the power to vote.

The Executive Council and the Chief Executive

The executive council, composed of the factory manager, the superintendents, and general foremen, considers the suggestions received from the two lower bodies and refers them to the chief executive with their recommendations. The members also consider recommendations made by the chief executive and suggestions submitted by one of the members of the council for the consideration of the other members of that body. The chief executive has the power to veto any recommendation passed to him, in case he finds it necessary. He has not been required to exercise this power, however, because all proposals so far on which there has been a disagreement between the legislature and the judiciary, have been agreed upon by a joint conference committee of these two bodies before the propositions have been passed to the upper bodies.

Annual Meeting of the Employes

At the general annual meeting of the employes, when representatives are elected to the legislature for the various departments, all other matters of mutual interest to the employer and the employes are discussed, and recommendations

and resolutions are offered which the representatives later will take up with the management. Matters are also submitted by the members of the executive council or by the chief executive for the consideration of the employes, and a vote is taken. Reports of the various committees, indicating their activity during the past year are also presented. This meeting is presided over by the officers of the legislature.

In order to bring the representatives of the workers into more direct contact with the executives of the firm, meetings are also held twice a year, presided over by the chief executive, at which the executive officers of the firm, the executive council, the members of the judiciary, and the workmen's representatives in the legislature are present.

The minutes of all meetings are carefully kept and copies are made by the industrial relations manager so that he has a complete record of all the minutes of every branch of the representative bodies or committees involved in this plan of representation.

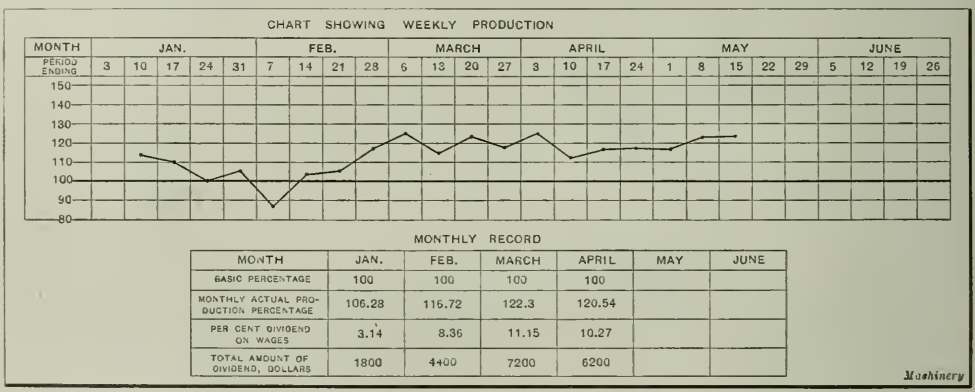
The Committees and their Work

There are four standing committees which handle the greater part of the detail work of considering proposals made in the legislature and carry on all general investigation work required in connection with suggestions made. These technical education, manual training lectures, sick benefit, life insurance, etc.

The Plan in Operation

The organization required for a complete plan of workmen's representation has been given in considerable detail, so that manufacturers in general may be able to form an idea of the method by which the plan is applied in practice. The greatest general interest, however, will doubtless center upon the actual working of the plan, the questions that are considered, and the results that have been obtained.

Briefly described, the method of procedure when a member of the legislature wishes to make a proposal for adoption by the management is as follows: He introduces what is known as a "bill" in the legislature, in writing. If adopted, the bill is referred to the judiciary for approval. If approved by the judiciary, it is submitted to the executive council, and if approved by the council, to the chief executive. On the other hand, if the judiciary originates a bill it goes first to the executive council and then to the chief executive, who will refer the matter to the legislature in case he deems the subject one upon which the legislature's opinion would be of value; or, if the matter relates purely to a management problem, he will decide without referring to the legislature.



MONTHLY RECORD

MONTH	JAN.	FEB.	MARCH	APRIL	MAY	JUNE
BASIC PERCENTAGE	100	100	100	100		
MONTHLY ACTUAL PRODUCTION PERCENTAGE	106.28	116.72	122.3	120.54		
PER CENT DIVIDEND ON WAGES	3.14	8.36	11.15	10.27		
TOTAL AMOUNT OF DIVIDEND, DOLLARS	1800	4400	7200	6200		

Machinery

Fig. 3. Type of Production Chart posted in the Plants to show the Average Weekly Production and to record Dividends earned

are the joint committee on industrial cooperation and conciliation; the joint committee on safety and accidents; the joint committee on health, sanitation, and housing; and the joint committee on recreation, education, and insurance. Each of these committees is composed of six members, three of whom are designated by the judiciary and three by the legislature.

The committee on industrial cooperation and conciliation is by far the most important, because this committee deals with all questions pertaining to the prevention and settlement of industrial disputes, conditions of employment, reported grievances, appeals from discharge notices, and rules relating to the maintenance of discipline, etc.; in addition, it handles all questions relating to improved production methods, machinery required, etc.

The committee on safety and accidents, as the name implies, deals with matters pertaining to accidents and the safeguarding of machinery, fire protection, first aid, fire drills, etc.

The committee on health, sanitation, and housing deals with all questions relating to physical examinations, medical treatment, sanitation, wash and locker rooms, rest rooms, drinking water, restaurant service, as well as housing problems.

The committee on recreation, education and insurance, as the name implies, deals with all questions pertaining to social activities, club houses, playgrounds, entertainments, moving pictures, athletics, schools, libraries, naturalization,

If the legislature makes a recommendation which is not approved by the next body, the recommendation is returned to the body from which it originated, together with further recommendations, after which it is reconsidered. If it is to be passed in its original form over the veto of the next succeeding body, it requires a two-thirds vote. For example, if a recommendation originates in the legislature, but is disapproved of by the judiciary, it will be returned to the legislature with a complete statement of the reasons for disapproval. The legislature then takes a second vote, and if two-thirds of those present vote in favor of the original recommendation, the matter is referred to a joint committee. Usually all differences of opinion are settled to the satisfaction of everyone concerned by the joint committee, but provisions are made for arbitration in cases of a tie vote in the committee. No such case has ever been met with in the experience of the corporation whose plan is here described.

The Suggestion Box

In order that all employes may have an opportunity to present suggestions for improvement either in the manufacturing methods or for the general comfort and welfare of the employes, suggestion boxes are provided in the plant, and special blanks are available upon which any employe may make suggestions. These suggestions are not signed, but the suggestion blanks are provided with a coupon having a number corresponding to the number on the blank. This coupon is torn off by the employe making the suggestion and

kept by him for identification. The suggestions are collected by the industrial relations manager, who prepares copies, one of which is filed for permanent record and the others handed over to the permanent committee having charge of that part of the work to which the suggestion pertains. The clerical work is handled by the industrial relations department, and careful records are kept of all suggestions made and the actions taken upon them. Sometimes the suggestions, instead of being passed to a committee, are referred directly to the legislature, and in some cases they may be referred directly to the executive council or the chief executive, according to the nature of the suggestions.

Every suggestion and every bill is kept in a special envelope carrying a consecutive number and giving the date when it is received by the industrial relations manager. The envelope also has upon it a printed form giving the date when it is referred to one of the standing committees, the legislature, the judiciary, the executive council, or the chief executive, as the case may be, and has also upon it spaces for recording whether the action taken by any of these bodies was favorable or unfavorable, and whether an award was recommended. The award refers to a special compensation being made for suggestions considered valuable. Substantial awards have been recommended and paid in many instances for suggestions of a constructive nature. Many suggestions, of course, are of a nature to call for no award, although they may be acted upon favorably. Announcement is made on the bulletin boards whenever a suggestion has been finally acted upon, whether it be a favorable or an unfavorable decision. The number of the suggestion blank is given, and by means of the coupon corresponding to this number, the employe having made the suggestion may claim the award.

How Does the Plan Work out in Practice?

Most of the employers unacquainted with the results obtained by workmen's representation fear that the proposals made by the representatives of the men may be of such a nature that it would be impossible for the management and the representatives of the employes to agree, and that instead of creating harmonious feelings, a state of friction and dissatisfaction might be the result. The experience of the Greenfield Tap & Die Corporation indicates that no such fears need be entertained. The majority of the employes in any factory when given the responsibility of expressing themselves as representatives of the whole body of workers will be found to be reasonable and conservative. There has been no question brought up during the past year upon which a satisfactory settlement to all concerned has not been found possible. One of the proposals dealt with during the year, and doubtless the most important of all that was handled, has been the question of working hours. The legislature proposed a reduction of working hours from fifty-five to forty-eight, but upon representation made to the legislature by the management of the corporation, a compromise of fifty hours per week—nine hours for five days and five hours on Saturday—was reached. It was made a condition of this arrangement that the employes should make a special effort to increase their production so that within a given period, the production in fifty hours should equal the production in fifty-five hours. Not only was this condition met, but as will be referred to later, due to a special incentive of increased compensation, the employes have through their efforts been able to increase production materially, even beyond the past production in fifty-five hours.

In another instance, a question of piece rates came up in the legislature. One employe asked to have the piece rate on a certain performance upon which he worked, increased. The committee appointed to investigate the matter found that the increase was reasonable. A recommendation to that effect was made and approved by the management. Later, the same man requested an increase in piece rates on some other operation that he performed. At this time the representatives of the employes made an adverse recommendation, stating that they thought the piece rate as set was satisfactory. This indicates that the representatives will take a reasonable view of things when they are given the responsibility of going definitely on record with their decisions.

Actual Questions Dealt with by the Legislature

In order to indicate to employers interested in installing a system of this kind in their plant what the questions are that the representatives of the employes are most likely to bring up, a review is given of the questions handled at the meetings of the legislature during three consecutive months. It will be found that questions relating to heating occupied a fair proportion, due to the fact that the three months selected were winter months. At the meeting of the first month, a new member was appointed to one of the standing committees; a recommendation was made to change the pay-day from the present day in the week to Saturday; a recommendation was made for improved heating facilities for certain departments; and the conditions in the locker-room were discussed and certain recommendations made.

At the meeting the following month heating conditions were again discussed, and a plan was proposed for preventing draft through the door by which steel coming into the factory was trucked and unloaded. Previous to this meeting membership in the employes' association was permitted only to employes who had been continuously employed for three months, and as only members participate in the dividends paid as a result of increased efficiency, it was recommended that membership should be extended to include all those who had been in the employ of the company one month, giving them a chance to participate in the dividends. This recommendation was later approved by the management. It was further proposed by the workmen's representatives that if an employe was late more than twice during any one month, he should lose twenty-five per cent of his dividend for each time of lateness in excess of the minimum of two times allowed. This recommendation was passed by the legislature, but on recommendation of the chief executive it was later rescinded.

At the meeting of the third month the following questions were dealt with: The keeping of an alley clear from trucks and boxes; the providing of a truck for the exclusive use of the tool-room; an investigation into the reason for the falling off in production at a time when the men felt that they were working as hard as ever; and a proposal for the establishment of a cooperative store. The proposal with regard to the cooperative store was approved by the upper bodies and the chief executive, and it has been decided to start this enterprise. The firm will finance the undertaking and will also pay the overhead, so that the men will be able to buy actually at cost. The employes recognize that an opportunity to buy at reasonable prices is more valuable than a flat increase in wages, because an increase in wages would soon be absorbed by the increased prices that storekeepers would be enabled to charge, whereas cheaper goods bought in the cooperative store give permanently a greater value to the wages earned.

As will be noted, none of these proposals show any radical or unreasonable tendencies, but on the contrary, they indicate a disposition on the part of the employes to cooperate with the management of the firm for the best interest of the welfare of all concerned.

How the Standing Committees Investigate Problems and Aid in Establishing Cordial Relations

In order to show how the standing committees, through their investigations and recommendations, are an actual help to the management, it may be of interest to note a few of the problems that they have handled. During one month the committee on industrial cooperation and conciliation dealt with questions relating to piece rates; a proposed mechanical improvement eliminating two operations in performing a certain class of work; desirability of installing two new machines for one department; better artificial

lighting facilities for certain work; installation of a system for handling certain matters in the shop; the distribution of pay slips; requisition of blanks; and in addition three other mechanical improvements for increasing the shop efficiency.

The committee on health and sanitation dealt with such questions as heating conditions; the providing of special ventilating windows; the reduction of drafts in certain parts of the factory; certain improvements in the restaurant; racks for girls' clothing; improvement in the lighting systems; conditions of the rest room; and many similar problems.

The safety and accident committee dealt with questions relating to guarding the switches on motors; wooden pulleys in poor condition; the guarding of grinding wheels; the providing of handles on elevator cables; the covering for electric wires, etc.

The committee on recreation, education and insurance dealt with certain phases of the work of the employes' benefit association and group insurance, and with various details relating to recreations and amusements.

The Results Obtained

The main question after all is: What are the results in the Greenfield plants? Here is an elaborate piece of machinery requiring considerable clerical work and attention on the part of the management and considerable thought, interest, and effort on the part of those employes who are elected to represent their fellow-workers. What are the benefits to be derived from this method, and are the benefits accruing to the management alone, or to the workers alone, or are they mutual? The answer given at the Greenfield Tap & Die Corporation's plant is that the results are definite and that the advantages gained accrue to employer and employe alike. There has been a material increase in production as compared with the period before the introduction of the plan, especially in the larger plants operated by the corporation; and as the workers share in the form of dividends in the increased production, their net earnings have been increased proportionately. In one of the plants operated by the corporation during two successive months, the employes received over 10 per cent of their earnings during the month in the form of dividends. An incentive has been created, and the men in the shop can see that their interest and that of the firm can be promoted simultaneously. They show a greater interest in their work and are interested in improvements that eliminate waste. They are satisfied with the general shop conditions because, within reasonable limits, they are given a free hand in creating those conditions.

Permanent Record of Production

In order to keep the results obtained in the plant permanently before the eyes of the workers, and to stimulate their efforts in earning for themselves as big dividends as possible, a chart along the lines of that shown in Fig. 3 is kept for the workmen's inspection in each of the plants controlled by the corporation. The base line 100 indicates normal production. The curve shown indicates from week to week whether the production in the plant is above or below normal. It will be seen that during one week the production fell below normal, while the general tendency is for the production to be from 15 to 20 per cent above normal. If the average production rises to 20 per cent above normal during any month, one-half, or 10 per cent of this, is credited directly to the workers, and they receive at the end of the month a dividend of 10 per cent on their wages. On the bottom of the chart is a monthly record which gives the basic percentage, the actual average percentage of production achieved during the month, the percentage of the dividends on the wages, and the total amounts of dividends paid in dollars. This chart and the figures given have proved to be of great value in keeping the men informed as to actual production of the plant and in stimulating their interest in increasing production.

Conclusions Drawn from the Experience of the Greenfield Tap & Die Corporation with Workmen's Representation

The opposition generally found to workmen's representation is in most cases due to a misunderstanding of the application of the principle. Much has been said and written in opposition to this method by those who have not tried it and whose information upon the subject has been incomplete. It is not proposed in any plan of workmen's representation to turn the actual management of the plant over to the employes; that would be impossible, and 95 per cent of the toolmakers and machinists in our metal-working industries know that such a scheme would result in failure. But what the employes appreciate is a chance to be permitted to have something to say about the actual conditions under which they work and to be assured of a share of that part of the increase in production that can be traced directly to the increased effort, interest, and energy, which they display where their cooperation has been enlisted by methods such as outlined. This has been the experience of the Greenfield Tap & Die Corporation, and the facts presented in the foregoing are merely intended to record the methods and the results obtained in a plant in the tool manufacturing field where the workmen's representation plan has been fairly tried.

* * *

COMPARISON OF HARD AND SOFT SNAGGING WHEELS

The following interesting data concerning the relative merits of hard and soft grinding wheels for snagging steel castings and high-speed steel billets were published by the Norton Co., Worcester, Mass., in a recent issue of *Grits and Grinds*. In a test on open-hearth steel castings, a wheel 18 inches in diameter was used, both sides having a ¾-inch taper. The labor was employed at piece-rate, and the overhead cost was $1 per hour. Two standard Norton alundum vitrified wheels were used in the test, the softer of which, 6610-U 0115, showed an average life of 47.5 hours. The hard wheel, 6610-W 0115, showed an average wheel life of 100 hours, yet the total cost per ton including overhead expense was $4.91, as compared with $4.16 for the soft wheel. The fact that the wheel life was increased more than 100 per cent with the harder wheel and yet that the grinding cost was greater than with the soft wheel is due to the slower cutting of the harder wheel, the result in pounds of castings ground per hour for each wheel being 874 for the soft wheels and 700 for the hard wheels.

Two tests were made on high-speed steel billets, each test being run with a different grain of alundum vitrified Norton wheels, 14 inches in diameter. The labor cost on one of these tests was 43 cents per hour and the overhead cost $15 per day. The softer wheel, grain 20, grade R, showed an average wheel life of 39 hours, grinding away the steel at the rate of 2.21 pounds per hour, while the hard wheel, grain 20, grade U, showed better results as regards wheel life, the average number of hours being 60, but the amount of steel ground off was only 1.32 pounds per hour. Thus, although the life of the softer wheel was only 65 per cent that of the hard one, the total grinding cost was reduced about 30 per cent due to the increased hourly production. The total cost per pound of steel ground off on the two wheels was 61 cents and 85 cents, respectively.

In making the other test on the billets, the labor was employed at piece-rate, and the overhead expense was 90 cents an hour. Norton 20-R and 20-W wheels showed the following results: 22 hours, average wheel life of the 20-R, or soft wheel, as against 61.2 hours on the hard wheel; steel ground off per hour 4.1 and 2.4 pounds per hour, respectively; total cost per pound of steel ground off 43 cents and 57 cents, respectively. These data show that by reducing the wheel life practically one-third and using a softer wheel, the actual grinding cost was reduced 14 cents per pound of steel removed.

Manufacturing Seamless Steel Tubes

Practice of the National Tube Co., Pittsburg, Pa., in Producing Shelby Seamless Steel Tubes, Including the Processes for Hot-finished and Cold-drawn Tubes and the Manufacture of Large Tubes and Seamless Cylinders



THE first and one of the most essential steps connected with the manufacture of seamless tubing is the production of a uniform, homogeneous steel of the right physical and chemical properties. The manufacture of the steel used for making Shelby seamless tubing is controlled entirely by one organization to insure uniformity and a continuation of these uniform qualities. This steel, as delivered to the heating furnace, is in blooms about 11 feet long and usually from 6 to 10 inches square. After these blooms have been carefully inspected for surface defects and any irregularities removed with pneumatic chipping hammers, they are placed one at a time in a heating furnace by an electrically operated charging mechanism (see the heading illustration). This heating is preparatory to the rolling operation.

Rolling the Blooms into Round Bars or Billets

When the proper temperature for rolling has been reached, the bloom is pulled from the furnace by the long arm of the crane or transfer mechanism and placed upon a small electric buggy; this buggy transfers it to the rolling table of the bar mill where it passes through a series of rolls which changes the square bloom into a round bar or billet of smaller size and greater length. Different sizes of round bars are rolled according to the size of tubes required to be made from them; some of the bars are 8 inches in diameter when finished, and others are as small as 3 inches. While still at the rolling heat, the round bars are cut to different weights (according to the length and wall thickness of the finished tube) by a circular saw, and centered while still hot. They are then allowed to become cold, after which they are inspected, marked with a die to identify the steel, and sent to the piercing mill.

Centering the Billets

The billets, or "rounds," contain just enough metal for making tubes of the desired length, thickness, and diameter, and to compensate for normal losses incident to manufacturing the tube. The first operation in making a seamless tube from the billets is known as "centering." This is performed by a pneumatically operated machine, as shown in Fig. 1, while the billet is still hot from the rolling mill; an indentation is made in the center of one end of the billet by a punch, in much the same manner as preparation is made for drilling holes in metal by center-punching. The cavity or countersink thus produced, which is about 1 inch deep, insures proper starting of the hot billet in the piercing operation, permits insertion of the piercing point at its most effective position in relation to the piercing rolls, and makes for an equalized displacement of metal from the center of the billet.

How Rough Seamless Tube is Formed in Piercing Mill

After the billets have been centered, inspected, and marked, they are placed in a heating furnace of special construction. The bottom of the furnace is inclined, and centered billets of the proper length are fed into the upper and cooler end, from which they roll by gravity to the lower end, where the temperature is high enough to render the steel semi-plastic.

The piercing mill is located close to the discharging end of this furnace and the billets are fed into it, centered end foremost, as in Fig. 2. The solid billet, almost white hot,



Fig. 1. Pneumatic Centering Machine for centering One End of the Hot Billet preparatory to the Piercing Operation

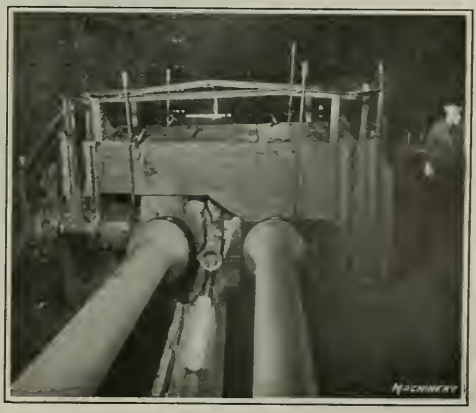


Fig. 2. A Heated Billet entering the Piercing Mill where the Centered End is forced over the Piercing Point of a Mandrel

is pushed forward until it is caught by the revolving rolls of the piercing machine, which force it over the piercing point of a mandrel as illustrated by the diagram Fig. 5. As the billet is forced over this bullet-shaped point by the combined forwarding and rotating action of the heavy revolving rolls, a dull, grinding sound is audible. While enormous force is required to operate the piercing machines, there is nothing spectacular about the operation, nor is there much suggestion of the enormous power required to displace the metal from the center of the hot billet toward the outside. The newly pierced billet at this stage in the process is simply a rather rough, thick-walled, seamless tube. It is raw in appearance and not particularly true to size, and it retains the knurl marks of the piercing rolls on its battered surface. But it is without seam or weld, the round bar of steel having been pierced throughout its length.

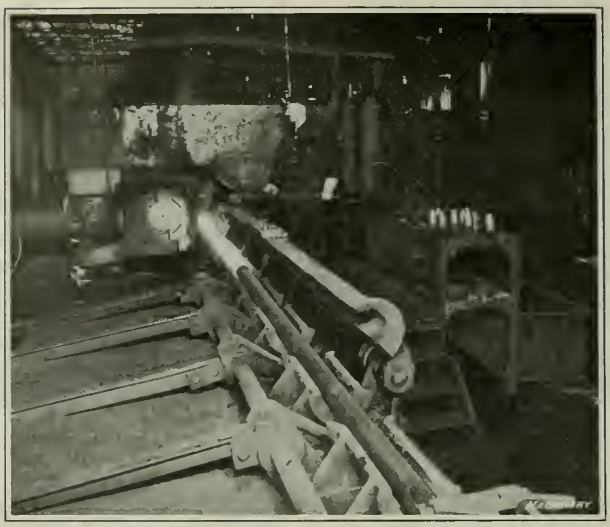


Fig. 3. Rough Tube coming through the Piercing Mill

Lengthening Tube and Reducing Diameter by Rolling

The tube at this point is short and has thick walls, and to change this thickness into length is the next requirement. Accordingly, it is rolled through adjustable rolls and over a mandrel held in the roll groove by a long steel bar, where the wall thickness and diameter are reduced, and in this manner it is converted into a longer tube with walls of uniform thickness having a fairly smooth finish. This operation is illustrated in Figs. 4 and 6.

While still at a suitable working temperature, the rolled tube passes on through the reeling machine shown in Fig. 8. This is another form of rolling machine, consisting of two heavy rolls of special design, set with axes askew, which may be adjusted to a thousandth of an inch. (See the diagram Fig. 7.) As the tubes are fed through these rolls, any mill scale is removed, a smooth, burnished surface is produced, and the outside diameter of the tube is corrected to some extent. From the reeling machine, the tubes pass to the sizing or finishing rolls Fig. 9, which reduce the outside diameter to exactly the required size.

Cooling the Tubes, and Trimming and Cutting to Length

From the finishing rolls, the tubes travel to an inclined cooling table, Fig. 10, up which they are rolled slowly by conveyor chains, and after being sorted and inspected they are put into racks, ready for removal by electric cranes. The electric cranes transfer the hot-finished tubes to cutting-off machines where the rough ends are trimmed from the tubes and the tubes cut to proper length. Any slight straightening necessary is then done, the tubes are thoroughly inspected (if boiler tubes, a hydrostatic pressure is also applied), after which they are stencilled. They are then put in stock or sent to the shipping room.

Tubes which have passed through the operations described up to this point are known as hot-finished tubes. The term "hot-finished" is used to distinguish these tubes from hot-rolled tubes which are intended for cold-drawing to smaller sizes. When tubes are hot-finished, they are ready for use without further treatment in the mill, and all operations are performed on the tube before it becomes cold, thus differing from the manipulation of cold-drawn tubes, which are allowed to become atmospherically cold before reaching the draw-benches.

Cold-drawing Seamless Steel Tubing

Hot-rolled tubes that are to be cold-drawn are given the same piercing, rolling, reeling, and sizing operations as tubes that are to be hot-finished. The first operation preliminary to cold-drawing is pointing the tubes. One end of each tube is heated and then pointed in swaging dies under a power hammer. Pointing the tube furnishes a "bait" which is grasped by the heavy tongs of the draw-bench in which the tube is to be cold-drawn.

Before tubes can be cold-drawn they must be clean and free from mill scale. They are therefore pickled in an acid bath, which is heated and kept in constant agitation by jets of steam. While the operation of cold-drawing is simple in principle, expert mechanical supervision is necessary to secure uniform, accurate results. The operation is practically the same for steel tubes as it is for brass and copper tubes. The apparatus used consists of a heavily constructed steel draw-bench, in the center of which is the die through which the tube is to be drawn. A heavy, square-linked endless chain runs over a wheel located underneath the die, and travels along the top of the bench for a

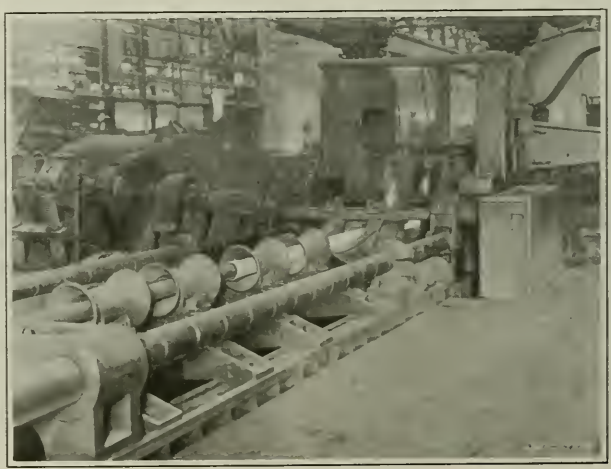


Fig. 4. Rolling Mill which lengthens the Rough Tube and reduces its Diameter

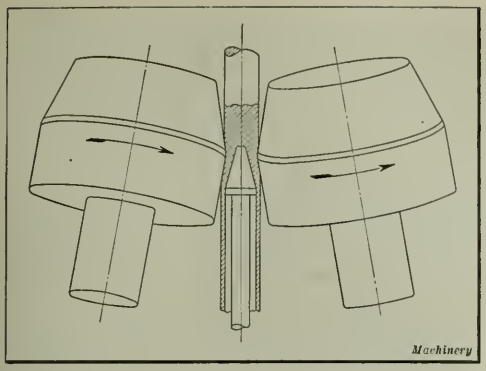


Fig. 5. Diagram of Piercing Operation showing the Revolving Rolls of Piercing Machine and End of Mandrel over which Billet is forced

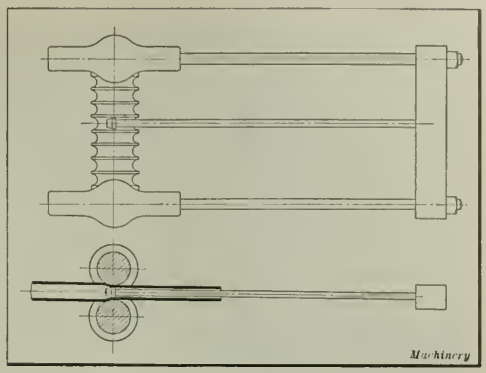


Fig. 6. Diagram of the Rolling Operation for reducing the Wall Thickness and Diameter of the Tube after a Piercing Operation

distance of from 15 to 40 feet to a sprocket which is geared to a suitable source of power. The chain returns underneath the draw-bench.

Operation of a Draw-bench

In operation, a hot-rolled tube (now perfectly cold) is partially inserted in the die with its pointed end projecting through as shown in Fig. 11. A workman slides a mandrel into the tube from the opposite end, and an operator seizes the pointed end of the tube with heavily constructed tongs which run on wheels along the bed of the draw-bench. (See Figs. 12 and 13.) The tongs have a strong hook that catches on the traveling chain. By a tremendous pulling force the tube is drawn or literally squeezed through the die, or between the die and the mandrel previously inserted. All tubes except those of ½-inch inside diameter and less, and those in which the wall is very heavy relative to the diameter are drawn over mandrels. The mandrel is kept in position by a long bar which goes inside of the tube and holds the mandrel just even with the die while the tube is being drawn. Dies are made from the very best grade of crucible steel, and are machined to a thousandth inch, to govern the outside diameter of the tube that is to be drawn. Shelby seamless steel tubes are drawn from two to twenty times through dies of varying diameter to obtain the required dimensions; some tubes are drawn still more by the manufacturing consumer.

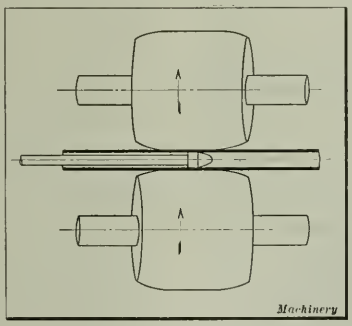


Fig. 7. Diagram of Reeling Operation, showing Rolls which are inclined to each other and the Central Mandrel

Annealing the Tubes

After the tube receives the final pass through the dies, which reduces it to the desired outside diameter and thickness, the point is cut off and the tube passes to the annealing furnaces. Cold-drawing makes the tube hard and brittle, and therefore after each cold-drawing pass it is necessary to anneal the tube in order to make it soft enough to withstand further drawing. The process of annealing forms scale on the tube, which must be removed by pickling; otherwise the scale would scratch the tube and score the die on subsequent cold-drawing passes.

After the last cold-drawing operation, the tube is subjected to one of various anneals, according to the use for which it is intended. This anneal may vary from a "light" anneal to remove drawing strains, to a "long" anneal in a closed box ("retort anneal"), which makes the tube extremely ductile.

Straightening and Cutting to Length

After the required anneal has been given, the cold-drawn tube passes to the straightening machines, where any deviations from straightness are corrected. These straightening



Fig. 8. Rolled Tube entering Reeling Machine equipped with Rolls for removing Mill Scale and partially correcting Outside Diameter



Fig. 9. Reheated Tube passing through the Sizing or Finishing Rolls which give the Exact Diameter Required

machines are of different types; some of them are based on a planetary system of roll-rotation, others consist of horizontal and vertical rolls together, and still others are nothing more nor less than presses designed for the purpose. In the two first-mentioned types, the straightening of the tube is practically automatic, while the human element enters to some extent in straightening tubes with the press type of machine. Small tubes are sometimes straightened by hand in a bending rack, the workman's eye and expert judgment being the main factors in securing the result.



Fig. 10. Cooling Table receiving Tubes from the Sizing Rolls

After leaving the straightening machine, the tube passes to a cutting-off machine where it is either cut to specified lengths or multiples, or to the best advantage in random lengths. When this has been accomplished, the tube (if for mechanical purposes) is given a final inspection and sent to the stock rack or shipping room.

Hydrostatic Tests

Seamless steel boiler tubes are given an internal hydrostatic pressure test immediately after they leave the cutting-off machines and have been inspected. The test pressure applied to tubes under 5 inches in diameter is 1000 pounds per square inch, and for tubes 5 inches in diameter or over an internal hydrostatic pressure of 800 pounds per square inch is employed, provided the fiber stress corresponding to these pressures does not exceed 16,000 pounds per square inch. In certain cases where the fiber stress is over 16,000 pounds per square inch, tubes of standard thickness over 6 inches in diameter are tested to 500 pounds per square inch at the mill. After the tubes have been fully tested they are marked with a stencil, showing the name of the manufacturer, the test pressure used, the kind of material of which the tube is made, and how it is finished. Tubes intended for mechanical purposes are tested differently from those used for boiler tubes. All tubing is subjected to frequent and rigid inspections and tests.



Fig. 11. Pointed Tube projecting through the Die of a Draw-bench used for the Cold-drawing Operation

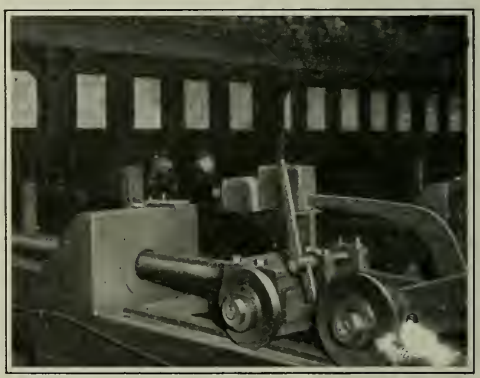


Fig. 12. Tongs of the Draw-bench pulling a Tube through the Die, illustrated diagrammatically in Fig. 13

Drawing Seamless Steel Tubing from Flat Plates

Seamless steel tubes, in diameters up to and including 5½ inches, are made by the piercing process described in the foregoing; tubes 5½ inches to 9¼ inches can be made by either the piercing or the cupping process, while for tubes larger than 9¼ inches the cupping process is generally employed. By the cupping process, large, heavy-walled tubes are made from square plates of steel. It will be readily comprehended that to obtain a seamless tube, say 20 inches in diameter, from a solid billet of steel, would necessitate the use of rolling and piercing machinery of gigantic and unwieldy proportions, and to drive such machinery would require tremendous power, but a tube 20 inches in diameter is seldom required in lengths greater than 10 feet, and for such lengths the cupping process obviously can be more economically and advantageously employed.

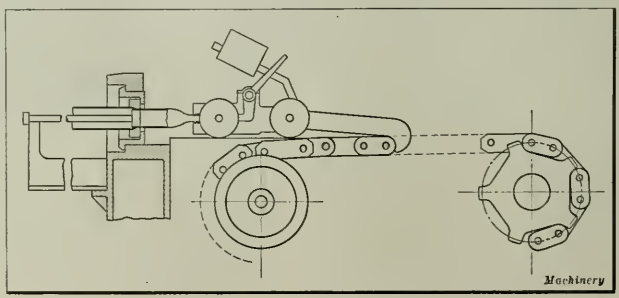


Fig. 13. Diagram illustrating the Arrangement of the Draw-bench with its Traveling Chain, Tongs, and Die

Cutting Circular Disk and Drawing Shallow Cup

The steel plates from which these larger tubes are made contain the calculated volume of metal required for



Fig. 14. Hot-punching Round Disks from Square Plates



Fig. 15. Converting a Flat Disk into a Shallow Cup

the finished tube, plus a sufficient amount to compensate for the normal losses in manufacture. They are made from the same grade of steel as the billets for the smaller sizes of tubing, and are delivered to the heating furnace in squares varying in thickness from $\frac{3}{8}$ inch to 4 inches, and in size from 2 to 7 feet square.

The square plates are placed in a heating furnace, and when they have reached the proper temperature they are withdrawn, and round disks are cut out in the press shown in Fig. 14; these hot disks are immediately passed to the hydraulic press, Fig. 15, where they are forced through a die, thus forming a rough shallow cup; these cups are again heated and pushed through a smaller die, Fig. 16, which elongates them and reduces the diameter.



Fig. 16. Second Cupping Operation for reducing the Diameter and elongating the Cup

After a plate, or disk, has been formed into a cup of suitable dimensions, it is reheated and drawn through a series of dies in a horizontal bench. This apparatus, which is shown in Fig. 17, consists of a heavy cast-steel frame or body, provided with a powerful hydraulically operated plunger which can operate through the full length of the bench. Punches of various sizes are placed on the end of the plunger, according to the size of tube desired, and dies of successively decreasing diameter are dropped in recesses in the bench frame in positions so that the heated elongated steel cup may be forced through them one after another by the punch. Inasmuch as the reduction of diameter and walls is limited for each heat, a cup may be heated and drawn as many as twelve times before it is a finished tube.

The plate has now passed into tubular form, and the original head, or the bottom of the cup, forms but a small portion of it. Subsequent hot-drawing operations may be



Fig. 17. Drawing Hot Cup into Seamless Tube in Series of Dies



Fig. 18. Dishing Ends of Seamless Steel Cylinders to form Bottoms

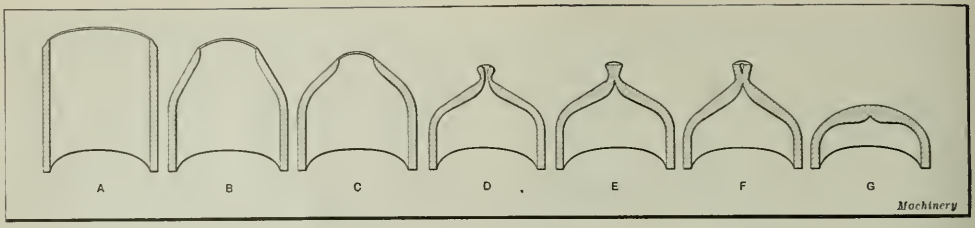


Fig. 19. Successive Stages in Spinning Operation for closing the End of a Seamless Cylinder

necessary to produce a tube with a smaller diameter, a thinner wall, or a greater length. Finally the head, or closed end of the tube, which remains until the last operation is completed, is cut off, the tube is inspected and tested hydrostatically and the process is finished. If the tube is to be used in making seamless steel cylinders, the head is left on to form the bottom of the cylinder, or a special type of head can be made by spinning, welding, or other operations.

Manufacture of Seamless Steel Cylinders

Seamless steel cylinders are used for containers of liquefied and nonliquefied gases, such as carbonic acid gas, hydrogen, oxygen, etc. To meet the varied requirements of different services, they are made in a wide variety of diameters, thicknesses, and lengths.

One method used in the manufacture of seamless steel cylinders, 6 inches in diameter or under, consists in cutting a piece of seamless steel tubing to the required length. The second step is forming a closed end on the tube by "spinning." The idea of spinning metal is old, but the adaptation of the spinning process in the seamless tube business, for converting tubes into cylinders, flasks, etc., is comparatively new.

In the spinning process, the open end of a tube can be closed and also perfectly welded in the same operation. The machine itself is a type of lathe with a hollow spindle provided with a chuck for holding the tubes to be spun. Before the tube is put in the spinning machine, the end to be spun is slightly heated. The spindle is then rotated at a high speed, with the tube. A blunt steel tool is brought to bear against the tube and swung around the end of it. Little by little the tool is brought forward at each sweep around the end, causing the tube to close up into a half-spherical form. The friction of this tool against the tube creates a high heat, and as the metal is gathered closer and closer toward the center the heat at the center becomes so intense as to melt the metal and close the opening with a perfect weld.

The different stages through which a spun end of a tube passes in this closing and welding operation are shown in Fig. 19. When the heat, in the judgment of the operator, is sufficient for welding, the tool is swept across the end of the tube, cutting off the projecting end shown in next to the last sectional view, and the welding of the center is performed, resulting in a closed tube end as shown at the extreme right. The power required to close a tube 6 inches in diameter by ¼-inch wall is about 40 horsepower.

As the majority of cylinders are required to stand on end, the half-spherical form of the tube end produced by the spinning operation must be re-formed to meet this condition. Therefore the tube is forced into a die, or matrix, of a press, which is so designed as to push the spun end inward or dish it, and change its form from convex to concave. This furnishes a level rim at the bottom of the cylinder upon which it may rest. The press used to "dish" the bottom of cylinders as described is shown in Fig. 18.

After the bottoms are formed, the cylinders are conveyed by an electric crane to the pickling tanks, where they are immersed in an acid solution to remove any mill scale from the interior. Upon removal from the pickling tanks, the open ends of the cylinders are raised to a forging heat and swaged under a power hammer to form a "bottle neck."

Heat-treatment and Hydrostatic Test

After the cylinders have been formed, they are heated in a continuous furnace, removed, and quenched in water. After this hardening process, they are removed to an annealing furnace and annealed, or drawn, to a degree which will make them ductile enough to withstand the flattening test required by the Bureau of Explosives' specification, and yet be strong enough to meet the high-pressure hydrostatic test. From the annealing oven the cylinders are again placed in a pickling bath to remove any scale that may have formed in the hardening furnace, after which they are placed in a lathe where the necks are trimmed off, bored, and threaded for valve connections.

When the threads of the cylinders have beeen inspected and gaged, the cylinders are given a hydrostatic pressure test. In this test, the cylinders are filled with water and lowered into a water-filled jacket, as shown in Fig. 20. The jacket is closed tightly and pressure is applied to the cylinder. This test serves a double purpose, as it proves the strength of the cylinder and serves to detect any permanent set in the walls after expansion under pressure. As the cylinder walls expand under the test pressure, the water in the jacket surrounding the cylinder rises and is indicated in a gage. Upon relieving the internal pressure of the cylinder, the gage connected with the water jacket indicates whether any permanent set has been produced in the cylinder.

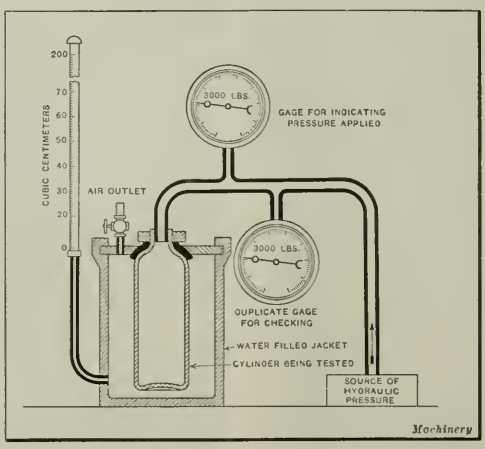


Fig. 20. Diagram showing Equipment for subjecting Cylinder to a Hydrostatic Pressure Test

The larger sizes of seamless steel cylinders (over 6 inches in diameter) are manufactured by the cupping process. The cupping process of making cylinders is identical with the process of making large hot-drawn tubes with the exception that in the manufacture of cylinders by this process, the end of the drawn cup is invariably used as the bottom of the cylinder, after being properly formed. After the plate has been punched into a cup and drawn into a tube, the open end is trimmed even and the cylinder is pickled, necked, heat-treated, finished, tested, and inspected.

Allowances and Tolerances for Screw Threads

Thread Standards of the National Screw Thread Commission, and the Tolerances and Diameters for Different Classes of Fits

THE National Screw Thread Commission was authorized by Congress, July, 1918, for the purpose of ascertaining and establishing screw thread standards for the use of manufacturers and various branches of the Federal Government. The aim of the commission in establishing thread systems has been to eliminate all unnecessary sizes and to utilize, as far as possible, present predominating sizes. Some of the terms used in this summary of the commission's report will be defined first to avoid any misunderstanding, especially in regard to certain of the terms which have not been generally used heretofore in connection with screw threads.

Definitions of Terms

Major Diameter—The largest diameter of the thread on the screw or nut. The term "major diameter" replaces the term "outside diameter" as applied to the thread of a screw and also the term "full diameter" as applied to the thread of a nut.

Minor Diameter—The smallest diameter of the thread on the screw or nut. The term "minor diameter" replaces the term "core diameter" as applied to the thread of a screw and also the term "inside diameter" as applied to the thread of a nut.

Pitch Diameter—On a straight screw thread, the diameter of an imaginary cylinder which would pass through the threads at such points as to make the width of the threads and the width of the spaces cut by the surface of the cylinder equal.

Angle of Thread—The angle included between the sides of the thread measured in an axial plane.

Helix Angle—The angle made by the helix of the thread at the pitch diameter, with a plane perpendicular to the axis.

Crest—The top surface joining the two sides of a thread.

Root—The bottom surface joining the sides of two adjacent threads.

Base of Thread—The bottom section of the thread or the greatest section between the two adjacent roots.

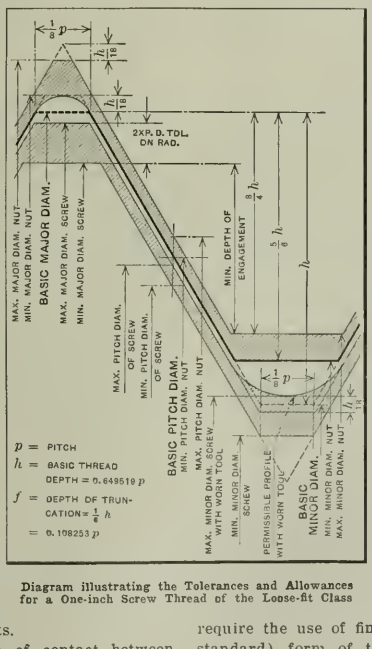


Diagram illustrating the Tolerances and Allowances for a One-inch Screw Thread of the Loose-fit Class

Length of Engagement—The length of contact between two mating parts, measured axially.

Depth of Engagement—The depth of thread in contact of two mating parts, measured radially.

Tolerance—A definite difference in the dimensions prescribed in order to permit of variations in manufacture. The "extreme tolerance" is the maximum and minimum tolerance permitted by the designer, the limits of which are to be placed on the drawings; it is the net tolerance as affected by the master gage tolerance. The "net tolerance" is the tolerance limits within which the product is ordinarily passed by the master gages; it is the extreme tolerance as affected by the master gage increment.

Basic—The theoretical or nominal standard size from which all variations are made.

Crest Clearance—Defined on a screw form as the space between top of a thread and root of its mating thread.

Neutral Zone (Allowance)—A space between the mating parts which must not be encroached upon.

Gage Increment—A predetermined allowance by which the net tolerance of the product is increased for gaging purposes.

Limits—Dimensions, the extremes of which are prescribed, to provide for variations in fit and workmanship.

Form of Thread Adopted by the National Screw Thread Commission

The form of thread profile that is recommended by the commission is known as the "National" form and is the same as the U. S. standard or Sellers profile. The National form is intended for all screw thread work except when otherwise specified for special purposes. A clearance is to be provided at the minor diameter of the nut by removing the thread form at the crest by an amount equal to from 1/6 to 1/4 of the basic thread depth. A clearance at the major diameter of the nut is to be provided by decreasing the depth of the truncation triangle by an amount equal to from 1/3 to 2/3 of its theoretical value.

National Coarse Thread Series

Specifications for what is known as the National coarse thread series are given in Table 1, which contains the numbered and fractional sizes and the basic diameters. This series contains certain sizes known previously as the U. S. standard threads and also certain sizes known as the A. S. M. E. machine screw threads. There are included in the National coarse thread series only those sizes that are essential. The National coarse threads are recommended for general use in engineering work, in machine construction where conditions are favorable to the use of bolts, screws, and other threaded components where quick and easy assembly of the parts is desired, and for all work where conditions do not require the use of fine pitch threads. The National (U. S. standard) form of thread profile is used for the coarse series.

National Fine Thread Series

The National fine thread series contains certain sizes known previously as the S. A. E. threads and also certain sizes known as the A. S. M. E. machine screw sizes. The fine thread series is recommended for general use in automotive and aircraft work, for use where the design requires both strength and reduction in weight, and where special conditions require a fine thread, such as, for instance, on large sizes where sufficient force cannot be secured to set properly a screw or bolt of coarse pitch, by exerting on an ordinary wrench the strength of a man. The specifications for the fine thread series are given in Table 2. The National (U. S. standard) form of thread profile is used for the fine series.

TABLE 1. NATIONAL COARSE THREAD SERIES

Numbered and Fractional Sizes	Number of Threads per Inch	Basic Diameters: Major Diam., Inches	Basic Diameters: Pitch Diam., Inches	Basic Diameters: Minor Diam., Inches	Metric Equivalent of Major Diam., Millimeters	Pitch, Inches	Depth of Thread, Inches
1	64	0.0730	0.0629	0.0527	1.854	0.01562	0.0101
2	56	0.0860	0.0744	0.0628	2.184	0.01783	0.0116
3	48	0.0990	0.0855	0.0719	2.515	0.02083	0.0135
4	40	0.1120	0.0958	0.0795	2.845	0.02500	0.0162
5	40	0.1250	0.1088	0.0925	3.175	0.02500	0.0162
6	32	0.1380	0.1177	0.0974	3.505	0.03125	0.0203
8	32	0.1640	0.1437	0.1234	4.166	0.03125	0.0203
10	24	0.1900	0.1629	0.1359	4.826	0.04166	0.0271
12	24	0.2160	0.1889	0.1619	5.486	0.04166	0.0271
¼	20	0.2500	0.2175	0.1850	6.350	0.05000	0.0325
5/16	18	0.3125	0.2764	0.2403	7.938	0.05555	0.0361
⅜	16	0.3750	0.3344	0.2938	9.525	0.06250	0.0406
7/16	14	0.4375	0.3911	0.3447	11.113	0.07142	0.0464
½	13	0.5000	0.4500	0.4001	12.700	0.07692	0.0500
9/16	12	0.5625	0.5084	0.4542	14.288	0.08333	0.0541
⅝	11	0.6250	0.5660	0.5069	15.875	0.09090	0.0590
¾	10	0.7500	0.6850	0.6201	19.050	0.10000	0.0650
⅞	9	0.8750	0.8028	0.7307	22.225	0.11111	0.0722
1	8	1.0000	0.9188	0.8376	25.400	0.12500	0.0812
1⅛	7	1.1250	1.0322	0.9394	28.575	0.14285	0.0928
1¼	7	1.2500	1.1572	1.0644	31.750	0.14285	0.0928
1½	6	1.5000	1.3917	1.2835	38.100	0.16666	0.1083
1¾	5	1.7500	1.6201	1.4902	44.450	0.20000	0.1299
2	4½	2.0000	1.8557	1.7113	50.800	0.22222	0.1443
2¼	4½	2.2500	2.1057	1.9613	57.150	0.22222	0.1443
2½	4	2.5000	2.3376	2.1752	63.500	0.25000	0.1624
2¾	4	2.7500	2.5876	2.4252	69.850	0.25000	0.1624
3	4	3.0000	2.8376	2.6752	76.200	0.25000	0.1624

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TABLE 2. NATIONAL FINE THREAD SERIES

Numbered and Fractional Sizes	Number of Threads per Inch	Basic Diameters: Major Diam., Inches	Basic Diameters: Pitch Diam., Inches	Basic Diameters: Minor Diam., Inches	Metric Equivalent of Major Diam., Millimeters	Pitch, Inches	Depth of Thread, Inches
0	80	0.0600	0.0519	0.0438	1.524	0.01250	0.00812
1	72	0.0730	0.0640	0.0550	1.854	0.01388	0.00902
2	64	0.0860	0.0759	0.0657	2.184	0.01562	0.01014
3	56	0.0990	0.0874	0.0758	2.515	0.01785	0.01160
4	48	0.1120	0.0985	0.0849	2.845	0.02083	0.01353
5	44	0.1250	0.1102	0.0955	3.175	0.02272	0.01476
6	40	0.1380	0.1218	0.1055	3.506	0.02500	0.01624
8	36	0.1640	0.1460	0.1279	4.166	0.02777	0.01804
10	32	0.1900	0.1697	0.1494	4.826	0.03125	0.02030
12	28	0.2160	0.1928	0.1696	5.486	0.03571	0.02319
¼	28	0.2500	0.2268	0.2036	6.350	0.03571	0.02319
5/16	24	0.3125	0.2854	0.2584	7.938	0.04166	0.02706
⅜	24	0.3750	0.3479	0.3209	9.525	0.04166	0.02706
7/16	20	0.4375	0.4050	0.3725	11.113	0.05000	0.03248
½	20	0.5000	0.4675	0.4350	12.700	0.05000	0.03248
9/16	18	0.5625	0.5264	0.4903	14.288	0.05555	0.03608
⅝	18	0.6250	0.5889	0.5528	15.875	0.05555	0.03608
¾	16	0.7500	0.7094	0.6688	19.050	0.06250	0.04060
⅞	14	0.8750	0.8286	0.7822	22.225	0.07142	0.04640
1	14	1.0000	0.9536	0.9072	25.400	0.07142	0.04640
1⅛	12	1.1250	1.0709	1.0167	28.575	0.08333	0.05413
1¼	12	1.2500	1.1959	1.1417	31.750	0.08333	0.05413
1½	12	1.5000	1.4459	1.3917	38.100	0.08333	0.05413
1¾	12	1.7500	1.6959	1.6417	44.450	0.08333	0.05413
2	12	2.0000	1.9459	1.8917	50.800	0.08333	0.05413
2¼	12	2.2500	2.1959	2.1417	57.150	0.08333	0.05413
2½	12	2.5000	2.4459	2.3917	63.500	0.08333	0.05413
2¾	12	2.7500	2.6959	2.6417	69.850	0.08333	0.05413
3	10	3.0000	2.9350	2.8701	76.200	0.10000	0.06495

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National Fire Hose Coupling Threads

The National "fire hose" threads are intended for all couplings and hydrant connections for fire protection systems and for all other purposes where hose couplings and connections are required in sizes between 2½ and 4½ inches in diameter. The basic sizes and dimensions and the form of thread profile correspond to those recommended by the National Fire Protection Association and by the Bureau of Standards. The specifications are similar to those given in the table "Fire Hose Connections," page 1013, in MACHINERY'S HANDBOOK. Specifications for the special form of thread for fire hose couplings are given in the table referred to.

National Hose Coupling Threads

The National hose coupling thread is intended for all couplings and connections for sizes between ¾ inch and 2 inches in diameter. The form of thread profile is the same as the National (U. S. standard) form. The sizes and basic dimensions are specified in Table 3.

Manufacturing Specifications for National Screw Threads

The National coarse threads, fine threads, fire hose coupling threads, and hose coupling threads are to be produced in accordance with the following specifications covering the classification of screw thread fits and the tolerances. It is recommended that all specifications be so written that the qualities in the product desired shall be stated in definite terms of known measurable standards and correctly defined by the largest tolerance limits compatible with the satisfactory operation or performance of the articles or material for the purpose intended. To this end every factor involved in the acceptability of the manufactured product required should be comparable within specified limits with a known measurable standard. Every specification should be so concise that there can be no possible misunderstanding or dispute regarding the limiting lines of acceptance.

TABLE 3. NATIONAL HOSE COUPLING THREADS

Nominal Size, Inches	Thds. per Inch	Pitch, Inches	Depth of Thread, Inches	Major Diameter: Millimeters	Major Diameter: Inches	Pitch Diam., Inches	Minor Diam., Inches	Allowance, Inches
Basic Minimum Coupling Dimensions								
¾	11½	0.08696	0.0565	27.242	1.0725	1.0160	0.9595	0.01
1	11½	0.08696	0.0565	33.150	1.3051	1.2486	1.1922	0.01
1¼	11½	0.08696	0.0565	41.908	1.6499	1.5934	1.5369	0.01
1½	11½	0.08696	0.0565	47.976	1.8888	1.8323	1.7759	0.01
2	11½	0.08696	0.0565	60.015	2.3628	2.3063	2.2498	0.01
Basic Maximum Nipple Dimensions								
¾	11½	0.08696	0.0565	26.988	1.0625	1.0060	0.9495	0.01
1	11½	0.08696	0.0565	32.896	1.2951	1.2386	1.1822	0.01
1¼	11½	0.08696	0.0565	41.654	1.6399	1.5834	1.5269	0.01
1½	11½	0.08696	0.0565	47.722	1.8788	1.8223	1.7659	0.01
2	11½	0.08696	0.0565	59.761	2.3528	2.2963	2.2398	0.01

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The specifications previously referred to, covering classification and tolerances, are intended for the sole purpose of establishing the physical dimensions of screw thread products. While under tolerances various grades of workmanship are covered, it is not intended in any way to specify or limit the material or physical qualities required by the user. These specifications as to material and physical qualities must be established according to individual needs. Here again the importance of stating these requirements by concise and definite specifications is emphasized.

Classification of Screw Thread Fits

The National Screw Thread Commission established for general use, unless otherwise specified, four distinct classes of screw thread fits with certain subdivisions, for the purpose of insuring the interchangeable manufacture of screw thread parts throughout the country. The examples referred to in connection with each of the following classes of fits are for purposes of illustration only, as it was not the intention of the commission arbitrarily to place a general class or grade of work in a specific class of fit. Tables 4 to 15 give the tolerances and dimensions for each class of fit.

Loose Fit—This class includes screw threads of a rough commercial quality which must assemble readily, a certain amount of looseness or play not being objectionable, for example, stove bolts, carriage bolts, hose couplings, threads for artillery ammunition, and other similar threaded work.

Medium Fit — This class is subdivided into "regular" and "special" fits. The "regular" subdivision includes the great bulk of screw thread work of ordinary quality, such as finished and semi-finished bolts and nuts; machine screws; cap-screws; most of the fastening screws for instruments, small arms, and other ordnance; screws for sewing machines, typewriters, etc. The "special" subdivision includes the better grade of interchangeable screw thread work, such as high-grade automobile and aircraft bolts and nuts.

TABLE 4. ALLOWANCES AND TOLERANCES FOR LOOSE FIT

(Screws, Nuts and Gages)

No. of Thds. per Inch	Allowances, Inches	Extreme or Drawing Pitch Diam. Tolerances, Inches	Master Gage Tolerances: Diameter, Inches	Master Gage Tolerances: Lead,* Inches, Plus or Minus	Master Gage Tolerances: ½ Angle, Plus or Minus	Net Pitch Diameter Tolerances, Inches
80	0.0007	0.0024	0.0002	0.0002	0° 30′	0.0020
72	0.0007	0.0025	0.0002	0.0002	0° 30′	0.0021
64	0.0007	0.0026	0.0002	0.0002	0° 30′	0.0022
56	0.0008	0.0028	0.0002	0.0002	0° 30′	0.0024
48	0.0009	0.0031	0.0002	0.0002	0° 30′	0.0027
44	0.0009	0.0032	0.0002	0.0002	0° 30′	0.0028
40	0.0010	0.0034	0.0002	0.0002	0° 20′	0.0030
36	0.0011	0.0036	0.0002	0.0002	0° 20′	0.0032
32	0.0011	0.0038	0.0002	0.0002	0° 20′	0.0034
28	0.0012	0.0043	0.0003	0.0002	0° 15′	0.0037
24	0.0013	0.0046	0.0003	0.0002	0° 15′	0.0040
20	0.0015	0.0051	0.0003	0.0002	0° 15′	0.0045
18	0.0016	0.0057	0.0004	0.0003	0° 10′	0.0049
16	0.0018	0.0063	0.0004	0.0003	0° 10′	0.0055
14	0.0021	0.0070	0.0004	0.0003	0° 10′	0.0062
13	0.0022	0.0074	0.0004	0.0003	0° 10′	0.0066
12	0.0024	0.0079	0.0004	0.0003	0° 10′	0.0071
11	0.0026	0.0085	0.0004	0.0003	0° 10′	0.0077
10	0.0028	0.0092	0.0004	0.0004	0° 5′	0.0084
9	0.0031	0.0100	0.0004	0.0004	0° 5′	0.0092
8	0.0034	0.0111	0.0004	0.0004	0° 5′	0.0103
7	0.0039	0.0124	0.0004	0.0004	0° 5′	0.0116
6	0.0044	0.0145	0.0006	0.0005	0° 5′	0.0133
5	0.0052	0.0169	0.0006	0.0005	0° 5′	0.0157
4½	0.0057	0.0184	0.0006	0.0005	0° 5′	0.0172
4	0.0064	0.0204	0.0006	0.0005	0° 5′	0.0192

*Allowable variation in lead between any two threads not farther apart than the length of engagement.

Machinery

TABLE 5. ALLOWANCES AND TOLERANCES FOR MEDIUM FIT (REGULAR)

(Screws, Nuts and Gages)

No. of Thds. per Inch	Allowances, Inches	Extreme or Drawing Pitch Diam. Tolerances, Inches	Master Gage Tolerances: Diameter, Inches	Master Gage Tolerances: Lead,* Inches, Plus or Minus	Master Gage Tolerances: ½ Angle, Plus or Minus	Net Pitch Diameter Tolerances, Inches
80	0.0000	0.0017	0.0002	0.0002	0° 30′	0.0013
72	0.0000	0.0018	0.0002	0.0002	0° 30′	0.0014
64	0.0000	0.0019	0.0002	0.0002	0° 30′	0.0015
56	0.0000	0.0020	0.0002	0.0002	0° 30′	0.0016
48	0.0000	0.0022	0.0002	0.0002	0° 30′	0.0018
44	0.0000	0.0023	0.0002	0.0002	0° 30′	0.0010
40	0.0000	0.0024	0.0002	0.0002	0° 20′	0.0020
36	0.0000	0.0025	0.0002	0.0002	0° 20′	0.0021
32	0.0000	0.0027	0.0002	0.0002	0° 20′	0.0023
28	0.0000	0.0031	0.0003	0.0002	0° 15′	0.0025
24	0.0000	0.0033	0.0003	0.0002	0° 15′	0.0027
20	0.0000	0.0036	0.0003	0.0002	0° 15′	0.0030
18	0.0000	0.0041	0.0004	0.0003	0° 10′	0.0033
16	0.0000	0.0045	0.0004	0.0003	0° 10′	0.0037
14	0.0000	0.0049	0.0004	0.0003	0° 10′	0.0041
13	0.0000	0.0052	0.0004	0.0003	0° 10′	0.0044
12	0.0000	0.0056	0.0004	0.0003	0° 10′	0.0048
11	0.0000	0.0059	0.0004	0.0008	0° 10′	0.0051
10	0.0000	0.0064	0.0004	0.0004	0° 5′	0.0056
9	0.0000	0.0070	0.0004	0.0004	0° 5′	0.0062
8	0.0000	0.0076	0.0004	0.0004	0° 5′	0.0068
7	0.0000	0.0085	0.0004	0.0004	0° 5′	0.0077
6	0.0000	0.0101	0.0006	0.0005	0° 5′	0.0089
5	0.0000	0.0116	0.0006	0.0005	0° 5′	0.0104
4½	0.0000	0.0127	0.0006	0.0005	0° 5′	0.0116
4	0.0000	0.0140	0.0006	0.0005	0° 6′	0.0128

*Allowable variation in lead between any two threads not farther apart than the length of engagement.

Machinery

Close Fit—This class includes screw thread work requiring a fine snug fit, which is somewhat closer than the "special" medium fit. Selective assembly of parts may be required for screw threads of the "close fit" class.

Wrench Fit—This class applies to threaded parts of ¼-inch diameter or larger, which are to be set or assembled with a wrench. As the material in this case is an important factor in determining the fit between the threaded members, there are two subdivisions for this class of fit, which differ mainly in the amount of allowance (interference) values for the different pitches. The first subdivision includes screw threads used in light sections with moderate stresses, such as aircraft and automobile engine work. The second subdivision includes screw threads used in heavy sections and for higher stresses, as for example in steam engine and heavy hydraulic work. On account of the lack of data, tolerances and allowances are not specified for wrench fits.

General Specifications

The following general specifications apply to the different classes of screw thread fits referred to:

Basic Diameter—The minimum threaded hole or nut corresponds to the basic size; that is, the pitch diameter of the minimum nut is basic for all classes of fit. This condition permits the use of taps which when new are over size and which are discarded when the hole cut is the basic size. In order to secure the desired fit, the screw size is varied. Thus, the maximum screw corresponds to the basic size for the "medium fit" class, is slightly above basic size for the "close fit" class, considerably above the basic size for the "wrench fit" class, and below the basic size for the "loose fit" class.

Length of Engagement—The maximum length of engagement for screw threads manufactured in accordance with any of the classes of fit specified shall not exceed the amount

TABLE 6. LOOSE FIT—NATIONAL COARSE THREAD SERIES

Numbered and Fractional Sizes	No. of Threads per Inch	Screw Sizes: Major Diam. Max. Inches	Screw Sizes: Major Diam. Min. Inches	Screw Sizes: Pitch Diam. Max. Inches	Screw Sizes: Pitch Diam. Min. Inches	Screw Sizes: Minor Diam. Max.* Inches	Screw Sizes: Minor Diam. Min. Inches	Nut Sizes: Minor Diam. Min. Inches	Nut Sizes: Minor Diam. Max. Inches	Nut Sizes: Pitch Diam. Min. Inches	Nut Sizes: Pitch Diam. Max. Inches	Nut Sizes: Major Diam. Min.* Inches	Nut Sizes: Major Diam. Max. Inches	Basic Major Diam., Inches	Numbered and Fractional Sizes
1	64	0.0723	0.0671	0.0622	0.0596	0.0531	0.0494	0.0561	0.0578	0.0629	0.0655	0.0741	0.0779	0.0730	1
2	56	0.0852	0.0796	0.0736	0.0708	0.0633	0.0592	0.0667	0.0686	0.0744	0.0772	0.0873	0.0914	0.0860	2
3	48	0.0981	0.0881	0.0846	0.0815	0.0725	0.0679	0.0764	0.0787	0.0855	0.0886	0.1005	0.1051	0.0990	3
4	40	0.1110	0.1042	0.0948	0.0914	0.0803	0.0751	0.0849	0.0876	0.0958	0.0992	0.1138	0.1190	0.1120	4
5	40	0.1240	0.1172	0.1078	0.1044	0.0933	0.0881	0.0979	0.1006	0.1088	0.1122	0.1268	0.1320	0.1250	5
6	32	0.1369	0.1293	0.1166	0.1128	0.0986	0.0925	0.1042	0.1076	0.1177	0.1215	0.1403	0.1463	0.1380	6
8	32	0.1629	0.1553	0.1426	0.1388	0.1246	0.1186	0.1302	0.1336	0.1437	0.1475	0.1663	0.1723	0.1640	8
10	24	0.1887	0.1795	0.1616	0.1570	0.1376	0.1300	0.1449	0.1494	0.1629	0.1675	0.1930	0.2006	0.1900	10
12	24	0.2147	0.2055	0.1876	0.1830	0.1636	0.1560	0.1709	0.1754	0.1889	0.1935	0.2190	0.2266	0.2160	12
¼	20	0.2485	0.2383	0.2160	0.2109	0.1872	0.1784	0.1959	0.2013	0.2175	0.2226	0.2536	0.2623	0.2500	¼
5/16	18	0.3109	0.2995	0.2748	0.2691	0.2427	0.2330	0.2524	0.2584	0.2764	0.2821	0.3165	0.3262	0.3125	5/16
3/8	16	0.3732	0.3606	0.3326	0.3263	0.2965	0.2857	0.3073	0.3141	0.3344	0.3407	0.3795	0.3903	0.3750	3/8
7/16	14	0.4354	0.4214	0.3890	0.3820	0.3478	0.3356	0.3602	0.3679	0.3911	0.3981	0.4427	0.4548	0.4375	7/16
½	13	0.4978	0.4830	0.4478	0.4404	0.4034	0.3905	0.4167	0.4251	0.4500	0.4574	0.5036	0.5185	0.5000	½
9/16	12	0.5601	0.5443	0.4960	0.4881	0.4579	0.4339	0.4723	0.4813	0.5084	0.5183	0.5685	0.5824	0.5625	9/16
5/8	11	0.6224	0.6034	0.5634	0.5549	0.5109	0.4998	0.5266	0.5364	0.5660	0.5745	0.6316	0.6466	0.6250	5/8
¾	10	0.7472	0.7288	0.6822	0.6730	0.6235	0.6125	0.6417	0.6526	0.6850	0.6942	0.7572	0.7736	0.7500	¾
⅞	9	0.8719	0.8519	0.7997	0.7897	0.7360	0.7225	0.7547	0.7667	0.8028	0.8128	0.8830	0.9010	0.8750	⅞
1	8	0.9966	0.9744	0.9154	0.9043	0.8432	0.8287	0.8647	0.8782	0.9188	0.9299	1.0090	1.0291	1.0000	1
1⅛	7	1.1211	1.0963	1.0283	1.0159	0.9458	0.9295	0.9704	0.9858	1.0322	1.0446	1.1353	1.1580	1.1250	1⅛
1¼	7	1.2461	1.2213	1.1533	1.1409	1.0708	1.0545	1.0954	1.1108	1.1572	1.1696	1.2603	1.2830	1.2500	1¼
1½	6	1.4956	1.4666	1.3873	1.3728	1.2911	1.2712	1.3196	1.3376	1.3917	1.4062	1.5120	1.5386	1.5000	1½
1¾	5	1.7448	1.7110	1.6149	1.5980	1.4994	1.4773	1.5335	1.5551	1.6201	1.6370	1.7644	1.7958	1.7500	1¾
2	4½	1.9943	1.9575	1.8500	1.8316	1.7217	1.6976	1.7594	1.7835	1.8557	1.8741	2.0160	2.0505	2.0000	2
2¼	4½	2.2443	2.2075	2.1000	2.0816	1.9717	1.9476	2.0094	2.0335	2.1057	2.1241	2.2660	2.3005	2.2500	2¼
2½	4	2.4936	2.4528	2.3312	2.3108	2.1869	2.1601	2.2294	2.2564	2.3376	2.3580	2.5180	2.5565	2.5000	2½
2¾	4	2.7436	2.7028	2.5812	2.5608	2.4369	2.4101	2.4794	2.5064	2.5876	2.6080	2.7680	2.8065	2.7500	2¾
3	4	2.9936	2.9528	2.8312	2.8108	2.6869	2.6601	2.7294	2.7564	2.8376	2.8580	3.0180	3.0565	3.0000	3

* Dimensions given are figured to the intersection of the worn tool arc with a center line through crest and root (see accompanying diagram). The dimensions given in the tables of screw and nut sizes are the dimensions of the work and not the gages.

determined by the following formula, in which L = length of engagement and D = basic major diameter of thread:

$$L = 1.5\ D$$

Scope of Classification—The specifications established for the various classes of fit are applicable to the National coarse threads, fine threads, hose threads, and to any special thread required in manufacture which is not intentionally tapered.

Tolerances and Diameters for Loose Fits

The "loose fit" class of screw threads is intended to cover the manufacture of strictly interchangeable threaded parts which are produced in two or more manufacturing plants, and this class applies to work of such a nature that rapid assembly is necessary, and a certain amount of looseness or play is not objectionable.

Minimum Nut Basic Size—The pitch diameter of the minimum nut of a given diameter and pitch corresponds to the basic pitch diameter. For example, the minimum pitch diameter of a nut for a nominal screw thread size of ¼ inch is 0.2175 inch as given in the right-hand half of Table 6; this corresponds to the basic pitch diameter for the National coarse thread series as given in Table 1. The accompanying diagram illustrates the tolerances, allowances, and clearances for a 1-inch screw thread (eight threads per inch) of the "loose fit" class.

Maximum Screw below Basic Size—The major and pitch diameters of a maximum screw of given pitch and diameter are below the basic dimensions specified in Table 1 by the amount of allowance given in Table 4. For example, the maximum pitch diameter of a ¼-inch screw thread (see Table 6) is 0.2160. The basic pitch diameter (see Table 1) is 0.2175. Hence, the difference equals 0.2175 — 0.2160 = 0.0015, which equals the allowance given in Table 4 for twenty threads per inch. The maximum minor diameter of the screw is above the basic minor diameter.

Direction of Tolerances—The tolerance on a nut will be plus, and is to be applied from the basic size to above the basic size. The tolerance on the screw will be minus, and

TABLE 7. LOOSE FIT—NATIONAL FINE THREAD SERIES

Numbered and Fractional Sizes	No. of Threads per Inch	Screw Sizes						Nut Sizes						Basic Major Diam., Inches	Numbered and Fractional Sizes
		Major Diam.		Pitch Diam.		Minor Diam.		Minor Diam.		Pitch Diam.		Major Diam.			
		Max. Inches	Min. Inches	Max. Inches	Min. Inches	Max.* Inches	Min. Inches	Min. Inches	Max. Inches	Min. Inches	Max. Inches	Min.* Inches	Max. Inches		
0	80	0.0593	0.0545	0.0512	0.0488	0.0440	0.0407	0.0465	0.0478	0.0519	0.0543	0.0609	0.0642	0.0600	0
1	72	0.0723	0.0673	0.0633	0.0608	0.0553	0.0518	0.0580	0.0595	0.0640	0.0665	0.0740	0.0775	0.0730	1
2	64	0.0853	0.0801	0.0752	0.0726	0.0661	0.0624	0.0691	0.0708	0.0759	0.0785	0.0871	0.0909	0.0860	2
3	56	0.0982	0.0926	0.0866	0.0838	0.0763	0.0722	0.0797	0.0816	0.0874	0.0902	0.1003	0.1044	0.0990	3
4	48	0.1111	0.1049	0.0976	0.0945	0.0855	0.0809	0.0894	0.0917	0.0985	0.1016	0.1135	0.1181	0.1120	4
5	44	0.1241	0.1177	0.1093	0.1061	0.0962	0.0914	0.1004	0.1029	0.1102	0.1134	0.1266	0.1315	0.1250	5
6	40	0.1370	0.1302	0.1208	0.1174	0.1063	0.1011	0.1109	0.1136	0.1218	0.1252	0.1398	0.1450	0.1380	6
8	36	0.1629	0.1557	0.1449	0.1413	0.1288	0.1232	0.1339	0.1369	0.1460	0.1496	0.1660	0.1716	0.1640	8
10	32	0.1889	0.1823	0.1686	0.1618	0.1506	0.1445	0.1562	0.1596	0.1697	0.1735	0.1923	0.1983	0.1900	10
12	28	0.2148	0.2062	0.1916	0.1873	0.1710	0.1641	0.1773	0.1812	0.1928	0.1971	0.2186	0.2255	0.2160	12
¼	28	0.2488	0.2402	0.2256	0.2213	0.2050	0.1981	0.2113	0.2152	0.2268	0.2311	0.2526	0.2595	0.2500	¼
5/16	24	0.3112	0.3020	0.2831	0.2795	0.2601	0.2525	0.2674	0.2719	0.2851	0.2900	0.3155	0.3231	0.3125	5/16
3/8	24	0.3737	0.3645	0.3466	0.3420	0.3225	0.3150	0.3299	0.3344	0.3479	0.3425	0.3780	0.3856	0.3750	3/8
7/16	20	0.4360	0.4258	0.4035	0.3984	0.3747	0.3659	0.3834	0.3888	0.4050	0.4101	0.4411	0.4498	0.4375	7/16
½	20	0.4985	0.4883	0.4660	0.4609	0.4372	0.4284	0.4459	0.4513	0.4675	0.4726	0.5036	0.5123	0.5000	½
9/16	18	0.5609	0.5495	0.5248	0.5191	0.4927	0.4830	0.5024	0.5084	0.5264	0.5321	0.5665	0.5762	0.5625	9/16
5/8	18	0.6234	0.6120	0.5873	0.5816	0.5552	0.5455	0.5649	0.5709	0.5889	0.5946	0.6290	0.6387	0.6250	5/8
¾	16	0.7482	0.7356	0.7076	0.7013	0.6715	0.6607	0.6823	0.6891	0.7094	0.7157	0.7545	0.7653	0.7500	¾
⅞	14	0.8629	0.8489	0.8255	0.8195	0.7853	0.7731	0.7977	0.8054	0.8286	0.8356	0.8802	0.8923	0.8750	⅞
1	14	0.9979	0.9839	0.9515	0.9445	0.9103	0.8981	0.9227	0.9304	0.9536	0.9606	1.0052	1.0173	1.0000	1
1⅛	12	1.1226	1.1068	1.0685	1.0606	1.0204	1.0064	1.0348	1.0438	1.0709	1.0788	1.1310	1.1449	1.1250	1⅛
1¼	12	1.2476	1.2318	1.1935	1.1856	1.1454	1.1314	1.1598	1.1688	1.1959	1.2038	1.2560	1.2699	1.2500	1¼
1⅜	12	1.3726	1.3568	1.3185	1.3106	1.2704	1.2564	1.2848	1.2938	1.3209	1.3288	1.3810	1.3949	1.3750	1⅜
1¾	12	1.4976	1.4818	1.4435	1.4356	1.3954	1.3814	1.4098	1.4188	1.4459	1.4538	1.5060	1.5199	1.5000	1½
2	12	1.7476	1.7318	1.6935	1.6856	1.6454	1.6314	1.6598	1.6688	1.6959	1.7038	1.7560	1.7699	1.7500	1¾
2	12	1.9976	1.9818	1.9435	1.9356	1.8954	1.8814	1.9098	1.9188	1.9459	1.9538	2.0060	2.0199	2.0000	2
2¼	12	2.2476	2.2318	2.1935	2.1856	2.1454	2.1314	2.1598	2.1688	2.1959	2.2038	2.2560	2.2699	2.2500	2¼
2½	12	2.4976	2.4818	2.4435	2.4356	2.3954	2.3814	2.4098	2.4188	2.4459	2.4538	2.5060	2.5199	2.5000	2½
2¾	12	2.7476	2.7318	2.6935	2.6856	2.6454	2.6314	2.6598	2.6688	2.6959	2.7038	2.7560	2.7699	2.7500	2¾
3	10	2.9972	2.9788	2.9332	2.9230	2.8745	2.8581	2.8917	2.9026	2.9350	2.9442	3.0072	3.0236	3.0000	3

* Dimensions given are figured to the intersection of the worn tool arc with a center line through crest and root.

TABLE 8. MEDIUM FIT (REGULAR)—NATIONAL COARSE THREAD SERIES

Numbered and Fractional Sizes	No. of Threads per Inch	Screw Sizes						Nut Sizes						Basic Major Diam., Inches	Numbered and Fractional Sizes
		Major Diam.		Pitch Diam.		Minor Diam.		Minor Diam.		Pitch Diam.		Major Diam.			
		Max. Inches	Min. Inches	Max. Inches	Min. Inches	Max.* Inches	Min. Inches	Min. Inches	Max. Inches	Min. Inches	Max. Inches	Min.* Inches	Max. Inches		
1	64	0.0730	0.0692	0.0629	0.0610	0.0538	0.0508	0.0561	0.0578	0.0629	0.0648	0.0741	0.0772	0.0730	1
2	56	0.0860	0.0820	0.0744	0.0724	0.0641	0.0608	0.0667	0.0686	0.0744	0.0764	0.0873	0.0906	0.0860	2
3	48	0.0990	0.0946	0.0855	0.0833	0.0734	0.0697	0.0764	0.0787	0.0855	0.0877	0.1005	0.1042	0.0990	3
4	40	0.1120	0.1072	0.0958	0.0934	0.0813	0.0771	0.0849	0.0876	0.0958	0.0982	0.1138	0.1180	0.1120	4
5	40	0.1250	0.1202	0.1088	0.1064	0.0943	0.0901	0.0979	0.1006	0.1088	0.1112	0.1268	0.1310	0.1250	5
6	32	0.1380	0.1326	0.1177	0.1150	0.0997	0.0947	0.1042	0.1076	0.1177	0.1204	0.1403	0.1452	0.1380	6
8	32	0.1640	0.1586	0.1437	0.1410	0.1257	0.1207	0.1302	0.1336	0.1437	0.1464	0.1663	0.1712	0.1640	8
10	24	0.1900	0.1834	0.1629	0.1596	0.1389	0.1326	0.1449	0.1494	0.1629	0.1662	0.1930	0.1992	0.1900	10
12	24	0.2160	0.2094	0.1889	0.1856	0.1649	0.1586	0.1709	0.1754	0.1889	0.1922	0.2190	0.2253	0.2160	12
¼	20	0.2500	0.2428	0.2175	0.2139	0.1887	0.1814	0.1959	0.2013	0.2175	0.2211	0.2536	0.2608	0.2500	¼
5/16	18	0.3125	0.3043	0.2764	0.2723	0.2443	0.2362	0.2524	0.2584	0.2764	0.2805	0.3165	0.3246	0.3125	5/16
3/8	16	0.3750	0.3660	0.3344	0.3299	0.2983	0.2893	0.3073	0.3141	0.3344	0.3389	0.3795	0.3895	0.3750	3/8
7/16	14	0.4375	0.4277	0.3911	0.3862	0.3499	0.3398	0.3602	0.3679	0.3911	0.3960	0.4427	0.4527	0.4375	7/16
½	13	0.5000	0.4896	0.4500	0.4448	0.4036	0.3949	0.4167	0.4251	0.4500	0.4552	0.5036	0.5163	0.5000	½
9/16	12	0.5625	0.5513	0.5084	0.5028	0.4603	0.4486	0.4723	0.4813	0.5084	0.5140	0.5685	0.5800	0.5625	9/16
5/8	11	0.6250	0.6132	0.5660	0.5601	0.5135	0.5010	0.5266	0.5364	0.5660	0.5719	0.6316	0.6430	0.6250	5/8
¾	10	0.7500	0.7372	0.6850	0.6786	0.6273	0.6137	0.6417	0.6526	0.6850	0.6914	0.7572	0.7708	0.7500	¾
⅞	9	0.8750	0.8610	0.8028	0.7958	0.7357	0.7237	0.7547	0.7667	0.8028	0.8098	0.8830	0.8980	0.8750	⅞
1	8	1.0000	0.9848	0.9188	0.9112	0.8466	0.8309	0.8647	0.8782	0.9188	0.9264	1.0090	1.0256	1.0000	1
1⅛	7	1.1250	1.1080	1.0322	1.0237	0.9497	0.9309	0.9701	0.9858	1.0322	1.0407	1.1353	1.1541	1.1250	1⅛
1¼	7	1.2500	1.2330	1.1572	1.1487	1.0747	1.0559	1.0954	1.1108	1.1572	1.1657	1.2603	1.2791	1.2500	1¼
1½	6	1.5000	1.4798	1.3917	1.3816	1.2955	1.2734	1.3196	1.3379	1.3917	1.4018	1.5120	1.5342	1.5000	1½
1¾	5	1.7500	1.7268	1.6201	1.6085	1.5046	1.4786	1.5338	1.5551	1.6201	1.6317	1.7641	1.7905	1.7500	1¾
2	4½	2.0000	1.9746	1.8557	1.8430	1.7274	1.6986	1.7594	1.7835	1.8557	1.8684	2.0160	2.0448	2.0000	2
2¼	4½	2.2500	2.2246	2.1057	2.0930	1.9774	1.9486	2.0094	2.0335	2.1057	2.1184	2.2660	2.2948	2.2500	2¼
2½	4	2.5000	2.4720	2.3376	2.3236	2.1933	2.1612	2.2294	2.2563	2.3376	2.3516	2.5180	2.5501	2.5000	2½
2¾	4	2.7500	2.7220	2.5876	2.5736	2.4433	2.4112	2.4794	2.5063	2.5876	2.6016	2.7680	2.8001	2.7500	2¾
3	4	3.0000	2.9720	2.8376	2.8276	2.6933	2.6612	2.7294	2.7563	2.8376	2.8516	3.0180	3.0501	3.0000	3

* Dimensions given are figured to the intersection of the worn tool arc with a center line through crest and root.

is applied from the maximum screw dimension to below the maximum screw dimension.

Allowance and Tolerance Values—The allowance provided between the size of the minimum nut, which is basic, and the size of the maximum screw for a screw thread of given pitch will be as specified in Table 4. The tolerance on a screw or nut of a given pitch will also be as there specified.

Tolerances and Diameters for Medium Fits

As previously explained, screw threads of the "medium fit" class are subdivided into "regular" and "special" fits. The "regular" fits are intended to apply to interchangeable manufacture where the threaded members are to be assembled nearly or entirely with the fingers and where a moderate amount of play between the assembled threaded members is not objectionable.

Minimum Nut and Maximum Screw Basic Sizes—The pitch diameter of the minimum nut and also the major diameter and pitch diameter of the maximum screw of a given pitch and diameter correspond to the basic dimensions. The maximum minor diameter of the screw is above the basic minor diameter.

Direction of Tolerance on Nut and Screw—The tolerance on the nut will be plus and is to be applied from the basic size to above the basic size. The tolerance on the screw will be minus and is applied from the basic size to below the basic size.

Allowance and Tolerance—The allowance between the size of the maximum screw and minimum nut will be zero for all pitches and all diameters. The tolerance for a screw or nut of a given pitch will be as specified in Table 5. The "special" fits of the medium class apply particularly to high grades of automobile screw thread work. This "special" subdivision of the "medium fit" class is the same as the "regular" subdivision except that the tolerances are smaller as shown by Table 12.

TABLE 9. MEDIUM FIT (REGULAR) — NATIONAL FINE THREAD SERIES

Numbered and Fractional Sizes	No. of Threads per Inch	Screw Sizes						Nut Sizes						Basic Major Diam., Inches	Numbered and Fractional Sizes
		Major. Diam.		Pitch Diam.		Minor Diam.		Minor Diam.		Pitch Diam.		Major Diam.			
		Max. Inches	Min. Inches	Max. Inches	Min. Inches	Max.* Inches	Min. Inches	Min. Inches	Max. Inches	Min. Inches	Max. Inches	Min.* Inches	Max. Inches		
0	80	0.0600	0.0566	0.0519	0.0502	0.0447	0.0421	0.0465	0.0478	0.0519	0.0536	0.0609	0.0635	0.0600	0
1	72	0.0730	0.0694	0.0640	0.0622	0.0560	0.0532	0.0580	0.0595	0.0640	0.0658	0.0740	0.0768	0.0730	1
2	64	0.0860	0.0822	0.0759	0.0740	0.0668	0.0638	0.0691	0.0708	0.0759	0.0778	0.0871	0.0902	0.0860	2
3	56	0.0990	0.0950	0.0874	0.0854	0.0771	0.0738	0.0797	0.0816	0.0874	0.0894	0.1003	0.1036	0.0990	3
4	48	0.1120	0.1076	0.0985	0.0963	0.0864	0.0827	0.0894	0.0917	0.0985	0.1007	0.1135	0.1172	0.1120	4
5	44	0.1250	0.1204	0.1102	0.1079	0.0971	0.0932	0.1004	0.1029	0.1102	0.1125	0.1266	0.1306	0.1250	5
6	40	0.1380	0.1332	0.1218	0.1194	0.1073	0.1031	0.1109	0.1136	0.1218	0.1242	0.1398	0.1440	0.1380	6
8	36	0.1640	0.1590	0.1460	0.1435	0.1299	0.1254	0.1339	0.1369	0.1460	0.1485	0.1660	0.1705	0.1640	8
10	32	0.1900	0.1846	0.1697	0.1670	0.1517	0.1467	0.1562	0.1596	0.1697	0.1724	0.1923	0.1972	0.1900	10
12	28	0.2160	0.2058	0.1928	0.1857	0.1722	0.1665	0.1773	0.1812	0.1929	0.1959	0.2186	0.2243	0.2160	12
1/4	28	0.2500	0.2438	0.2268	0.2237	0.2062	0.2005	0.2113	0.2152	0.2268	0.2299	0.2526	0.2583	0.2500	1/4
5/16	24	0.3125	0.3059	0.2854	0.2821	0.2614	0.2551	0.2674	0.2719	0.2854	0.2887	0.3155	0.3218	0.3125	5/16
3/8	24	0.3750	0.3684	0.3479	0.3446	0.3239	0.3176	0.3299	0.3344	0.3479	0.3512	0.3780	0.3843	0.3750	3/8
7/16	20	0.4375	0.4303	0.4059	0.4014	0.3762	0.3689	0.3834	0.3888	0.4059	0.4086	0.4411	0.4483	0.4375	7/16
1/2	20	0.5000	0.4928	0.4675	0.4639	0.4387	0.4314	0.4459	0.4513	0.4675	0.4711	0.5036	0.5108	0.5000	1/2
9/16	18	0.5625	0.5543	0.5264	0.5223	0.4943	0.4862	0.5024	0.5084	0.5264	0.5305	0.5665	0.5746	0.5625	9/16
5/8	18	0.6250	0.6168	0.5889	0.5848	0.5568	0.5487	0.5649	0.5709	0.5889	0.5930	0.6290	0.6371	0.6250	5/8
3/4	16	0.7500	0.7419	0.7094	0.7049	0.6733	0.6643	0.6823	0.6891	0.7094	0.7139	0.7545	0.7635	0.7500	3/4
7/8	14	0.8750	0.8652	0.8286	0.8237	0.7874	0.7773	0.7977	0.8054	0.8286	0.8335	0.8802	0.8902	0.8750	7/8
1	14	1.0000	0.9902	0.9536	0.9487	0.9124	0.9023	0.9227	0.9304	0.9536	0.9585	1.0052	1.0152	1.0000	1
1 1/8	12	1.1250	1.1138	1.0799	1.0653	1.0228	1.0111	1.0348	1.0438	1.0799	1.0765	1.1310	1.1426	1.1250	1 1/8
1 1/4	12	1.2500	1.2388	1.1959	1.1903	1.1478	1.1361	1.1598	1.1688	1.1959	1.2015	1.2560	1.2676	1.2500	1 1/4
1 1/2	12	1.5000	1.4888	1.4459	1.4403	1.3978	1.3861	1.4098	1.4188	1.4459	1.4515	1.5060	1.5176	1.5000	1 1/2
1 3/4	12	1.7500	1.7388	1.6959	1.6903	1.6478	1.6361	1.6598	1.6688	1.6959	1.7015	1.7560	1.7676	1.7500	1 3/4
2	12	2.0000	1.9888	1.9459	1.9403	1.8978	1.8861	1.9098	1.9188	1.9459	1.9515	2.0060	2.0176	2.0000	2
2 1/4	12	2.2500	2.2388	2.1959	2.1903	2.1478	2.1361	2.1598	2.1688	2.1959	2.2015	2.2560	2.2676	2.2500	2 1/4
2 1/2	12	2.5000	2.4888	2.4459	2.4403	2.3978	2.3861	2.4098	2.4188	2.4459	2.4515	2.5060	2.5176	2.5000	2 1/2
2 3/4	12	2.7500	2.7388	2.6959	2.6903	2.6478	2.6361	2.6598	2.6688	2.6959	2.7015	2.7560	2.7676	2.7500	2 3/4
3	10	3.0000	2.9872	2.9350	2.9286	2.8773	2.8637	2.8917	2.9026	2.9350	2.9414	3.0072	3.0208	3.0000	3

* Dimensions given are figured to the intersection of the worn tool arc with a center line through crest and root.

TABLE 10. MEDIUM FIT (SPECIAL) — NATIONAL COARSE THREAD SERIES

Numbered and Fractional Sizes	No. of Threads per Inch	Screw Sizes						Nut Sizes						Basic Major Diam., Inches	Numbered and Fractional Sizes
		Major Diam.		Pitch Diam.		Minor Diam.		Minor Diam.		Pitch Diam.		Major Diam.			
		Max. Inches	Min. Inches	Max. Inches	Min. Inches	Max.* Inches	Min. Inches	Min. Inches	Max. Inches	Min. Inches	Max. Inches	Min.* Inches	Max. Inches		
1	64	0.0730	0.0702	0.0629	0.0615	0.0538	0.0513	0.0561	0.0578	0.0629	0.0643	0.0741	0.0767	0.0730	1
2	56	0.0860	0.0830	0.0744	0.0729	0.0641	0.0613	0.0667	0.0686	0.0744	0.0759	0.0873	0.0901	0.0860	2
3	48	0.0990	0.0958	0.0855	0.0839	0.0734	0.0703	0.0764	0.0787	0.0855	0.0871	0.1005	0.1036	0.0990	3
4	40	0.1120	0.1086	0.0958	0.0941	0.0813	0.0778	0.0849	0.0876	0.0958	0.0975	0.1138	0.1173	0.1120	4
5	40	0.1250	0.1216	0.1088	0.1071	0.0943	0.0908	0.0979	0.1006	0.1088	0.1105	0.1268	0.1303	0.1250	5
6	32	0.1380	0.1342	0.1177	0.1158	0.0997	0.0955	0.1042	0.1076	0.1177	0.1196	0.1403	0.1444	0.1380	6
8	32	0.1640	0.1602	0.1437	0.1418	0.1257	0.1215	0.1302	0.1336	0.1437	0.1456	0.1663	0.1704	0.1640	8
10	24	0.1900	0.1852	0.1629	0.1605	0.1389	0.1335	0.1449	0.1494	0.1629	0.1653	0.1930	0.1984	0.1900	10
12	24	0.2160	0.2112	0.1889	0.1865	0.1649	0.1595	0.1709	0.1754	0.1889	0.1913	0.2190	0.2244	0.2160	12
1/4	20	0.2500	0.2448	0.2175	0.2149	0.1887	0.1824	0.1959	0.2013	0.2175	0.2201	0.2536	0.2598	0.2500	1/4
5/16	18	0.3125	0.3065	0.2764	0.2734	0.2443	0.2373	0.2524	0.2584	0.2764	0.2794	0.3165	0.3235	0.3125	5/16
3/8	16	0.3750	0.3686	0.3344	0.3312	0.2983	0.2906	0.3073	0.3141	0.3344	0.3376	0.3795	0.3862	0.3750	3/8
7/16	14	0.4375	0.4303	0.3911	0.3875	0.3499	0.3411	0.3662	0.3679	0.3911	0.3947	0.4427	0.4514	0.4375	7/16
1/2	13	0.5000	0.4926	0.4500	0.4463	0.4056	0.3961	0.4167	0.4251	0.4500	0.4537	0.5036	0.5148	0.5000	1/2
9/16	12	0.5625	0.5545	0.5084	0.5044	0.4603	0.4502	0.4723	0.4813	0.5084	0.5124	0.5685	0.5785	0.5625	9/16
5/8	11	0.6250	0.6166	0.5660	0.5618	0.5135	0.5027	0.5266	0.5364	0.5660	0.5702	0.6316	0.6423	0.6250	5/8
3/4	10	0.7500	0.7410	0.6859	0.6805	0.6273	0.6156	0.6417	0.6526	0.6859	0.6895	0.7572	0.7689	0.7500	3/4
7/8	9	0.8750	0.8652	0.8028	0.7979	0.7387	0.7258	0.7547	0.7667	0.8028	0.8077	0.8830	0.8959	0.8750	7/8
1	8	1.0000	0.9892	0.9188	0.9134	0.8466	0.8322	0.8647	0.8782	0.9188	0.9242	1.0090	1.0234	1.0000	1
1 1/8	7	1.1250	1.1132	1.0322	1.0263	0.9497	0.9335	0.9704	0.9858	1.0322	1.0381	1.1353	1.1515	1.1250	1 1/8
1 1/4	7	1.2500	1.2382	1.1572	1.1513	1.0747	1.0585	1.0954	1.1108	1.1572	1.1631	1.2603	1.2765	1.2500	1 1/4
1 1/2	6	1.5000	1.4858	1.3917	1.3846	1.2955	1.2764	1.3196	1.3376	1.3917	1.3988	1.5120	1.5312	1.5000	1 1/2
1 3/4	5	1.7500	1.7336	1.6201	1.6119	1.5046	1.4820	1.5335	1.5551	1.6201	1.6283	1.7644	1.7871	1.7500	1 3/4
2	4 1/2	2.0000	1.9822	1.8557	1.8468	1.7274	1.7024	1.7594	1.7835	1.8557	1.8646	2.0160	2.0410	2.0000	2
2 1/4	4 1/2	2.2500	2.2322	2.1057	2.0968	1.9774	1.9524	2.0094	2.0335	2.1057	2.1146	2.2600	2.2910	2.2500	2 1/4
2 1/2	4	2.5000	2.4806	2.3376	2.3279	2.1933	2.1655	2.2294	2.2564	2.3376	2.3473	2.5180	2.5458	2.5000	2 1/2
2 3/4	4	2.7500	2.7306	2.5876	2.5779	2.4433	2.4155	2.4794	2.5064	2.5876	2.6973	2.7680	2.7958	2.7500	2 3/4
3	4	3.0000	2.9806	2.8376	2.8279	2.6933	2.6655	2.7294	2.7564	2.8376	2.8473	3.0180	3.0458	3.0000	3

* Dimensions given are figured to the intersection of the worn tool arc with a center line through crest and root.

TABLE 11. MEDIUM FIT (SPECIAL)—NATIONAL FINE THREAD SERIES

Numbered and Fractional Sizes	No. of Threads per Inch	Screw Sizes						Nut Sizes						Basic Major Diam., Inches	Numbered and Fractional Sizes
		Major Diam.		Pitch Diam.		Minor Diam.		Minor Diam.		Pitch Diam.		Major Diam.			
		Max. Inches	Min. Inches	Max. Inches	Min. Inches	Max.* Inches	Min. Inches	Min. Inches	Max. Inches	Min. Inches	Max. Inches	Min.* Inches	Max. Inches		
0	80	0.0600	0.0574	0.0519	0.0506	0.0447	0.0425	0.0465	0.0478	0.0519	0.0532	0.0609	0.0631	0.0600	0
1	72	0.0730	0.0704	0.0640	0.0627	0.0560	0.0537	0.0580	0.0595	0.0640	0.0653	0.0740	0.0763	0.0730	1
2	64	0.0860	0.0832	0.0759	0.0745	0.0668	0.0643	0.0691	0.0708	0.0759	0.0773	0.0871	0.0897	0.0860	2
3	56	0.0990	0.0960	0.0874	0.0859	0.0771	0.0743	0.0797	0.0816	0.0874	0.0889	0.1003	0.1031	0.0990	3
4	48	0.1120	0.1088	0.0985	0.0969	0.0864	0.0833	0.0894	0.0917	0.0985	0.1001	0.1135	0.1166	0.1120	4
5	44	0.1250	0.1218	0.1102	0.1086	0.0971	0.0939	0.1004	0.1029	0.1102	0.1118	0.1266	0.1299	0.1250	5
6	40	0.1380	0.1346	0.1218	0.1201	0.1073	0.1038	0.1109	0.1136	0.1218	0.1235	0.1398	0.1433	0.1380	6
8	36	0.1640	0.1604	0.1460	0.1442	0.1299	0.1261	0.1339	0.1369	0.1460	0.1478	0.1660	0.1698	0.1640	8
10	32	0.1900	0.1862	0.1697	0.1678	0.1517	0.1475	0.1562	0.1596	0.1697	0.1716	0.1923	0.1964	0.1900	10
12	28	0.2160	0.2116	0.1928	0.1906	0.1722	0.1674	0.1773	0.1812	0.1928	0.1950	0.2186	0.2234	0.2160	12
1/4	28	0.2500	0.2456	0.2268	0.2246	0.2062	0.2014	0.2113	0.2152	0.2268	0.2290	0.2526	0.2574	0.2500	1/4
5/16	24	0.3125	0.3077	0.2854	0.2830	0.2614	0.2560	0.2674	0.2719	0.2854	0.2878	0.3155	0.3209	0.3125	5/16
3/8	24	0.3750	0.3702	0.3479	0.3455	0.3239	0.3185	0.3299	0.3344	0.3479	0.3503	0.3780	0.3834	0.3750	3/8
7/16	20	0.4375	0.4323	0.4050	0.4024	0.3762	0.3699	0.3834	0.3888	0.4050	0.4076	0.4411	0.4473	0.4375	7/16
1/2	20	0.5000	0.4948	0.4675	0.4649	0.4387	0.4324	0.4459	0.4513	0.4675	0.4701	0.5036	0.5098	0.5000	1/2
9/16	18	0.5625	0.5565	0.5264	0.5234	0.4943	0.4873	0.5024	0.5084	0.5264	0.5294	0.5665	0.5735	0.5625	9/16
5/8	18	0.6250	0.6190	0.5889	0.5859	0.5568	0.5498	0.5649	0.5709	0.5889	0.5919	0.6290	0.6360	0.6250	5/8
3/4	16	0.7500	0.7436	0.7094	0.7062	0.6733	0.6656	0.6823	0.6891	0.7094	0.7126	0.7545	0.7622	0.7500	3/4
7/8	14	0.8750	0.8678	0.8286	0.8250	0.7874	0.7786	0.7977	0.8054	0.8286	0.8322	0.8802	0.8889	0.8750	7/8
1	12	1.0000	0.9928	0.9536	0.9500	0.9124	0.9036	0.9227	0.9304	0.9536	0.9572	1.0052	1.0139	1.0000	1
1 1/8	12	1.1250	1.1170	1.0709	1.0669	1.0228	1.0127	1.0348	1.0438	1.0709	1.0749	1.1310	1.1410	1.1250	1 1/8
1 1/4	12	1.2500	1.2420	1.1959	1.1919	1.1478	1.1377	1.1598	1.1688	1.1959	1.1999	1.2560	1.2660	1.2500	1 1/4
1 3/8	12	1.3750	1.3670	1.4159	1.4119	1.3678	1.3877	1.3898	1.4188	1.4459	1.4499	1.5060	1.5160	1.5000	1 1/2
1 3/4	12	1.7500	1.7420	1.6959	1.6919	1.6478	1.6377	1.6598	1.6688	1.6959	1.6999	1.7560	1.7660	1.7500	1 3/4
2	12	2.0000	1.9920	1.9459	1.9419	1.8978	1.8877	1.9098	1.9188	1.9459	1.9499	2.0060	2.0160	2.0000	2
2 1/4	12	2.2500	2.2420	2.1959	2.1919	2.1478	2.1377	2.1598	2.1688	2.1959	2.1999	2.2560	2.2660	2.2500	2 1/4
2 1/2	12	2.5000	2.4920	2.4459	2.4419	2.3978	2.3877	2.4098	2.4188	2.4459	2.4499	2.5060	2.5160	2.5000	2 1/2
2 3/4	12	2.7500	2.7420	2.6959	2.6919	2.6478	2.6377	2.6598	2.6688	2.6959	2.6999	2.7560	2.7660	2.7500	2 3/4
3	10	3.0000	2.9910	2.9350	2.9305	2.8773	2.8656	2.8917	2.9026	2.9350	2.9395	3.0072	3.0189	3.0000	3

* Dimensions given are figured to the intersection of the worn tool arc with a center line through crest and root.

Tolerances and Diameters for Close Fits

Screw threads of the "close fit" class are intended for threaded work of the finest commercial quality (where the thread has practically no backlash), and for light screwdriver fits. In the manufacture of screw thread products belonging in this class, it will be necessary to use precision tools, selected master gages, and many other refinements. This quality of work should, therefore, be used only in cases where requirements of the mechanism being produced are exacting, or where special conditions require screws having a precision fit. In order to secure the fit desired, it may be necessary, in some cases, to select the parts when the product is being assembled.

Maximum Screw above Basic Size—The major diameter and the pitch diameter of the maximum screw of a given diameter and pitch will be above the basic dimensions by the allowance (interference) specified in Table 13.

Direction of Tolerance on Nut and Screw—The tolerance on the nut will be plus and is to be applied from the basic size to above the basic size. The tolerance on the screw will be minus and is to be applied from the maximum screw dimensions to below the maximum screw dimensions.

Allowance and Tolerance Values—The allowance (interference) provided between the size of the minimum nut, which is basic, and the size of the maximum screw, which is above basic, will be as specified in Table 13. The tolerance for a screw or nut of given pitch will be as specified in this same table.

Application of Tolerances

Three different sets of tolerances are given in Tables 4, 5, 12, and 13 for use in connection with the various classes of screw thread fits previously mentioned. The tolerance limits established represent, in reality, the sizes of the "Go" and "Not Go" master gages. Errors in lead and angle which

TABLE 12. ALLOWANCES AND TOLERANCES FOR MEDIUM FIT (SPECIAL)

(Screws, Nuts and Gages)

No. of Thds. per Inch	Allowances, Inches	Extreme or Drawing Pitch Diam. Tolerances, Inches	Master Gage Tolerances			Net Pitch Diameter Tolerances, Inches
			Diameter, Inches	Lead,* Inches, Plus or Minus	½ Angle, Plus or Minus	
80	0.0000	0.0013	0.0002	0.0002	0° 30′	0.0009
72	0.0000	0.0013	0.0002	0.0002	0° 30′	0.0009
64	0.0000	0.0014	0.0002	0.0002	0° 30′	0.0010
56	0.0000	0.0015	0.0002	0.0002	0° 30′	0.0011
48	0.0000	0.0016	0.0002	0.0002	0° 30′	0.0012
44	0.0000	0.0016	0.0002	0.0002	0° 30′	0.0012
40	0.0000	0.0017	0.0002	0.0002	0° 20′	0.0013
36	0.0000	0.0018	0.0002	0.0002	0° 20′	0.0014
32	0.0000	0.0019	0.0002	0.0002	0° 20′	0.0015
28	0.0000	0.0022	0.0003	0.0002	0° 15′	0.0016
24	0.0000	0.0024	0.0003	0.0002	0° 15′	0.0018
20	0.0000	0.0026	0.0003	0.0002	0° 15′	0.0020
18	0.0000	0.0030	0.0004	0.0003	0° 10′	0.0022
16	0.0000	0.0032	0.0004	0.0003	0° 10′	0.0024
14	0.0000	0.0036	0.0004	0.0003	0° 10′	0.0028
13	0.0000	0.0037	0.0004	0.0003	0° 10′	0.0029
12	0.0000	0.0040	0.0004	0.0003	0° 10′	0.0032
11	0.0000	0.0042	0.0004	0.0003	0° 10′	0.0034
10	0.0000	0.0045	0.0004	0.0004	0° 5′	0.0037
9	0.0000	0.0049	0.0004	0.0004	0° 5′	0.0041
8	0.0000	0.0054	0.0004	0.0004	0° 5′	0.0046
7	0.0000	0.0059	0.0004	0.0004	0° 5′	0.0051
6	0.0000	0.0071	0.0006	0.0005	0° 5′	0.0059
5	0.0000	0.0082	0.0006	0.0005	0° 5′	0.0070
4½	0.0000	0.0089	0.0006	0.0005	0° 5′	0.0077
4	0.0000	0.0097	0.0006	0.0005	0° 5′	0.0085

*Allowable variation in lead between any two threads not farther apart than the length of engagement.

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TABLE 13. ALLOWANCES AND TOLERANCES FOR CLOSE FIT

(Screws, Nuts and Gages)

No. of Thds. per Inch	Interference or Negative Allowances, Inches	Extreme or Drawing Pitch Diam. Tolerances, Inches	Master Gage Tolerances			Net Pitch Diameter Tolerances, Inches
			Diameter, Inches	Lead,* Inches, Plus or Minus	½ Angle, Plus or Minus	
80	0.0001	0.0006	0.0001	0.0001	15′ 00″	0.0004
72	0.0001	0.0007	0.0001	0.0001	15′ 00″	0.0005
64	0.0001	0.0007	0.0001	0.0001	15′ 00″	0.0005
56	0.0002	0.0007	0.0001	0.0001	15′ 00″	0.0005
48	0.0002	0.0008	0.0001	0.0001	15′ 00″	0.0006
44	0.0002	0.0008	0.0001	0.0001	15′ 00″	0.0006
40	0.0002	0.0009	0.0001	0.0001	10′ 00″	0.0007
36	0.0002	0.0009	0.0001	0.0001	10′ 00″	0.0007
32	0.0002	0.0010	0.0001	0.0001	10′ 00″	0.0008
28	0.0002	0.0011	0.00015	0.0001	7′ 30″	0.0008
24	0.0003	0.0012	0.00015	0.0001	7′ 30″	0.0009
20	0.0003	0.0013	0.00015	0.0001	7′ 30″	0.0010
18	0.0003	0.0015	0.0002	0.00015	5′ 00″	0.0011
16	0.0004	0.0016	0.0002	0.00015	5′ 00″	0.0012
14	0.0004	0.0018	0.0002	0.00015	5′ 00″	0.0014
13	0.0004	0.0019	0.0002	0.00015	5′ 00″	0.0015
12	0.0005	0.0020	0.0002	0.00015	5′ 00″	0.0016
11	0.0005	0.0021	0.0002	0.00015	5′ 00″	0.0017
10	0.0006	0.0023	0.0002	0.0002	2′ 30″	0.0019
9	0.0006	0.0024	0.0002	0.0002	2′ 30″	0.0020
8	0.0007	0.0027	0.0002	0.0002	2′ 30″	0.0023
7	0.0008	0.0030	0.0002	0.0002	2′ 30″	0.0026
6	0.0009	0.0036	0.0003	0.00025	2′ 30″	0.0030
5	0.0010	0.0041	0.0003	0.00025	2′ 30″	0.0035
4½	0.0011	0.0044	0.0003	0.00025	2′ 30″	0.0038
4	0.0013	0.0048	0.0003	0.00025	2′ 30″	0.0042

*Allowable variation in lead between any two threads not farther apart than the length of engagement.

Machinery

occur on the threaded work can be offset by a suitable alteration of the pitch diameter of the work. If the "Go" gage passes the threaded work, interchangeability is secured and the thread profile may differ from that of the "Go" gage in either pitch diameter, lead, or angle. The "Not Go" gage checks pitch diameter only, and thus insures that the pitch diameter is such that the fit will not be too loose.

The pitch diameter tolerances provided for a screw of a given class of fit are the same as the pitch diameter tolerances provided for a nut corresponding to the same class of fit. The tolerances established for loose and medium fits

The minimum minor diameter of a screw of a given pitch will be such as to result in a basic flat ($\frac{1}{8}$ × pitch) at the root when the pitch diameter of the screw is at its minimum value. (*Note*: When the maximum screw is basic, the minimum minor diameter of the screw will be below the *basic* minor diameter by the amount of the specified pitch diameter tolerance.)

The maximum minor diameter may be such as results from the use of a worn or rounded threading tool, when the pitch diameter is at its maximum value. In no case, however, should the form of the screw, resulting from tool wear, be

TABLE 14. CLOSE FIT—NATIONAL COARSE THREAD SERIES

Numbered and Fractional Sizes	No. of Threads per Inch	Screw Sizes						Nut Sizes						Basic Major Diam., Inches	Numbered and Fractional Sizes
		Major Diam.		Pitch Diam.		Minor Diam.		Minor Diam.		Pitch Diam.		Major Diam.			
		Max. Inches	Min. Inches	Max. Inches	Min. Inches	Max.* Inches	Min. Inches	Min. Inches	Max. Inches	Min. Inches	Max. Inches	Min.* Inches	Max. Inches		
1	64	0.0731	0.0717	0.0630	0.0623	0.0539	0.0521	0.0561	0.0578	0.0629	0.0636	0.0741	0.0760	0.0730	1
2	56	0.0862	0.0848	0.0746	0.0739	0.0643	0.0623	0.0667	0.0686	0.0744	0.0751	0.0873	0.0893	0.0860	2
3	48	0.0992	0.0976	0.0857	0.0849	0.0736	0.0713	0.0764	0.0787	0.0855	0.0863	0.1005	0.1028	0.0990	3
4	40	0.1122	0.1104	0.0966	0.0951	0.0815	0.0788	0.0849	0.0876	0.0958	0.0967	0.1138	0.1165	0.1120	4
5	40	0.1252	0.1234	0.1099	0.1081	0.0945	0.0918	0.0979	0.1006	0.1088	0.1097	0.1268	0.1295	0.1250	5
6	32	0.1382	0.1362	0.1179	0.1169	0.0999	0.0966	0.1042	0.1076	0.1177	0.1187	0.1403	0.1435	0.1380	6
8	32	0.1642*	0.1622	0.1439	0.1429	0.1259	0.1226	0.1302	0.1336	0.1437	0.1447	0.1663	0.1695	0.1640	8
10	24	0.1903	0.1879	0.1632	0.1620	0.1392	0.1350	0.1449	0.1494	0.1629	0.1641	0.1930	0.1972	0.1900	10
12	24	0.2163	0.2139	0.1892	0.1880	0.1652	0.1610	0.1709	0.1754	0.1889	0.1901	0.2190	0.2232	0.2160	12
¼	20	0.2503	0.2477	0.2178	0.2165	0.1890	0.1840	0.1959	0.2013	0.2175	0.2188	0.2536	0.2585	0.2500	¼
5/16	18	0.3128	0.3098	0.2767	0.2752	0.2446	0.2391	0.2524	0.2584	0.2764	0.2779	0.3165	0.3220	0.3125	5/16
3/8	16	0.3754	0.3722	0.3348	0.3332	0.2987	0.2926	0.3073	0.3141	0.3344	0.3360	0.3795	0.3856	0.3750	3/8
7/16	14	0.4379	0.4343	0.3915	0.3897	0.3503	0.3433	0.3602	0.3679	0.3911	0.3929	0.4427	0.4496	0.4375	7/16
½	13	0.5004	0.4966	0.4504	0.4485	0.4059	0.3986	0.4167	0.4251	0.4500	0.4519	0.5056	0.5131	0.5000	½
9/16	12	0.5630	0.5590	0.5089	0.5069	0.4608	0.4527	0.4723	0.4813	0.5084	0.5104	0.5685	0.5765	0.5625	9/16
5/8	11	0.6255	0.6213	0.5665	0.5644	0.5140	0.5053	0.5266	0.5364	0.5660	0.5681	0.6316	0.6403	0.6250	5/8
3/4	10	0.7506	0.7460	0.6836	0.6833	0.6279	0.6184	0.6417	0.6526	0.6859	0.6873	0.7572	0.7667	0.7500	3/4
7/8	9	0.8756	0.8708	0.8034	0.8010	0.7393	0.7289	0.7547	0.7667	0.8028	0.8052	0.8830	0.8934	0.8750	7/8
1	8	1.0007	0.9953	0.9195	0.9168	0.8473	0.8356	0.8647	0.8782	0.9188	0.9215	1.0090	1.0207	1.0000	1
1⅛	7	1.1258	1.1198	1.0330	1.0300	0.9505	0.9372	0.9704	0.9858	1.0322	1.0352	1.1353	1.1486	1.1250	1⅛
1¼	7	1.2508	1.2448	1.1580	1.1550	1.0755	1.0622	1.0954	1.1108	1.1572	1.1602	1.2603	1.2736	1.2500	1¼
1½	6	1.5009	1.4937	1.3926	1.3890	1.2964	1.2808	1.3196	1.3376	1.3917	1.3953	1.5120	1.5277	1.5000	1½
1¾	5	1.7510	1.7428	1.6211	1.6170	1.5056	1.4871	1.5335	1.5551	1.6201	1.6242	1.7644	1.7830	1.7500	1¾
2	4½	2.0011	1.9923	1.8568	1.8524	1.7285	1.7080	1.7594	1.7835	1.8557	1.8601	2.0160	2.0365	2.0000	2
2¼	4½	2.2511	2.2423	2.1068	2.1024	1.9785	1.9580	2.0094	2.0335	2.1057	2.1101	2.2660	2.2865	2.2500	2¼
2½	4	2.5013	2.4917	2.3389	2.3341	2.1946	2.1717	2.2294	2.2564	2.3376	2.3424	2.5180	2.5409	2.5000	2½
2¾	4	2.7513	2.7417	2.5889	2.5841	2.4446	2.4217	2.4794	2.5064	2.5876	2.5924	2.7680	2.7909	2.7500	2¾
3	4	3.0013	2.9917	2.8389	2.8341	2.6946	2.6717	2.7294	2.7564	2.8376	2.8424	3.0180	3.0409	3.0000	3

* Dimensions given are figured to the intersection of the worn tool arc with a center line through crest and root.

TABLE 15. CLOSE FIT—NATIONAL FINE THREAD SERIES

Numbered and Fractional Sizes	No. of Threads per Inch	Screw Sizes						Nut Sizes						Basic Major Diam., Inches	Numbered and Fractional Sizes
		Major Diam.		Pitch Diam.		Minor Diam.		Minor Diam.		Pitch Diam.		Major Diam.			
		Max. Inches	Min. Inches	Max. Inches	Min. Inches	Max.* Inches	Min. Inches	Min. Inches	Max. Inches	Min. Inches	Max. Inches	Min.* Inches	Max. Inches		
0	80	0.0601	0.0589	0.0520	0.0514	0.0448	0.0433	0.0465	0.0478	0.0519	0.0525	0.0609	0.0624	0.0600	0
1	72	0.0731	0.0717	0.0641	0.0634	0.0561	0.0544	0.0580	0.0595	0.0640	0.0647	0.0740	0.0757	0.0730	1
2	64	0.0861	0.0847	0.0760	0.0753	0.0669	0.0651	0.0691	0.0708	0.0759	0.0766	0.0871	0.0890	0.0860	2
3	56	0.0992	0.0978	0.0876	0.0869	0.0773	0.0753	0.0797	0.0816	0.0874	0.0881	0.1003	0.1023	0.0990	3
4	48	0.1122	0.1106	0.0987	0.0979	0.0886	0.0843	0.0894	0.0917	0.0985	0.0993	0.1135	0.1158	0.1120	4
5	44	0.1252	0.1236	0.1104	0.1096	0.0973	0.0949	0.1004	0.1029	0.1102	0.1110	0.1266	0.1289	0.1250	5
6	40	0.1382	0.1364	0.1220	0.1211	0.1075	0.1048	0.1109	0.1136	0.1218	0.1227	0.1398	0.1425	0.1380	6
8	36	0.1642	0.1624	0.1462	0.1453	0.1301	0.1272	0.1339	0.1369	0.1460	0.1469	0.1660	0.1689	0.1640	8
10	32	0.1902	0.1882	0.1699	0.1689	0.1519	0.1486	0.1562	0.1596	0.1697	0.1707	0.1923	0.1955	0.1900	10
12	28	0.2162	0.2140	0.1930	0.1919	0.1724	0.1687	0.1773	0.1812	0.1928	0.1939	0.2186	0.2223	0.2160	12
¼	28	0.2502	0.2480	0.2270	0.2259	0.2064	0.2027	0.2113	0.2152	0.2268	0.2279	0.2526	0.2563	0.2500	¼
5/16	24	0.3128	0.3104	0.2857	0.2845	0.2617	0.2575	0.2674	0.2719	0.2854*	0.2866	0.3155	0.3197	0.3125	5/16
3/8	24	0.3753	0.3729	0.3482	0.3470	0.3242	0.3200	0.3299	0.3344	0.3479	0.3491	0.3780	0.3822	0.3750	3/8
7/16	20	0.4378	0.4352	0.4053	0.4040	0.3765	0.3715	0.3834	0.3888	0.4058	0.4073	0.4411	0.4460	0.4375	7/16
½	20	0.5003	0.4977	0.4678	0.4665	0.4390	0.4340	0.4459	0.4513	0.4675	0.4688	0.5036	0.5085	0.5000	½
9/16	18	0.5628	0.5598	0.5267	0.5252	0.4916	0.4891	0.5024	0.5084	0.5263	0.5279	0.5665	0.5720	0.5625	9/16
5/8	18	0.6253	0.6223	0.5892	0.5877	0.5541	0.5516	0.5649	0.5709	0.5889	0.5904	0.6296	0.6345	0.6250	5/8
3/4	16	0.7504	0.7472	0.7098	0.7082	0.6737	0.6676	0.6823	0.6891	0.7094	0.7110	0.7545	0.7606	0.7500	3/4
7/8	14	0.8751	0.8718	0.8290	0.8272	0.7878	0.7807	0.7977	0.8054	0.8286	0.8304	0.8802	0.8872	0.8750	7/8
1	14	1.0004	0.9968	0.9540	0.9522	0.9128	0.9058	0.9227	0.9304	0.9536	0.9554	1.0052	1.0121	1.0000	1
1⅛	12	1.1255	1.1215	1.0714	1.0694	1.0233	1.0152	1.0348	1.0438	1.0709	1.0729	1.1310	1.1390	1.1250	1⅛
1¼	12	1.2505	1.2465	1.1964	1.1944	1.1483	1.1402	1.1598	1.1688	1.1959	1.1979	1.2560	1.2640	1.2500	1¼
1½	12	1.5005	1.4965	1.4464	1.4444	1.3983	1.3902	1.4098	1.4188	1.4459	1.4479	1.5060	1.5140	1.5000	1½
1¾	12	1.7505	1.7465	1.6964	1.6944	1.6483	1.6402	1.6598	1.6688	1.6959	1.6979	1.7560	1.7640	1.7500	1¾
2	12	2.0005	1.9965	1.9464	1.9444	1.8983	1.8902	1.9098	1.9188	1.9459	1.9479	2.0060	2.0140	2.0000	2
2¼	12	2.2505	2.2465	2.1964	2.1944	2.1483	2.1402	2.1598	2.1688	2.1959	2.1979	2.2560	2.2640	2.2500	2¼
2½	12	2.5005	2.4965	2.4465	2.4444	2.3983	2.3902	2.4098	2.4188	2.4459	2.4479	2.5060	2.5140	2.5000	2½
2¾	12	2.7505	2.7465	2.6964	2.6944	2.6483	2.6402	2.6598	2.6688	2.6959	2.6979	2.7560	2.7640	2.7500	2¾
3	10	3.0006	2.9960	2.9336	2.9333	2.8779	2.8684	2.8917	2.9026	2.9350	2.9373	3.0072	3.0167	3.0000	3

* Dimensions given are figured to the intersection of the worn tool arc with a center line through crest and root.

permit the use of commercial taps. For close fits, when it is desired to produce a hole close to basic size, the use of a selected tap is recommended.

Tolerances on Major and Minor Diameters of Screw

The allowable tolerances on the major diameter of screws of a given classification will be twice the tolerance values allowed on the pitch diameters of screws of the same class, such as to cause the screw to be rejected on the maximum minor diameter by a "Go" ring gage, the minor diameter of which is equal to the minimum minor diameter of the nut.

Tolerances on Major and Minor Diameters of Nut

The maximum major diameter of the nut of a given pitch will be such as to result in a flat 1/3 of the basic flat (1/24

× pitch) when the pitch diameter of the nut is at its maximum value. (*Note*: When the minimum nut is basic, the maximum major diameter will be above the *basic* major diameter by the amount of the specified pitch diameter tolerance plus 2/9 of the basic thread depth.)

The nominal minimum major diameter of a nut will be above the basic major diameter by an amount equal to 1/9 of the basic thread depth plus the neutral space. This results in a clearance which is provided to facilitate manufacture by permitting a slight rounding or wear at the crest of the tap. In no case, however, should the minimum major diameter of the nut, resulting from a worn tap or cutting tool, be such as to cause the nut to be rejected on the minimum major diameter by a "Go" plug gage made to the standard form at the crest.

The tolerances on the minor diameter of a nut of a given pitch will be 1/6 of the basic thread depth regardless of the class of fit being produced.

Scope of Tolerance Specifications

The specifications establishing the various sets of tolerances for different classes of screw thread fits will apply to the manufacture of National coarse threads, National fine threads, National hose coupling threads, National fire hose coupling threads, straight pipe threads, and wherever applicable to the production of all special threads.

When tolerances are desired for a special thread and the pitch is not listed in the tables given, the tolerance values should be chosen corresponding to the number of threads per inch nearest to that of the special thread being produced. When the number of threads per inch is midway between two of the pitches listed, the tolerance corresponding to the coarser pitch should be used. For instance, the tolerance on a screw having 11½ threads per inch would correspond to the tolerances specified for a screw of 11 threads per inch.

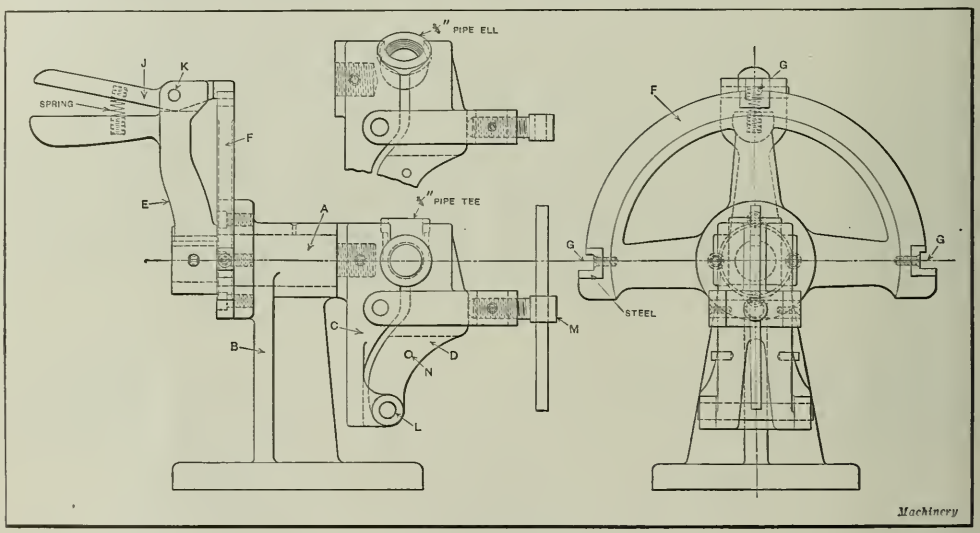
Concluding Remarks

The work of the National Screw Thread Commission has been very thorough, and the report presented is an exhaustive study of the whole subject. When the commission started its work, it held hearings in all of the larger industrial centers of the country and obtained in this way suggestions from a great many manufacturers and engineers. No effort was spared in obtaining all the information necessary to present a report that would be acceptable to all concerned.

JIG USED IN REAMING AND TAPPING PIPE TEES AND ELLS

By J. C. KING

A jig for use in holding pipe tees and ells during reaming and tapping operations is shown in the accompanying illustration. This jig is of the indexing type, its construction being clearly shown in the illustration. The cast-iron base *B* contains a bearing in which the arbor *A* is a slip fit. Jaw *C* is attached to the threaded end of this arbor by means of a set-screw, while the mating jaw *D* hinges on the lower end of the fixed jaw, to which it is assembled by means of the pin *L*. Both the fixed jaw *C* and the hinged jaw *D* are made of cast iron and are designed to conform to the size and shape of the part being machined. A crank handle *E* is keyed and fastened by a screw to the opposite end of the arbor and is located parallel with the vertical center line of the jaws. A 180-degree cast-iron quadrant *F*, which is provided with three steel-lined stops *G*, is mounted on the base by means of four machine screws as shown. It will be seen that these stops are spaced 90 degrees apart on the periphery of the quadrant; this enables the machined surfaces of the tees and ells to be accurately located in relation to each other when the parts are being reamed or tapped. It will be evident that by releasing pawl *J*, which is hinged to crank *E* by means of pin *K*, the fixture may be readily indexed to the desired position.



Indexing Jig for holding Pipe Tees and Ells

A quick clamping arrangement is employed for securing the work in place and for releasing it after being machined. This clamping device is hinged to jaw *C* and is operated by the pilot screw *M*, which, when released, enables the clamp to drop down against stops *N* and the jaw *D* to fall away from engagement with the tee or ell, as the case may be. The illustration also shows a partial view of the jaws as they would be designed for holding a 90-degree ell. Care must be exercised in mounting the jaws, particularly in the case of the ells, to position them so that the center lines of the stops *G* on the quadrant will be coincident with those of the holes in the pipe part.

In a concern where this jig is in daily use, 150 tees are reamed and tapped per hour, which represents an increase in the production rate of 87 per cent, the previous output when using a stationary jig being but 80 pieces per hour. In the case of ells, 175 pieces may be machined per hour as against 100 per hour by the old method.

The British Machine Tool Industry

From MACHINERY'S Special Correspondent

London, June 14

THE trade in machine and small tools in this country shows a steady tendency toward stability. The great influx of imports, the majority from the United States, rendered necessary by the artificial conditions in existence during and immediately after the war has now decreased to a figure more nearly comparable with exports. To compare the present trade with that before the war is impossible, the relative and varying money values alone preventing deductions being made that could carry any weight. Except in a few cases, all machine tool makers report a heavy home and continental demand. The exceptions state that the enormous sales of government machine tools have had a depressing effect on the market; that the effect should only be felt in a few instances is an indication of the phenomenal activity in buying. Before the war the value of machine tool exports was roughly four times that of imports; at the present time the export value is only 60 per cent of the import value.

Labor Conditions

Labor appears to be slowly settling down to more stable conditions. The principle of payment by results, although accepted by several branches of workers, has for the moment been repudiated by the Amalgamated Society of Engineers which has a large following of skilled mechanics. There is a strong antagonism to over-time throughout most of the trade unions; consequently the most urgent work cannot be expedited in this way. The men generally earn enough to live comfortably and the incentive of over-time is not as strong as in pre-war days. Iron founders in many districts find a shortage of suitable labor, and this greatly retards the efforts made to catch up some of the time lost by the recent disastrous strike. The arguments used by the labor spokesmen to the effect that decreased working hours would result in increased work being turned out is not borne out by results, and the Association of British Chambers of Commerce may appeal to the unions to agree temporarily to a longer working day. If successful, part of the demand for British machine tools throughout the world might be satisfied. In the Midlands, machine tool makers are very hopeful, since the supply of castings in this district has improved considerably, and a continuation of the present supply would enable early delivery of machines in arrears. During the molders' strike, many machine shops had to close certain departments because the lack of castings threw a great many men out of employment. This condition is now practically remedied.

Prices of Machine Tools

The prices of machine tools in this country are at the present time more stable than for some time past. In the heavier machines, the increasing price of castings is still felt, but generally quotations can be made with more certainty. The American exchange, which today is in the neighborhood of $3.80 to the pound, is a rather heavy handicap in the sale of American tools in this country. Previously, better deliveries have been obtainable from the United States, but with slowly improving conditions in supply, home deliveries are improving decidedly. Best quality machine tool castings cost 44 shillings per hundredweight, and steel has kept fairly constant during the last month, round stock averaging £27 per ton.

Developments in the Machine Tool Trade

The developments in the machine tool trade are numerous. The Birmingham Small Arms Co., of Sparbrook, has planned to assist in the equipment of manufacturers not only by supplying the jigs, fixtures, and tools they may require, but also by advising as to methods that should be used in the manufacture of any product from start to finish. Cammell Laird & Co., Ltd., Sheffield, are devoting to commercial work the whole of their great plant at Sheffield and Penistone with the exception of the armor plate department. Extensions to their Penistone works will enable a total of 7000 tons of steel per week to be produced on the Bessemer-acid and Siemens hearth processes. In the Govan district of Scotland the shipyards and works of Harland & Wolff are being extended considerably, and similar remarks apply to the Fairfield Shipbuilding Co., while a new steel works is being put up at Motherwell, Scotland. George Richards & Co., Ltd., of Broadheath in the Manchester district, are, in common with many other firms, building and equipping a foundry for the production of their own castings. The Lapointe Machine Tool Co., of Hudson, Mass., U. S. A., is equipping a factory in the London district for the supply of broaching tools and equipment to English users of their broaching machines.

New Machine Tools

A new boiler flue mouth boring and facing machine has been turned out by G. & A. Harvey, Ltd., of Govan. The machine, which has a box section column, is of substantial proportions, weighing 11 tons. Power is taken from a 10-horsepower variable-speed motor. The machine spindle, which is carried horizontally on a rising and falling carriage, carries a large flange to which the driving wheel and tool-slide are secured. The same firm has also recently completed a turbine boring machine with a work-plate 19 feet 6 inches long by 9 feet wide. Special facilities have been provided for making tool adjustment without interrupting the operation of the machine.

A new type of vertical turning and boring mill has been produced by Joshua Buckton & Co., Ltd., Leeds, which is capable of machining, all over, an oil-treated steel tire of 4 feet 5 inches in diameter by 5½ inches wide in 115 minutes. A depth of about ¼ inch of metal was removed from the entire surface. The machine, which is driven by a 25-horsepower motor, will admit 20 inches beneath the cross-slide, and the work is held by self-centering chuck jaws. Two tools are used simultaneously for boring and turning. The 500-ton boiler flanging presses made by Henry Berry & Sons, Ltd., of Leeds have three hydraulic cylinders in the base and one movable cylinder in the head; the mobility of the head cylinder allows pressure to be concentrated at any particular part of a job and is useful in plate straightening or for forming operations at a distance from the center. A clear space of 12 feet is available between the press uprights.

J. W. Barnes, Ltd., Rock Ferry, has introduced an electrically driven scarfing machine which is particularly useful for cutting propeller shaft keyways, scarfing boiler and ship plates, and for other jobs where the machine must go to the work. A forging furnace heated on the regenerative principle has been introduced by the Davis Furnace Co., of Luton. The normal working temperature of 1300 degrees C. is attained from cold in fifty minutes, and eight ¾-inch bars can be brought to welding heat every minute.

Building a Permanent Organization

By WILLIAM H. McGREGOR, President, National Twist Drill & Tool Co., Detroit, Mich.

The harmonious relations existing at the plant of the National Twist Drill & Tool Co., in Detroit, Mich., are of such interest at this time when labor problems are attracting the attention of the entire industrial world, that MACHINERY has requested the president of the company, William H. McGregor, to prepare, for the benefit of the readers, an outline of the methods employed for furthering friendly relations between employer and employes, and for the building up of a permanent organization to which the men and women employed would have a greater attachment than that produced by mere employment in a manufacturing plant.

IN the building of a permanent organization in which the various members will work harmoniously with each other and in which they will give their best efforts to the furtherance of the interests of the firm for which they are working, it is necessary to provide some means whereby those men and women upon whose efforts the results mainly depend, or whose loyalty has become an actual asset to the company, may acquire a definite financial interest in the concern. Steps were therefore taken by the National Twist Drill & Tool Co. with a view to permitting the men and women occupying responsible positions in the office or factory, to acquire stock in the company at a price less than the prevailing market price and upon terms of payment making it possible for them to become partners in the enterprise, by extending the payments over a period of years. In view of the fact that the stock is sold at less than market price, the buyer does not take title to it until five years have elapsed from the date of sale, and at that time, if he is still in the employ of the company, he becomes the absolute owner of the stock, all dividends that have become due in the meantime having been credited to his account. At the present time about thirty-five of the men and women in the company's employ who either hold responsible positions, or, who by length of service and loyalty have made themselves deserving of special consideration, have become stockholders of the company in this manner. It is intended gradually to extend this plan still further so that a constantly increasing number of employes may become financially interested in the company.

Promotions within the Organization

The company has about 800 employes of which about 200 are women. As the stock-owning proposition cannot apply to all of these, the company has endeavored to gain their loyalty and cooperation by such means as will insure everyone of the fairness and good faith of the employer. One of the effective means of doing this has been to promote to better positions from within the organization whenever possible. The office and the factory are treated alike. They are both placed under the same manager, and there is no well defined line between the two such as is found in many industrial organizations. It has been the policy of the company to promote girls from the factory to office positions whenever they have proved capable of performing work of the kind required. The general procedure is to first promote the girls from the factory to the factory office, and then from the factory office to the main or sales office.

This does not apply to women employes only, but applies to the whole working force. Every office employe begins his career in the factory, and young men are carefully selected to learn their trade in the shop with the idea that they ultimately may occupy executive positions within the organization. An effort is made for this purpose to obtain bright young men of high-school or college education, and place them for a couple of years in the factory. Their abilities and inclinations are then watched, and as the opportunity presents itself, they are promoted to positions for which they prove themselves fitted. Every executive now in the organization has reached his present position in this manner, which insures that everyone is thoroughly familiar with the work of the whole organization, and a homogeneous working force that can cooperate intelligently, is the result. It is also easy, in this manner, to place every man in a position that is exactly right for him. He is not hired from the outside to fill a certain job for which he may prove unsuited and from which it may be difficult to transfer him; but he is gradually brought into the position for which he is best fitted in the organization by a thorough study of his natural bent and capacity.

The Problem of Woman Labor

The employment of women has been considered a difficult problem in many factories. This is largely because the matter is not approached in the right manner. The National Twist Drill & Tool Co. has had no difficulty along these lines. On the contrary, this company has found the employment of the right kind of women an asset. A special effort has been made to take care of the welfare and comfort of the women employed, and a matron is provided who acts as an advisory counsel to the girls and who aids them in all matters that they care to bring to her attention. She looks after their interests in many ways and often acts as an intermediary in cases of differences between the girls and their foremen. A special effort is made to obtain a high grade of women for the factory. The method generally followed is to obtain new employes through present employes who have made a good record for themselves. A high-grade girl already employed is not likely to recommend another girl for employment, unless she is of her own standard, and in this way a high-class working force has been acquired. By the employment of a high grade of women, it is also possible to obtain a better class of men in the shop, and the men soon learn to act as gentlemen in all their relations with the women employed. There have been many cases of marriage between employes, and, as a rule, the man remains permanently with the concern, as both he and his wife have a more definite interest in the firm than they would have if he had married a girl who knew nothing about the place where he was working.

The Foreign-born Worker

During and since the war, the problem of the foreign-born worker has been given more attention than formerly. As a matter of fact, the foreign-born worker does not present any serious problem, provided the matter is properly handled. It has not been found advisable to place foreign-born men as foremen over departments where the majority of the men or women would be of their own nationality. This is a principle generally appreciated in the industries, as it has always been found unsatisfactory to have a department composed nearly or entirely of one nationality. It is much better to have various nationalities mixed; this avoids clannishness and promotes Americanization.

A definite effort is made to encourage all foreign-born workers to become American citizens. The public schools of Detroit maintain excellent evening schools in which the foreign-born worker may acquire a good knowledge of the English language, and a similar school is also maintained by the Y. M. C. A. The foreign-born workers who have not ac-

quired a knowledge of the English language are encouraged to attend these schools. Men of their own nationality, who are already citizens, are also selected in various departments to coach these men both as regards Americanization in general and citizenship. The employment bureau furnishes all information required by the men with regard to obtaining citizenship papers, and the men are paid for time lost in attending to naturalization.

Another feature which greatly encourages the foreign-born worker to become an American citizen is that the company maintains a group insurance for its employes, but this insurance applies only to American citizens. Any man in the company's employ, who is an American citizen, is automatically insured after six months of service for $500, this insurance increasing gradually up to $1000 after five years of service. In addition to the insurance feature, the firm allows men of good standing to borrow from the company on their insurance policies, in case of urgent need. This privilege is especially extended in cases of elderly men or employes who have been long in the company's service, when through misfortune they may happen to be in urgent need of money.

Providing for the Health and Welfare of the Workers

In order to provide for the health of the workers, the company maintains a shop hospital which is visited by a doctor one hour in the morning each day, and which is in charge of a nurse at all times. As the doctor in charge maintains an office but one block away from the factory, he is within call at practically all times, and the men and women employed receive, in this manner, all ordinary medical attendance free of charge, and all injuries are treated immediately and are properly cared for.

The company also maintains a restaurant where the noonday meal is served at the actual wholesale cost of the food alone. In this manner, meals can be served at less than one-half the price that the ordinary restaurant would have to charge. The price charged for meals naturally has to be set at a figure that will provide for a small margin, so as to prevent any direct loss, but the surplus that is created is converted into a sickness fund for the women employes.

A savings arrangement has also been put into effect by means of which any woman employe who puts into the saving fund a specified amount per week, will have this amount doubled by the company, provided she keeps up the saving for fifty consecutive weeks. Punctuality and regularity of attendance is encouraged in the case of women employes by the payment of 10 per cent of their wages additional weekly, provided they have a perfect punctuality and attendance record. Absence of one hour per week is allowed under this rule, and in certain cases exceptions are also made for sickness.

The company owns a number of individual houses as well as apartment houses, and as the factory is located in a residential district, these houses are within easy reach of the factory. These houses and apartments are rented to employes, and at the present time, with the great scarcity of houses in Detroit as elsewhere, this feature is of great importance in taking care of the interests of the workers.

General Methods of Management

The general management of the factory is in the hands of a committee of five men, of which Howard L. McGregor, assistant to the president, is chairman. Mr. McGregor is also in general charge of both office and factory, it having already been pointed out that both of these branches of the organization are in charge of the same man. The management committee, in addition, consists of the production manager, the chief engineer, the mechanical manager, and one department foreman. If any man in the shop has any grievance, he takes it up directly with the chairman of this committee, and the committee, in turn, investigates the matter and endeavors to settle it to the satisfaction of all concerned, making the reasons for their decisions clear, and endeavoring to have everybody understand their viewpoint.

A special effort is made to prevent men who are properly filling their positions from leaving the organization. If a man gives notice that he expects to change his job, he is not told to obtain his pay from the pay-master, but instead the assistant to the president has a talk with him to find out definitely the reasons for his wanting to leave, and if the matter can be so arranged that it will be satisfactory for the man to remain, every reasonable effort is made to meet his wishes. It is recognized that a satisfactory employe who has been with the company for some time is an asset, and that it is worth while retaining his services and good will. Too few manufacturers, in general, recognize this, and they seem to consider the number of men on the payroll rather than their qualifications and training. The cost of hiring and training new men constitutes a great waste in American industries, and the value of the asset of a permanent working force is not as thoroughly appreciated as it ought to be. By the methods outlined above, it has been possible for the National Twist Drill & Tool Co. to build up an organization of executives and employes that work together in a harmonious manner and whose loyalty to the company is best evidenced by the number of years that many of them have been in its service.

* * *

PAPER REPORT OF SENATE COMMITTEE

Readers in the mechanical field will be interested in the striking report and recommendations of the Senate Subcommittee which has been investigating the vitally important subject of paper. MACHINERY is paying more than a 300 per cent increase in the price of the paper it uses and an even higher percentage for book papers; and is warned that paper prices are going still higher. The searching investigation of the Senate Committee showed that while there is a scarcity of the wood pulp which forms the basis of paper manufacture, there has been and still is heavy profiteering in the paper market. Workers in every field are vitally interested in the cost and supply of paper—the medium of the printed word.

Paper manufacturers are accused by the committee of "unjust, illegal, and discriminatory practices," and present prices for newsprint paper are held to be "excessive and unwarranted." The recommendations for remedying this situation include provision for the small publishers to obtain paper from the mills at a minimum cost, placing print paper under the restrictions of the Lever food control act, and establishing an experimental fund for the discovery of a substitute for wood in the manufacture of pulp. The committee took into consideration the various disturbing elements that the newspaper industry has been subjected to during war-time and the subsequent period of rising material and labor costs, as well as the increased consumption of print paper, the apparent scarcity of wood pulp, and other unstabilizing factors common to all lines of business at the present time. Notwithstanding these conditions, the evidence indicated that "the scarcity of the product was more the result of artificial obstructions than of natural laws." This is a matter of importance to everyone, because of the universal dependence upon periodicals and books for supplying news and information which is so essential to national development.

* * *

The Carnegie Steel Co. has offered to aid its employes in acquiring homes by selling them homes owned by the company, with an initial payment of 15 per cent of the purchase price and the remainder in monthly installments over a period of ten years, interest on deferred payments to be paid at the rate of 5 per cent per year; or by purchasing homes for employes from private owners; or by building them homes directly; or by a mortgage plan, the loan not to exceed 75 per cent of the property cost and to be payable over a period of ten years with interest at 5 per cent.

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INCREASED USE OF DIE-CASTINGS

The high cost of labor is one reason for the increasing use of die-castings in mechanical devices where the strength and wearing qualities of the metals that can be die-cast are satisfactory. Manufacturers who formerly employed parts machined from steel find it necessary to use die-castings to avoid the labor cost of machining. In this respect the die-casting process occupies a somewhat similar place in the machine industry to that of the automatic machine.

To produce die-castings accurately requires intricate dies and complicated machinery, and in the diemaking and the building of this machinery highly skilled and high-priced labor is employed; but when the dies and the machines are once made, thousands of duplicate parts can be produced at a small labor cost. Conditions affecting the use of the automatic screw machine are similar. The machine is expensive and the tools must be produced by skilled and high-priced labor, but when the machine is once set up for the production of any part in quantity, it will continue to produce that part by thousands and tens of thousands with a minimum of attendance and at a very low labor cost.

Rising labor costs continually force the manufacturer and the engineer to devise new means for producing cheaply and with a minimum amount of manual labor. It is nothing new to say that the high development of the machine-building industries in the United States has been due largely to the high wages paid here, which forced the introduction of labor-saving and automatic machinery. The process of development is still going on, and a large new field has been opened up through the introduction of die-casting. If this new art were unknown, many of the instruments and mechanisms now so commonly used, such as speedometers and phonographs, would be much higher in price and would not be manufactured and used to the extent that they now are.

* * *

BUILDING VERSUS MANUFACTURING MACHINERY

When machines are produced one at a time, the parts for each machine being fitted together individually, we say that they are "built." When they are made in quantities, the parts all being interchangeable and every part exactly like every other corresponding part, they are "manufactured." This distinction was brought out by Henry M. Leland in a recent statement on the making of automobile engines in Germany and here in 1913. At that time, in a large German automobile factory where automobiles were "built," fifteen engines a day were assembled in a department four times as large as the assembling department of a certain Detroit automobile factory, and employing five times as many men as the latter. In the Detroit factory one hundred engines a day of the same type and general quality were assembled.

The difference was simply one of method. In the Detroit factory all the parts were made alike on an interchangeable basis and carefully inspected before they entered the assembling room to insure their interchangeability. In the German factory the parts, not being made on the interchangeable basis, were not exactly alike, and in assembling the engines had to be fitted together, with great waste of labor.

But this is not the whole story: If a part breaks in the engine that has been fitted, another part cannot be bought with the certainty that it will fit accurately into the place it is intended for. It will be necessary to employ a mechanic to put it in place, as a certain amount of fitting must be done. When a part breaks on a car made on the interchangeable basis, another part can be bought that will fit right into its place. And it costs less to manufacture on the interchangeable basis, because the additional cost of making all parts alike is negligible with the latest manufacturing methods, while the cost of assembling, if the parts are not interchangeable, may easily be several hundred per cent more.

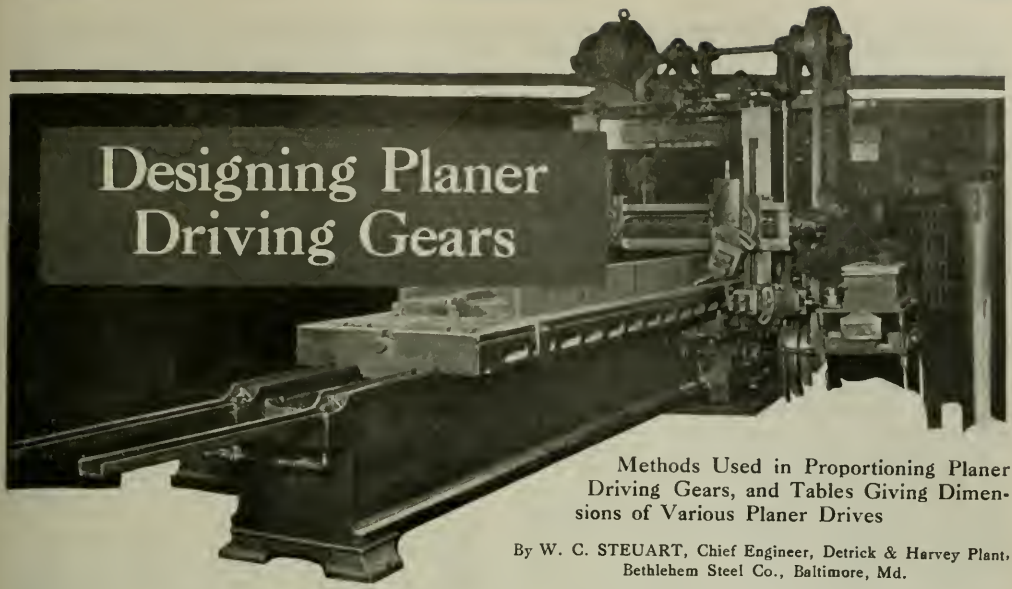
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POWER PRESS CASUALTIES

Although much has been done to prevent accidents caused by the power press, it still remains the most dangerous machine in the metal-working trades, according to a statement made by August L. Kaems of the Industrial Commission of Wisconsin in a paper read before the Eighth Annual Safety Congress. The accidents caused by power presses are not only more frequent, but are also more serious than those resulting from the operation of other machine tools. In the state of Wisconsin, in one year, 27 per cent of all the accidents in the metal trades, and 48 per cent of all the serious accidents resulting in permanent disability were caused by power presses. This would indicate that while the campaign for safeguarding machines in metal-working plants has been effective in many directions, many safeguards must still be provided for the most dangerous machines.

It was stated in the paper referred to that in one plant alone thirteen fingers had been lost during a perlod of six months; and what is more significant, the general superintendent of the plant did not know that this number of accidents had taken place. The plant had a "welfare man" who saw that the injured men received proper medical treatment and who also took care that the compensation required by law was paid. It is evident, however, that there is something lacking in the safety system of a plant when the general superintendent can remain ignorant of so many serious accidents. Suppose that instead of thirteen fingers having been lost, material had been spoiled in the process of manufacture, amounting in dollars and cents, to as much as the compensation paid to the victims of the accidents. In that case, doubtless, a report would have been made to the superintendent and an investigation held to determine how from $5000 to $6000 worth of material had been wasted.

The interest in the campaign for safety in the industries must not be permitted to lag for, while accidents have been cut down considerably during the past ten years, there is still room for improvement.



Designing Planer Driving Gears

Methods Used in Proportioning Planer Driving Gears, and Tables Giving Dimensions of Various Planer Drives

By W. C. STEUART, Chief Engineer, Detrick & Harvey Plant, Bethlehem Steel Co., Baltimore, Md.

THERE are at present no standard rules for calculating the strength of gears used in transmitting power to the table of a planer, and until someone evolves formulas for determining the strength of heavy slow-running gears, it will be necessary, when designing planer drives, to rely upon the experiences of the leading machine tool builders who manufacture machines of this type. While the Lewis spur gear formula is excellent for gears running at medium or high speeds, it cannot be used in calculating the proportions of gears running at from about 25 revolutions per minute down to a fraction of a revolution. If an attempt were made to proportion the bull gear of a planer, transmitting 100 horsepower at a peripheral speed of 18 feet per minute, by means of this formula, it would be found that the gear would be much too large for the machine. The purpose of this article is to give an idea of the size of the gears required to drive a given size of planer, to point out the difficulties encountered in proportioning the gears so as to obtain the proper ratio of speeds, and to explain the general principles involved in the design of these gears.

One point that is often a stumbling block to the inexperienced designer is the fact that the size of the bull gear has no influence on the speed of the table or on the ratios of the other gears. A little study will show that the speed of the table is identical with the velocity of the bull pinion at the pitch circle, and as far as the speed of the table is concerned, the bull gear acts only as an idler gear. There are two factors that determine the size of the bull gear: First, it must be large enough so that the centers of all the other gears will be sufficiently low in the bed to make the teeth of these gears clear the under side of the table. Second, it must also be large enough so that the gear mounted on the same shaft as the bull pinion will clear the hub of the bull gear. The power that can be transmitted by the slowest running portion of the drive depends upon the strength of the bull pinion which, by reason of its small number of teeth, is weaker than the rack unless, as is frequently the case, the rack is made of cast iron and the pinion of steel. A common practice is to make all of the pinions steel forgings, the bull gear a steel casting, the other large gears of a high grade of cast iron or semi-steel, and the table rack of a high grade of cast iron. Forge, frog and switch, and other shops where heavy cuts are taken usually specify that all parts of the gear must be steel castings or steel forgings, and it is probable that in the near future all planers will be built in that way. The most satisfactory method to employ when these specifications are given is to make the table rack and the pinions steel forgings, and the large gears steel castings.

Determining the Proper Speed of the Table on the Cutting and Return Strokes

In designing a planer drive, the first thing to be considered is the cutting speed or speeds. In the case of a special machine, these may be determined by the customer. However, when a standard line of machines is being developed the best method is to so fix the ratio of the gearing that when a standard reversible planer motor is connected to the driving shaft, a fair average cutting speed will be obtained for ordinary work on iron castings. These motors usually run at from 250 to 500 revolutions per minute on the cutting stroke and from 500 to 1000 revolutions per minute on the return stroke. Thus, in order to obtain the average or standard cutting speed, the speed of the planer driving shaft should be about 375 revolutions per minute, which is a very good speed for a belt-driven machine. Just what the standard speed of the table should be depends upon the weight of the planer and the nature of the work for which the machine is designed. Planers used for taking light accurate cuts are run at higher speeds than heavy forge or frog and switch planers.

The general practice in the United States tends toward moderate speeds and heavy cuts, while in England light cuts and high speeds are favored. The English probably have the advantage of running their planers at a speed nearer the ideal for high-speed steels, and in addition consume less time on the return stroke, but there is great wear and tear upon the machine, due to the fast running and the excessive shock at the moment of table reversal. In order to reduce this shock, many English planers are equipped with spring buffers or shock absorbers which take up the momentum of the table at the instant of reversal. The American practice is less racking to the machine, and in spite of the slower speed used and the greater amount of time consumed in the return stroke, the amount of metal removed per hour is probably greater, due to the heavier cuts and the coarser feeds. Large planers are usually operated at slower speeds than small ones because of the greater weight of the moving parts. It should be understood, however, that the momentum is produced largely by the rotating parts, such as the gears, pulleys, and motor armature, and not by the table and its load.

Manufacturers of planers differ in their ideas concerning the correct average cutting speed for a planer of a given size, but in the opinion of the writer this should be as given in Table 1. These figures are intended for fairly heavy planers having but one speed and doing the usual class of work that is handled in a machine shop. It is necessary for the designer when planning a standard line of planers to establish standard speeds to be used on belt-driven machines.

As previously mentioned, the ratio of the total range of speeds on direct-connected reversible motors is 4 to 1, so that if a planer has a minimum cutting speed of 20 feet per minute, the maximum cutting speed will be 40 feet per minute, and the return speeds will range from 40 to 80 feet per minute. The cutting and return speeds may be varied through independent rheostats so that any cutting speed may be used in combination with any return speed. The cutting speed may be varied to suit the toughness of the material, and the return speed may be adapted to the load on the planer table. On planers of the open side type, there is more need for varying the return speed because the heavy overhanging loads that are frequently put on the table of these planers, are likely to cause a certain amount of whip if the table is reversed at high speed, and this results in a considerable strain on the machine. Therefore in designing belt-driven single-speed machines of this type it is well to make the return speeds somewhat less than those of standard planers.

Planers often Operated far below their Capacity

Many operators do not take nearly the size of cut that their planer has capacity for, and this is especially true in the case of planers of the open side type. It is astonishing to go into some shops and see the nibbling trifling cuts being taken on machines of the latest design. In fact a trip to a frog and switch shop would be a revelation to some shop men. Of course, frog and switch planers are usually run with little regard to the effect of the excessive strain on the accuracy of the machine. The average modern frog and switch planer of 36- or 42-inch capacity is about as heavy as the average 60- or 72-inch planer of standard design and consequently more rigid owing to its smaller span. The writer has seen a 36-inch frog and switch planer provided with a tool 3 inches square, having practically no cutting rake and very little clearance, cut a tough steel rail the full width of the head. This cut was 3 inches wide and ⅛ inch deep, and the chip was torn rather than cut from the work. The ammeter showed that the machine took about 105 horsepower; of course, no ordinary planer is capable of taking such a cut.

TABLE 1. AVERAGE CUTTING AND RETURN SPEEDS FOR VARIOUS SIZES OF PLANERS

Size of Planer, Inches	Cutting Speed, Feet per Minute	Return Speed, Feet per Minute
30 by 30	45	90
42 by 42	40	85
48 by 48	35	80
54 by 54	35	75
60 by 60	30	75
72 by 72	30	70

Machinery

The foremen of shops handling heavy work should ascertain the capacity of their planers to rough-finish castings or forgings having a large amount of metal to be removed. On heavy cast-iron work cuts ½ inch deep can frequently be safely increased to 1¼ inches deep with a feed of from 3/16 to ¼ inch.

Dimensions of Planer Drives

The pitch of the table driving rack is the first problem to be solved when proportioning the gears of a planer drive. It has already been stated that the Lewis formula should not be used in figuring gears having a peripheral speed of 25 feet per minute or less, and so it becomes necessary to rely upon the experiences of various machine tool builders when determining the sizes of the rack. Table 2 gives the dimensions of racks for various sizes of planers. These dimensions do not agree exactly with some of those given in Tables 3 and 4, but represent a more ideal arrangement and are in slightly better progression. Such an ideal progression in sizes is generally only found where an entire line of machines is designed at the same time, and not always even then.

Tables 3 and 4 give the dimensions of the table drive gearing on machines that have been built and are performing work of the heaviest sort. A designer need not hesitate to adopt these proportions, as the machines have stood the test of time and service. Table 3 gives the dimensions for planers 42, 48, 54, and 60 inches in width, all of the gears being of the spur type. The dimensions given in Table 4 are for planers 72, 84, and 96 inches in width, the driving pinion and gear on these machines being of the herringbone type. It will be noted that in the illustration presented in connection with Table 4 the various mating gears are not shown in mesh. Nevertheless, the distances given between the centers of the various gears are the actual center distances.

TABLE 2. DIMENSIONS OF PLANER RACK TEETH

Size of Planer, Inches	Rack Dimensions, Inches		Size of Planer, Inches	Rack Dimensions, Inches	
	Circular Pitch	Width of Face		Circular Pitch	Width of Face
30	1	4½	60	2	9
36	1¼	5	72	2¼	11
42	1½	6	84	2½	13
48	1¾	7	96	3	15

Machinery

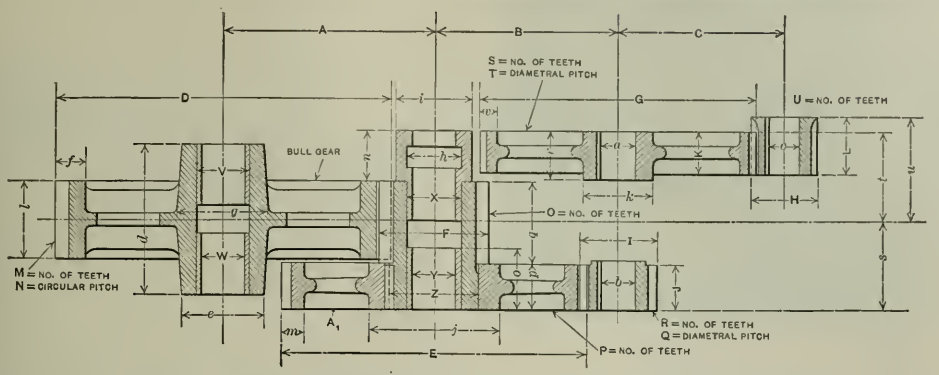
While the dimensions given in these tables are for machines rather heavier than the average, the trend is constantly toward heavier machines, and the designer who is developing a new line of planers will do well if he adheres to the sizes given.

Advantages of Using Same Gearing on Several Machines

For manufacturing reasons, it is often found desirable to use the same gearing on two or more sizes of planers. For example, it will be noticed that in the 48-, 54-, and 60-inch planers in Table 3, the respective gears all have the same pitch and number of teeth, but differ with respect to the width of the face. This system gives the same distances between the gear centers on all three of the machines and permits the use of the same jigs in boring the shaft holes in the planer beds. The 72-and 84-inch planers in Table 4 are provided with identical gearing. This gearing was originally designed for a very heavy frog and switch planer but was later applied to a 72-inch machine and finally was considered heavy enough for an 84-inch planer when a machine of that size was being developed. This is a question that must be decided by the individual shop. The reduction of the number of unlike parts on several machines undoubtedly lowers manufacturing costs.

The customer often feels that he is not getting a square deal when he purchases the larger of the two machines built on this principle, because he does not get a larger drive when paying for a larger machine. But if the drive is sufficiently large for the machine he is certainly not being cheated and he reaps the benefit of the decreased building cost in the decreased selling price. If a line of machines is built on this principle, it is more likely that repair parts will be on hand for less popular sizes of machines, which likewise benefits the customer. There is, of course, the argument that each part should be proportioned exactly according to its load so as not to be one pound heavier than necessary, but to offset this are the advantages already mentioned.

TABLE 3. DIMENSIONS OF TABLE DRIVE GEARING ON 42-, 48-, 54-, AND 60-INCH PLANERS



Planer Size, Inches	A	B	C	D	E	F	G	H	I
42	15.518	13.333	11.875	24.828	22.333	8.117	20	4.75	5.667
48	17.546	16.2	14.5	28.409	27.2	8.912	24.667	5.667	6.8
54	17.546	16.2	14.5	28.409	27.2	8.912	24.667	5.667	6.8
60	17.546	16.2	14.5	28.409	27.2	8.912	24.667	5.667	6.8

Planer Size, Inches	J	K	L	M	N	O	P	Q	R	S	T	U	V
42	3⅜	3	4⅛	50	1½	15	65	3	15	78	4	17	3 15/16
48	4½	4	6	49	1¾	14	66	2½	15	72	3	15	4½
54	6	5	7	49	1¾	14	66	2½	15	72	3	15	4½
60	6	5	7	49	1¾	14	66	2½	15	72	3	15	4½

Planer Size, Inches	W	X	Y	Z	a	b	c	d	e	f	g	h	i
42	3 3/16	3 15/16	3 3/16	6½	2 9/16	2 7/16	2 3/16	11	6	2¼	6¾	4	5½
48	3¾	4½	3¾	7	3 1/16	2 15/16	2 7/16	14	6¾	2⅝	7½	4½	6
54	3¾	4½	3¾	7	3 1/16	2 15/16	2 7/16	18¾	6¾	2⅝	7½	4½	6
60	3¾	4½	3¾	7	3 1/16	2 15/16	2 7/16	18¾	6¾	2⅝	7½	4½	6

Planer Size, Inches	j	k	l	m	n	o	p	q	r	s	t	u	v
42	9½	5	5¾	1⅝	3⅝	4½	3⅜	6	3½	6½	6½	7⅝	1⅛
48	10½	6	7	1⅞	5	5¾	4½	7¼	5	8¼	8½	10½	1⅝
54	10½	6	8	1⅞	6⅛	7	6	8¾	5¾	10¾	10⅛	12⅛	1⅝
60	10½	6	9	1⅞	6⅛	7	6	9¼	5¾	10¾	10⅝	12⅝	1⅝

Machinery

Designing the Bull Pinion of a Planer Drive

In order to illustrate the methods to be followed in designing the driving gears of a planer, assume that it is desired to design these gears for a 42-inch machine. By referring to Table 2, the circular pitch of the rack on a 42-inch planer will be found to be 1½ inches. Next assume that it has been determined that the bull pinion shaft should not be less than 3 3/16 inches in diameter, and as the pinion runs loose on this shaft, the outside diameter of the pinion bushing should be about 3 15/16 inches. If these dimensions are laid out to scale, it will be found that the bull pinion should not have less than 15 teeth in order to have a thickness of metal between the bottom of the teeth and the bore, about equal to the depth of the teeth. Thus if the bull pinion has 15 teeth of 1½ inch circular pitch, the pitch circumference will be 22½ inches, and consequently for every revolution of the bull pinion the platen will move 22½ inches. By referring to Table 1, it will be found that the average cutting speed of a 42-inch planer is 40 feet per minute, and from this the total ratio of the gearing must be determined. Suppose that the planer should have cutting speeds of from 24 to 48 feet per minute when driven by a direct-connected reversible motor. If the motor runs at from 250 to 500 revolutions per minute on the cutting stroke, the speed of the pulley shaft of a belt-driven machine can be found by the following proportion: $A : B :: C : D$, in which A equals the minimum cutting speed of the planer table in feet per minute; B equals the minimum number of revolutions per minute of the motor; C equals the average cutting speed of the planer in feet per minute; and D equals the number of revolutions per minute of the driving pulley on a belt-driven machine.

Substituting in the proportion, the values given in the example, we have:

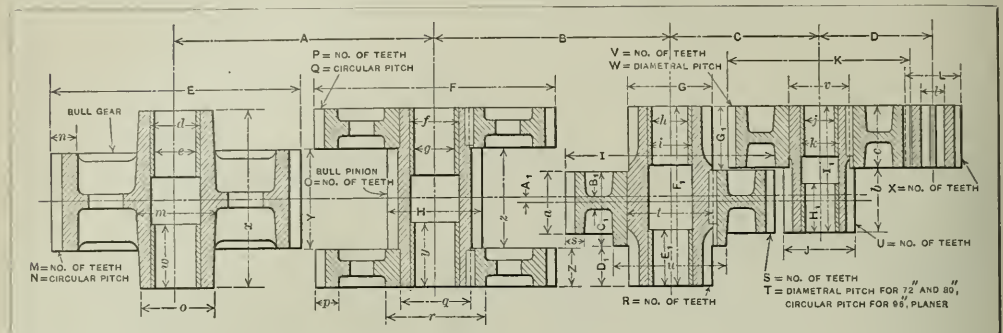
$$24 : 250 :: 40 : D$$

and

$$D = 416 \text{ revolutions per minute}$$

As the table will move 22½ inches or 1.87 feet per revolution of the bull pinion, the necessary revolutions per minute of the bull pinion can be determined by dividing the average cutting speed of the table per minute by the distance that the table is moved in one revolution of the bull pinion. Thus, $40 \div 1.87 = 21.4$ revolutions per minute, the speed of the bull pinion. After the number of revolutions per minute of the bull pinion has been ascertained, the ratio of the entire

TABLE 4. DIMENSIONS OF TABLE DRIVE GEARING ON 72-, 84-, AND 96-INCH PLANERS



Planer Size, Inches	A	B	C	D	E	F	G	H
72	19.735	18.383	15.75	13.333	30.558	28.966	10.027	11.459
84	19.735	18.383	15.75	13.333	30.558	28.966	10.027	11.459
96	24.351	22.599	18.104	15.4	37.242	36.923	10.822	15.279

Planer Size, Inches	I	J	K	L	M	N	O	P	Q
72	25	8.5	21.2	6.534	46	2	16	50	1¾
84	25	8.5	21.2	6.534	46	2	16	50	1¾
96	28.966	9.469	25.040	7.040	37	3	14	56	2

Planer Size, Inches	R	S	T	U	V	W	X	Y	Z	a	b
72	16	48	2	15	62	3	18	12	4¾	7½	7¾
84	16	48	2	15	62	3	18	12	4¾	7½	7¾
96	15	50	1¾	15	61	2½	16	14	5½	9½	10¾

Planer Size, Inches	c	d	e	f	g	h	i	j	k	l	m
72	7½	6	5¼	6	5¼	4¾	5¼	3 15/16	4 7/16	2 15/16	10
84	7½	6	5¼	6	5¼	4¾	5¼	3 15/16	4 7/16	2 15/16	10
96	7½	7¼	6¼	7¼	6¼	4¾	5½	4½	5	3 7/16	11½

Planer Size, Inches	n	o	p	q	r	s	t	u	v	w	x
72	2⅞	9	2⅝	8½	12	2¼	10¼	13½	7¼	8	21¾
84	2⅞	9	2⅝	8½	12	2¼	10¼	13½	7¼	8	21¾
96	4	11½	3	11	17	2¾	11	17	9¼	8¾	27

Planer Size, Inches	y	z	A_1	B_1	C_1	D_1	E_1	F_1	G_1	H_1	I_1
72	8	12¼	⅝	1½	9	5	7	21¾	7¾	6	15¼
84	8	12¼	⅝	1½	9	5	7	21¾	7¾	6	15¼
96	8¾	16	0	2	9½	8¾	8¾	27	8¾	6	18¼

Machinery

gearing can be found by dividing the revolutions per minute of the driving shaft by the revolutions per minute of the bull pinion. Thus 416 ÷ 21.4 = 19.4, or the ratio of the entire gearing. If the drive is to be of the same design as that shown in the illustration in Table 3, the next step is to divide the ratio between the two pairs of gears connecting the bull pinion shaft with the driving shaft.

Designing the Reduction Gears and Driving Pinion of a Planer Drive

If the bull gear is drawn to scale in mesh with the bull pinion, it will be found that the largest gear which can be put on the hub of the bull pinion cannot be much larger than 22 inches in pitch diameter or about 67 inches in pitch circumference. If the gear is larger than this, it will interfere with the hub of the bull gear. As 67 inches equals 5.6 feet, the velocity of a gear of this size at the pitch circle would be equal to 5.6 × 21.4 = 119.8 feet per minute. The ratio between the peripheral speed of this gear and that of the bull pinion is as 120 : 40 or as 3 : 1. Therefore, the teeth on gear A_1 in the illustration shown in Table 3 need only be one-third as strong as those of the bull pinion. This table gives the face width of the bull gear on a 42-inch planer as 5¾ inches, and that of gear A_1 as 3⅜ inches. The circular pitch of gear A_1 can then be found from the following equation:

$$P = \frac{A \times B}{C \times D}$$

in which

A = circular pitch of the bull pinion in inches;
B = width of the bull pinion face in inches;
C = width of face of gear A_1, in inches;
D = ratio between the peripheral speeds of the two gears;
P = circular pitch of gear A_1 in inches.

Thus

$$P = \frac{1.5 \times 5.75}{3.375 \times 3} = 0.85 \text{ inch}$$

Therefore, a gear of 3 diametral pitch will be amply large. A gear of this pitch, 22 inches in diameter, would have 66 teeth, but as gear A_1 on the planer of which the dimensions are given in Table 3, had 65 teeth, assume that a gear of this size is to be used.

The next step is to see how small a pinion can be meshed with this gear. If the diameter of the shaft on which the pinion is to be placed is 2 7/16 inches in diameter, as given for the 42-inch planer in Table 3, and due allowance is made for the key, a pinion having at least 15 teeth must be used. The ratio between gear A_1 and its pinion is then as 65 : 15 or as 4.33 : 1. It is now only necessary to find the ratio of the driving pinion and its mating gear.

It was previously determined that the ratio of the total gearing is as 19.4 : 1, and as the ratio between gear A_1 and its pinion is as 4.33 : 1, the ratio between gear B_1 and the driving pinion must be equal to 19.4 ÷ 4.3 = 4.5. If a layout has been developed to this point, it will be found that the largest gear that will clear the oil-cellared bushing that projects from the bull pinion will be 20½ inches outside diameter. The pitch of the driving pinion, then, should be about 4 diametral pitch. A gear of this diametral pitch having 80 teeth would have a pitch diameter of 20 inches and an outside diameter of 20½ inches. Assume that a gear having 78 teeth is selected; then in order to find the number of teeth in the driving pinion, divide the number of teeth in gear B_1 by the ratio between this gear and the pinion or 78 ÷ 4.5 = 17.3. The driving pinion will therefore have 17 teeth.

In order to calculate the actual cutting speed of the table in feet per minute obtained with this gearing, it is only necessary to multiply the speed of the driving shaft in revolutions per minute by the ratios of the two sets of reduction gears and by the velocity of the bull pinion at the pitch circle in feet per minute. Thus

$$\frac{416 \times 17 \times 15 \times 1.87}{78 \times 65} = 39.1 \text{ feet per minute}$$

Distinguishing Features of Various Planers

The proper relation between the cutting and return speeds is obtained by means of the driving pulley ratios. It is not the purpose to deal with this phase of the subject in this article. However, it is not out of place to warn the designer of two things: First, that the belt speeds should not greatly exceed 3000 feet per minute, as speeds in excess of this burn the belt because of the sudden reversal and consequent slippage. Second, that belts over 6 inches in width cannot be successfully shifted on a planer, so that where a 6-inch belt is inadequate, a four-belt drive should be employed, using two belts to produce the forward motion of the table and two for the return motion. The only alternative for this is a device employed some years ago by a leading planer builder, whereby the belts were alternately tightened and slackened by means of a pneumatically operated idler pulley.

The preceding methods may also be followed in designing any of the gear trains for the planers given in Table 4, the principle being the same. The chief differences between the heavier and lighter machines are that in the former herringbone gears are used in the first reduction; an additional pair of gears is necessary in order to obtain the desired reduction without making the gears excessively large; and, two pairs of gears are used in the last reduction in order to keep the gearing within the limits of the width of the planer bed. A little calculation will show that it is not only the slower speeds of the heavy planers that necessitate the increased reduction, but also the greater pitch circumference of the bull pinion due both to the larger shaft and the greater pitch required. The halftone illustration shows this type of drive on a very heavy frog and switch planer.

This particular machine is equipped with a unique oiling system. The metal of the bed extends under the gearing and forms an oil reservoir into which the larger gears dip, thus oiling the gear teeth and table rack as they rotate. This reservoir is connected to a smaller auxiliary settling tank, from which the oil is pumped, by means of a small electrically driven pump, through a strainer to the gear bearings and ways of the machine. The overflow from the bearings returns directly into the large tank, while the drippings from the rack and table ways are caught in extended pans at the end of the bed. These pans are fitted with felt wipers and coarse strainers, and the oil is returned by gravity through large pipes to the tanks. Each bearing and way has an independent stop-cock to regulate the flow of the lubricant as well as a pet-cock to serve as a telltale. In this way a constant oil circulation is kept up.



Driving Gears employed on a Heavy Frog and Switch Planer

* * *

FOREIGN CREDIT INSURANCE

Announcement has been made of the organization of a mutual company for the insurance of credits in foreign countries. The new company is to be known as the American Manufacturers' Foreign Credit Insurance Exchange. The purpose of this mutual exchange will be to supply that element in foreign trade that has heretofore been lacking—adequate information on the financial status of foreign merchants and a reasonable safeguard in individual business transactions. Being a company organized on reciprocal lines the insurance will be written at net cost, and not for profit. The organization of the American Manufacturers' Foreign Credit Insurance Exchange is the result of several years' search for ways and means to solve the problem of foreign credits. At the annual meeting of the Foreign Trade Council at Cincinnati three years ago, George R. Meyercord, first vice-president of the Illinois Manufacturers' Association, and president of the American Manufacturers' Foreign Credit Underwriters, presented a rough plan for the insurance of foreign credits. Since then the foreign trade committee of the Illinois Manufacturers' Association has been working on a flexible and effective plan to provide such a service to the American manufacturer. The result is that there has been formed by officials of the Illinois Manufacturers' Association, and with its approval and endorsement, the American Manufacturers' Foreign Credit Insurance Exchange, Chamber of Commerce Building, Chicago, Ill.

* * *

According to a report issued by the United States Bureau of Mines experiments conducted at Columbus, Ohio, by the use of 450 crucibles show that there are thirteen varieties of clay in the United States that are better bond clays for steel melting crucibles and two that are better for brass melting crucibles than Klingenberg clay formerly imported from Germany and believed to be indispensable.

Production Milling of Group Parts

Production Rates Obtained and Standard Fixtures Employed for Machining Groups of Parts of Similar Design by Straddle-milling

By GEORGE M. MEYNCKE, Sales Manager and Mechanical Engineer, Oesterlein Machine Co., Cincinnati, Ohio

THROUGH the joint activities of the Society of Automotive Engineers and the manufacturers of drop-forgings, a complete standardization of proportions has resulted in the design of automobile yokes, forks, and clevises. With few exceptions, these parts are drop-forgings, although in the tractor field malleable castings are frequently used. Enormous quantities of these fork-shaped parts are employed in the construction of automobiles, trucks, and tractors. A common application for the larger forgings of this general design is in the universal joint of an automobile. The most common example of the use of the medium-sized forging is in the tie-rod yokes that connect the front wheels of an automobile. The smaller forks are known as clevises, and range in size from those used on brake rods to the very small forks that are employed in the lever systems of carburetor and magneto control.

A good idea of the quantity of these parts regularly used may be gained from a report made by the sales promotion department of a machine tool manufacturer, which states that for pleasure cars alone the production schedule for 1920 calls for an output in the neighborhood of 80,000,000 forks, yokes, and clevises. This manufacturer builds a milling machine that is especially suitable for this class of work, so that an exhaustive study was given this particular group of forgings with the view of developing a fixture that would be of standard construction, with the exception of the holding jaws. These, of course, must be made to suit the particular size and shape of the forked forging being machined.

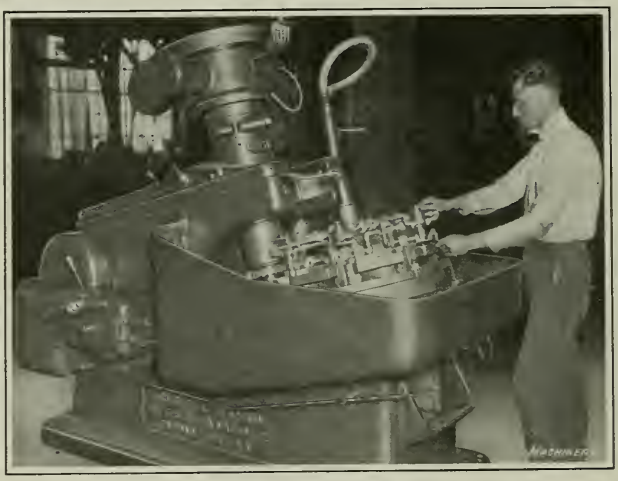


Fig. 1. Ohio Tilted Rotary Milling Machine equipped with Fixtures for straddle-milling Yokes

It appeared that by making the fixture a manufacturing rather than a tool-room proposition, a fixture would be developed which would be more highly efficient than the ordinary class of special fixtures. The fixture problem was complicated by the fact that some clevises are comparatively small, especially for handling on the type of machine produced by this machine tool concern. In other words, the operation of the machine is such that in order to work at full capacity, rapid handling of the parts is essential. As a means to this end, the application of compressed air for clamping purposes was adopted.

The type of machine on which it was planned to do the work was the Ohio tilted rotary milling machine, built by the Oesterlein Machine Co., which is shown in Fig. 1. This machine may be used as a continuous or as a station miller. For yoke, fork, and clevise milling, the station method is used—that is, there is a loading position for the operator from which the work-table indexes rapidly like a turret, and in due time arrives at the cutter position. During each indexing operation, the milling cutter is withdrawn radially and is automatically fed into the work as soon as the next automatic index motion has been completed. It was found that a higher output was obtainable when the machine was rigged up for station milling, using a quick indexing and a lower rate of feed, than could be obtained by continuous milling. It was also shown that only four work-holding stations were required to obtain an output greater than was possible with continuous milling. The type of fixture employed for the station method of milling is illustrated in Fig. 2, which also shows a tie-rod yoke in the work-holding jaws.

The operation of the machine is automatic, the operator's work consisting only of loading and unloading the fixtures. As previously stated, the cutters feed radially into the work, being carried in a reciprocating ram. The feed-cam *C*, Fig. 3, controls the traverse of the cutter, and is made to function as a double cam, thus providing positive return for the ram. The contour of the cam is designed to provide a quick return, a dwell while the table indexes to the next station, and a slow feeding rate. There may be one feed-cam for a group of parts, or it may be advantageous to have a cam for each sized part. If one feed-cam is used, the travel must be sufficient to mill the longest piece. The output and the rate of feed is the same for all parts on which the cam is used. By using a cam for each part, a finer feed for a given output is often obtainable, or a higher output may be secured at a given rate of feed. The function of the index cam *B* is to hold the table indexing mechanism in operation while the table is being indexed from one station to the next which, of course, in the present case is 90 degrees. At *D* in this illustration is shown the arbor and cutter gang in relation to the tie-rod yoke which it straddle-mills.

The design of the removable jaws may be seen at *A*. These jaws vary for each size or shape of yoke, the pair shown being die-sunk to accommodate the shape of the yokes. Smaller yokes are held two for each jaw, or "two-story" as it is called which, of course, requires twice as many cutters on the arbor. On clevises, the jaws are made with a central hinge in addition to being two-story high. These jaws hold four parts at each station. The production rate obtained when the fixture is equipped with jaws for holding one forging is 240 per hour; when using the two-story jaw, the rate is double, or 480 per hour; when four parts are held at a

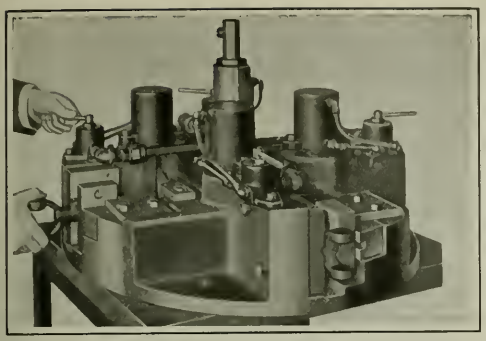


Fig. 2. Type of Fixture used for milling a Group or "Family" of Fork-shaped Automobile Parts

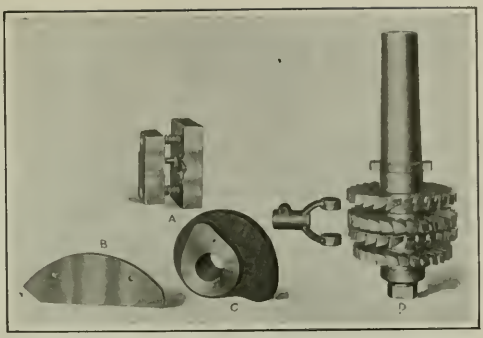


Fig. 3. (A) Jaws used on Special Fixtures. (B) and (C) Index and Feed-cams used on Machine. (D) Cutters mounted on Arbor

time at each station the output is 960 parts per hour. A higher degree of finish is obtained on the smaller yokes than on the large ones that are held one at each station, for since the timing is identical in both cases, (fifteen seconds per station) the feed is slower and the cam travel is much less.

Representative types of these forgings are shown in Figs. 4 and 5, which give an idea of some of the varieties encountered in this group or "family" of forgings. Those parts in the upper section of Fig. 4 are of the type held in the fixture singly; the four forgings at the left in the lower section are held two at each station, while the four remaining parts are held four at each station. Referring to Fig. 5, three groups of parts may be seen which are also applicable to the standard fixture, but require special jaws for each part. Of the four forgings shown in the lower left-hand corner of the illustration, the two smaller parts are rod ends and are produced at the rate of 960 per hour. The five parts shown in the right-hand side of the illustration are brake adjusting rods, the four parts in the upper left-hand corner are brake levers, and the two forgings in the lower left-hand corner are rod ends, all of which are produced at the rate of 480 per hour.

As previously stated, the jaws are pneumatically operated, the compressed air being piped to the air distributor at the center of the table, then through this distributor to the air valves, one of which is located at each operating station. Suitable pipe connections carry the air from the air valves to the cylinders in such a manner that when the piston is raised the work is released, and when it is lowered the work is clamped securely in position. The operation of the jaws is controlled by manipulating the air valve as shown in Fig. 2. An air pressure of 80 pounds per square inch is employed, and in connection with a system of multiplying levers, this produces the pressure necessary to hold the work rigidly.

GOVERNMENT BUREAUS AND FOREIGN COMMERCE

In view of the proposal to materially reduce the appropriation for the Bureau of Domestic and Foreign Commerce, the reasons why such a proposition was made should be placed on record. Inquiry from the Congressional Committee having this matter in hand indicates that it was not the intention to interfere with the facilities for the extension of foreign trade, but it was the desire of the committee to bring to the attention of Congress and the public the present waste of money resulting from duplication of effort.

The State Department has more than four hundred consular agents besides many special agents engaged in promoting our foreign trade. More than three-fourths of the commercial information received in this country comes through that source, sifted first through the State Department and then given to the Department of Commerce for the use of the public. The Department of Commerce, in its attempt to extend our foreign trade, has been sending its agents to the places where we already have consular agents. There is constant friction between these representatives, each contending that he is the one who should have entire supervision of the work immediately at hand, and the object of the Congressional Committee was to provide means whereby this work would be placed either all in the hands of the State Department or all in the hands of the Bureau of Foreign and Domestic Commerce.

Representatives of the State Department as well as representatives of the Department of Commerce examined by the Congressional Committee confirmed these facts in reference to duplication of effort, and agreed as to the necessity of unification of responsibility in one department or the other, but each contended that his department should be chosen.

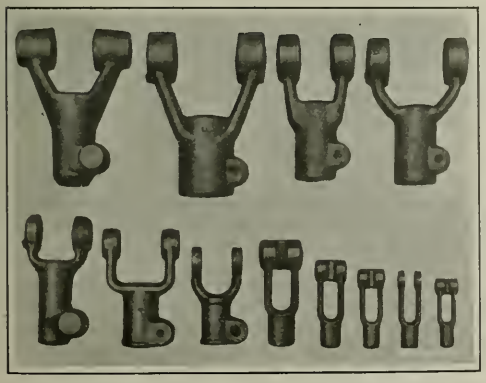


Fig. 4. Collection of Yokes, Forks, etc., of Various Sizes and Styles, machined on the Tilted Rotary Milling Machine

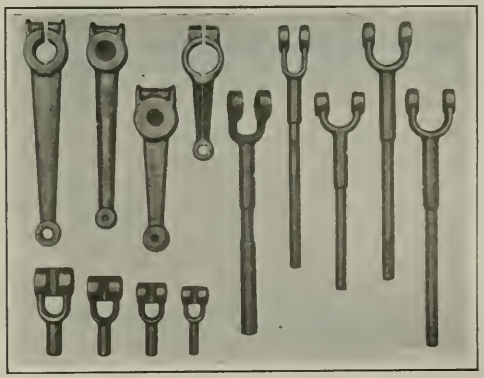


Fig. 5. Another Group of Forgings of the Yoke Type, such as may be handled conveniently by the Equipment shown in Fig. 2

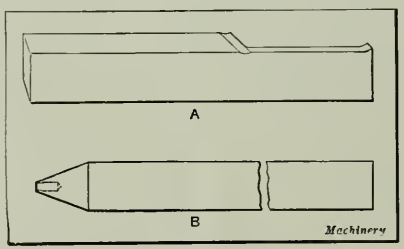
Wheel-truing Diamonds and their Settings

By EMIL GOOD

THERE are five different kinds of diamonds employed for truing grinding wheels, namely, Jaegers-Fontin, Ballas, black carbon, brown bort, and gray bort. The Jaegers-Fontin diamond is very hard and is the most brittle of all species. It is grayish in color, irregular in shape, and possesses a very coarse grain. It fractures easily, usually at the wearing point, which chips off in little pieces. It may be set firmly without difficulty on account of its rough surface, but it is in disfavor by the men using it, the claim being made that the wheel cannot be satisfactorily dressed on account of the rough surface of the stone. In addition to these disadvantages, it is also very expensive.

The Ballas type of diamond is a clear white stone, hard and brittle, but not to the same degree as the Jaegers-Fontin type. It is of a finer grain than the latter and generally gives more satisfactory results. The black diamond is soft but tough. It does not break but wears too quickly to be suitable for the purpose of truing grinding wheels. It is also very expensive.

Of the bort types, the brown stone has a smooth surface and a fine grain, and is transparent. It is not as hard, however, as either the Jaegers-Fontin or the Ballas types, but it is very tough. The color of the stone is produced by the presence of iron oxide. The gray stone is much the same as the brown stone except for the color and for the fact that it is a little harder and more brittle. Neither of these stones is very expensive; therefore, since diamonds are easily ruined, the loss of a brown or gray bort does not mean as much from an economical point of view as does the loss of any of the other three grades. The bort stones are sufficiently hard to withstand all reasonable wear, and their shape is such as to permit them to be securely set.



Diamond-holder and Combination Lathe Tool used in manufacturing it

The shape of the wheel-truing diamond is an important factor in determining its value, the ideal shape being an eight-sided stone. The diameter and face of the grinding wheel, its hardness, and the type of abrasive used are factors which should be considered when determining the proper size of stone to use. A diamond should never be used on a grinding wheel which is mounted on a loose spindle, as the tendency will be to shatter the diamond and probably to pulverize it. The diamond should never be rammed into the grinding wheel, and should not be traversed across the face of the wheel too quickly. It is important to note that a stream of water should always be used during the truing-up operation.

Making the Holder and Setting the Diamond

The accompanying illustration shows at *A* a combination cutting-off and taper-turning tool by means of which the manufacture of a suitable holder can be greatly facilitated. The holder *B* is made from cold-rolled bar stock, ½, ⅝, and ¾ inch in diameter, which is first squared on the end by the tool, after which a hole is drilled in the end, the drill being held in the tailstock of the lathe. The size and depth of this hole depends, of course, upon the size of the diamond to be used and should not be less than ⅛ inch or rarely greater than ¼ inch in diameter. In drilling this hole, the proper depth may be indicated by marking the drill, so as to obtain an even depth for all holders of the same size. The drill is next removed and the special tool *A* employed to form the taper on the nose of the holder. The angle of the taper-turning tool should be such as to produce an included angle of 35 degrees on the end of the holder. The tapered end should produce a sharp edge around the hole. The holder is finally cut off by the use of the same tool, the usual length being about 8 to 11½ inches. The angle of the taper is important, because if the taper is less than 35 degrees, the prongs which are later formed will be too weak and will spring, so that difficulty will be experienced in securing the diamonds in place. On the other hand, if the taper is as great as 45 degrees, the setting will be clumsy and so unyielding that the diamond setter is likely to deal the prongs such a severe blow with his hammer that a broken diamond may result.

After the taper has been turned and the hole drilled to the proper depth, this end of the holder is slit into quarters, the saw being run in to the same depth as that of the hole. This prevents any air pockets being formed during the operation of brazing, and also produces four prongs, similar to the setting of a ring. Next give the prongs a little clearance by running the corner of a mill file along the passageway of the saw cut on the tapered part of the holder, and then remove the knife-edge on the end by brushing it lightly with the file so as to produce a flat surface on the top.

Flaws and marks should be so placed that they are perpendicular in the setting. In sorting diamonds for their respective holders, the best point of the diamond is turned up, in which position it is held by the thumbnail of the left hand; then using an 8-ounce hammer, gripped short, the first prong is hammered down with a blow or two. The next prong to be hammered down is the one located diametrically opposite to the first one, and during this operation the diamond is still held by means of the thumbnail, after which the two remaining prongs are similarly hammered down. If the hole is of the correct depth and the diamond is properly set, the diamond will project somewhat from the setting. The prongs should then be worked down to the stone by using a punch which may be made from an old rat-tail file. In performing this operation, care should be exercised to see that the hammer blows are not delivered directly toward the diamond. The diamond is not securely set when the prongs enclose the stone. It should be held about its equator and not at the pole, as the latter is exposed when in use. It is of paramount importance that the diamond be set securely before it is brazed, as otherwise too much reliance is placed on the braze.

Brazing the Setting—Final Operations

In order to secure a firm setting for the diamond, it should be clamped securely in position by the prongs. These exercise a certain amount of pressure or tension, and if they lose this tension the diamond setting is then dependent on the brazing only. The best flux to use when brazing consists of equal parts of borax and boracic acid. An enameled pan should be filled one-third full with this mixture and the remainder filled with water. This liquid should be boiled until the powdered ingredients are dissolved, and then used to dip the setting in, prior to performing the brazing operation. In case the fluid is used more than once, it should be boiled each time before using. A tin can of powdered borax

and boracic acid should also be provided for tipping the brazing wire when depositing the spelter. In brazing, it is well to remember that the spelter will flow toward the locality where the greatest amount of heat is applied and that this metal will remain there. When applying the heat, using a neutral acetylene flame, the cone should be directed at least one-half inch below the taper of the setting; the expansion of the holder takes place at this point first and not at the setting, and as the brazing is done in a vise the flame is played all around the holder, so that it will become uniformly heated to a white heat. The brazing wire which is first heated, is then tipped in the powdered flux, and the spelter applied directly over the diamond point. As the wire melts, the spelter will be melted by the excessive heat below the taper of the holder and will flow into the hole under the diamond, surrounding it and filling the setting completely. After withdrawing the flame and allowing the holder to cool slightly, the diamond itself should be completely covered with spelter. Another advantage in applying the heat below the setting is that the prongs do not become overheated, and are thus kept in tension, obviating all possibility of the diamond becoming loose from the application of heat. It will be found if two diamonds are secured in their respective holders by means of the prongs, that if one is heated over the setting and the other somewhat below the taper and allowed to cool without brazing, the first will become loose, while the other will remain as firm as when first set.

Provided the diamond has been set according to the method described, no looseness will be found to exist. The diamond is then taken to a grinding wheel and the point of the diamond exposed by grinding the top. The coating of spelter on the taper is then turned off in a lathe, after which the diamond is freed from the metal to a distance of about 1/32 inch from the point, and then polished.

Diamonds that become loose in the setting or that become chipped can be reclaimed by either cutting or burning them out. Each stone should be tested for the purpose of detecting imperfections, and a test of the strength of the setting should be made by using a pair of tweezers in attempting to loosen the stone.

Among the other methods of setting diamonds may be mentioned the one in which the stone is set in copper and also the setting in which monel metal is used. In the latter case, the diamonds are either put in a casting or else the metal is poured into a mold, holding the diamond in a fine nickel screen. This method is extensively used, but it is quite complicated and not especially satisfactory. Good results can also be obtained by the peening method, but when this practice is followed the work should be done by an expert. Objections have been raised to the method here described, but in cases where it has been actually put to the test, it has given excellent results.

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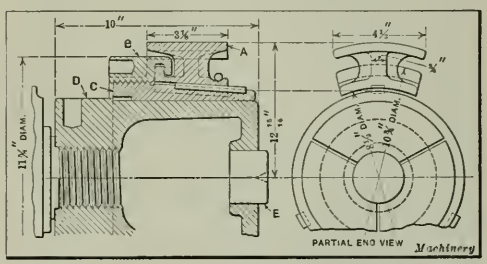
The larger portion of the steel-making pig iron is transported in molten condition from the blast furnace to the steel mill and is never marketed in the form of pig iron at all. Similarly, during the initial stages of rolling steel products, the ingots, blooms, and slabs are merely intermediate stages in the production of steel and not ordinarily commercial products. Thus, before the ingot has lost the heat acquired in producing the steel itself, it has been rolled into a bloom, a slab, or a billet and is ready to be rolled into some finished rolled product, such as rails, plates, or structural shapes. This saving of heat and the use of automatic machinery in handling these heavy rolled products keep down the fuel and labor costs; therefore, the prices of the heavy products are largely controlled by the cost of the crude steel. But in the case of light-rolled products, such as wire rods and sheets, more rolling is required, with a corresponding loss of heat and greater use of hand labor; therefore, the prices of light-rolled products are largely influenced by the fuel and labor costs.

EXPANSION MANDREL FOR INSIDE CHUCKING

By J. E. UNGER

The expansion mandrel illustrated represents a type of chucking device which has been in constant service for fifteen years on commutator work. For this particular kind of work, it has proved of great value, although its usefulness is not limited to commutator work alone, but may include any work of a similar type, and with proper modifications may be adapted to a large variety of work. The design of the mandrel is such that the parts can be rapidly chucked, and there is also a provision whereby the work may be removed and reversed, that is, it may be turned end for end, without releasing the grip or without disturbing its position. The work to be machined is placed over the shoes *A*, of which there are three located 120 degrees apart on the tapered cylinder *C*.

The circumferential location of each shoe is maintained by means of a key, and their longitudinal position is adjusted by means of a special nut *B*, which is designed to lock over a flange on each of the shoes, as the illustration clearly shows. A special wrench is employed to operate nut *B*, by means of which the shoes carrying the work are drawn up so as to lock the nut and the three shoes together. The taper plug *E* is then driven into the center hole of the cast-iron hub *D* which is slit, as shown by the end view. A light



Internal Chucking Device originally designed for Commutator Work

blow only is required to expand this split hub sufficiently to bind the cylinder *C* securely to the hub. When the work is reversed, a ram rod extending through the lathe spindle is employed to knock out plug *E*, after which cylinder *C*, carrying the clamping members of the device and the work, may be readily slipped off and turned end for end. The clearance between the hub and the cylinder is about 0.002 inch. Ordinarily the amount of expansion is from 3/16 to ¼ inch.

Commutators having segments from 4 to 16 inches in length are regularly held on this expansion mandrel while being machined, although there is nothing to prevent the use of extensions for hub *D* and the shoes *A* to suit the dimensions of the work to be machined. Extra extension pieces curved to suit the shape of the shoes may be bolted to them if it is desired to adapt the chucking device to work having larger bore diameters than those ordinarily handled. The inside diameter of arch-bound commutators is not trued up or bored, and for such work this mandrel has proved of great advantage in rapidly centralizing the work when turning it in the lathe. It is also profitable, in case of work which is likely to spring, to employ a greater number of shoes than three so as to overcome this tendency.

* * *

The magnitude of France's reconstruction work is partially indicated by some of the figures given out by the French government which show that about 100,000 houses must be entirely rebuilt, and the building work alone will require the labor of 700,000 people for one year. The reconstruction of the highways and railways will require the labor of 15,000 men for one year.



Gages in Interchangeable Manufacturing

By EARLE BUCKINGHAM
Engineer, Pratt & Whitney Co.
Hartford, Conn.

First of Two Articles Describing Various Types of Gages and Gaging Devices Employed in Manufacturing Interchangeable Parts

A GAGE is an instrument or apparatus for measuring a specific dimension. Every manufactured part is measured during its production and after its completion in one way or another. This applies equally to a single piece made for a special machine or as a repair part, or to a hundred thousand duplicate parts manufactured for an interchangeable product. The mere removing or shaping of the raw material in itself is seldom a difficult or exacting task. The critical point is in stopping this process at the proper moment. The approach to this point can be watched only by some form of measurement. The most elementary method of measuring a part is to try it with the companion parts with which it is to operate. Such was common practice in the early stages of mechanical industry. This practice necessarily continues to a great extent with repair work and also in the construction of small numbers of special machines, jigs, and fixtures.

A later method consisted of measuring the parts individually, with standard measuring tools such as scales, calipers, verniers, and micrometers. In many cases, these measurements were merely preliminary to the fitting together of the parts at assembly. Fitting at assembly is expensive. It takes time and requires a relatively large amount of space and highly skilled labor. Most of the metal removed at this time is done by hand. If any great amount of metal is to be removed, the part must be taken back to the machine shop and relocated on the machine thus interrupting other work. Under such conditions, the economic production of any great quantities of duplicate mechanisms is impossible.

Necessity of Gages in Economical Interchangeable Manufacturing

Interchangeable manufacturing was developed primarily to eliminate these conditions. If parts could be made close enough to some uniform size so that most, at least, of this fitting could be eliminated, it was evident that larger production could be secured with the expenditure of the same effort. Furthermore, many parts could be machined in advance and carried in stock, thus making earlier deliveries possible in many cases. Clearly, one of the most essential factors of such a plan is a reliable means of measuring each part as it is made. This measuring, to be effective, must insure uniformity and be economical. The use of standard measuring instruments such as micrometers is not always reliable in measuring large numbers of duplicate parts. In the first place, for many exacting conditions, measurements hurriedly made by several different men do not prove sufficiently uniform. In the second place, many of the surfaces to be measured are not readily accessible by standard measuring tools. And, in the third place, while both of the preceding conditions may often be satisfactorily met, the time consumed by this method would be too great to be economical.

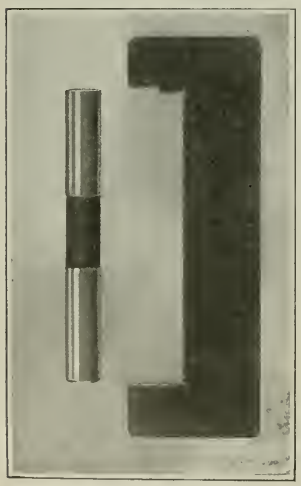


Fig. 1. Snap Gage with Shallow Throat for measuring Lengths

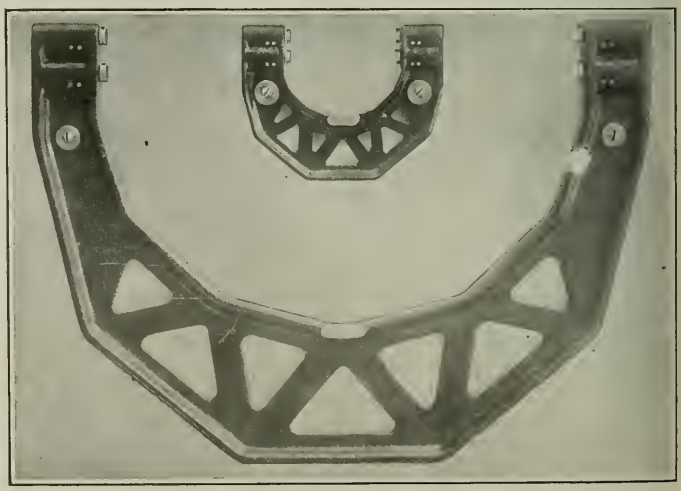


Fig. 2. Adjustable Snap Gages employed for Comparatively Large Pieces or when the Rate of Production is Small

In order to meet all these conditions, special measuring tools known as gages have been developed.

Gages are an integral part of interchangeable manufacturing equipment. They comprise that part of the equipment whose purpose is to measure the product, as distinguished from that part of the equipment whose purpose is to change the form of the material or to hold the part during a manufacturing operation. Under this broad definition of a gage, it is apparent that some of the manufacturing equipment may be not only a holding device, but also a gage. In fact it is good practice to make fixtures so that an unserviceable part cannot be inserted. It often happens that when the normal manufacturing variations of certain machining processes are small and within known limits, a gage may be employed to test the size or form of the cutting tool, and not be applied directly to the product. At other times, a gage in the form of a setting block for the position of the cutting tool is made as an integral part of the fixture. Therefore, to determine the character of the gages that are required for the production of any particular part, it is necessary to consider both the requirements of the part in question and the other manufacturing equipment that is provided.

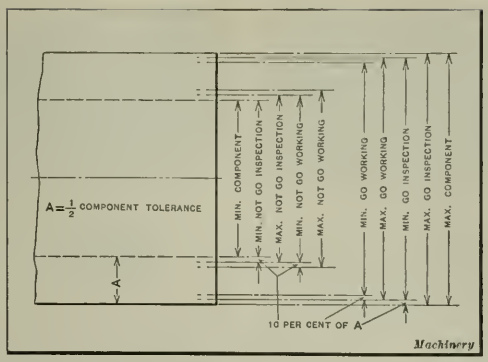


Fig. 3. Diagrammatic Illustration showing Differences between Working and Inspection Gages and Tolerances on these Gages.

Classification of Gages According to their Use

In general, there are three purposes for which gages may be needed: First, in the manufacture of large numbers of duplicate pieces, it is a measure of economy to detect and discard all unserviceable parts as soon as possible, thus saving the expenditure of additional effort on such parts. The gages provided for the purpose are commonly known as working gages. These are often limit gages, placed in the hands of the machine operator to check each individual machining operation as it is performed.

Second, it is necessary to check the parts as they are transferred from one manufacturing department to another, and also before the finished parts are sent to the stock-room or assembling floor, so as to prevent unserviceable parts from proceeding farther. It is also customary to inspect the parts in process after certain groups of operations have been performed. The gages used for these purposes are commonly known as inspection gages. Some of these are limit gages which are often duplicates of some of the working gages, while others are functional gages which check the results of several operations at one time. These inspection gages are generally used by a force of inspectors who are independent of the production department.

Third, when gages are used to any extent, it is necessary to have reliable standards as a means of checking the working and inspection gages and to establish the sizes of new gages as the old ones wear out. Such standards are variously known as checks, reference gages, standards, master gages, and model parts. These gages are usually kept in the tool-room or in the hands of a gage inspector, and their purpose is to test the working and inspection gages so as to insure a suitable degree of precision in them.

Required Accuracy of Gages

Extreme refinement in gages is very expensive and is unwarranted by the functioning of the majority of component parts. The accuracy required by a gage depends in a great measure upon the extent of the manufacturing tolerances. If these tolerances have been properly established, only a small percentage of them will be exacting. It is evident that a gage used to measure a dimension which has a tolerance of 0.002 inch must be made closer to size than one which measures a dimension having a tolerance of 0.020 inch. It is common practice to establish the tolerance on a gage at 10 per cent of the component tolerance. A tolerance of less than 0.0002 inch should seldom be specified unless the conditions are unusually exacting and economy is no object.

With variations in gages, no matter how slight, and with parts passing through successive inspections, many misunderstandings are inevitable unless precautions are taken to guard against them. The most common method of meeting this condition is to establish the limits of the working gages inside the limits of the inspection gages. Fig. 3 is a diagrammatical illustration showing the differences between working and inspection gages and the tolerance on these gages. The full lines represent the maximum size of a part while the dotted lines represent the minimum size. The maximum size of the "Go" inspection gage is identical with the maximum size of the component. The minimum size of the "Go" inspection gage is 10 per cent of the component tolerance smaller than its maximum size. The maximum size of the "Go" working gage is identical with the minimum size of the "Go" inspection gage, while its minimum size is 10 per cent of the component tolerance smaller. In a similar manner,



Fig. 4. A Ring Gage of the Ordinary Type

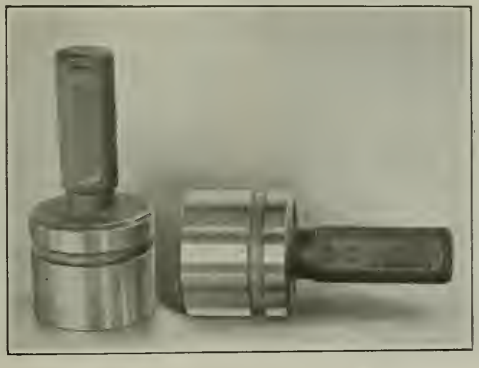


Fig. 5. Two-step Plug Gages used for the Inspection of Through Holes



Fig. 6. Counterbore Plug Gage

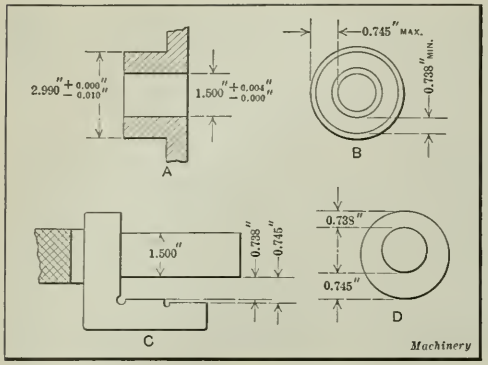


Fig. 7. Illustration showing how Compound Tolerances are involved when testing the Concentricity of a Hub with a Hole

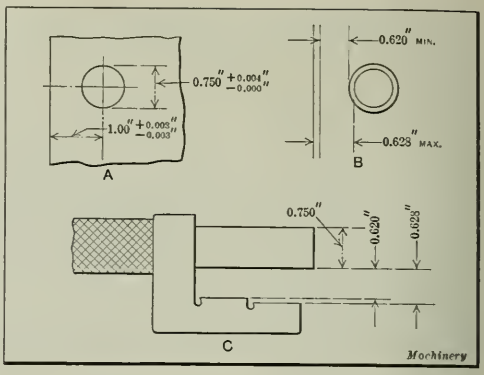


Fig. 8. Application of a Combination Plug and Snap Gage in testing the Location of a Hole from the Edge of a Part

the minimum size of the "Not Go" inspection gage is identical with the minimum size of the component while its maximum size is 10 per cent of the component tolerance larger. The minimum size of the "Not Go" working gage is identical with the maximum size of the "Not Go" inspection gage, while its maximum size is 10 per cent of the component tolerance larger. As the tolerance on the component increases, it is often advisable to reduce this percentage. Thus, for plain plug and snap gages, a tolerance greater than 0.001 to 0.002 inch is seldom necessary.

Desired Relation between Working and Inspection Gages

It is evident that if the sizes of the working gages are always kept inside of the sizes of the inspection gages, few questions should arise due to parts passing the working gages and being rejected by the inspection gages. This arrangement may be secured by making and maintaining the gages as outlined in the foregoing or by a process of selection and grading. If all the gages used at the same time for the same surface are checked concurrently, those permitting the widest variation in the product should be used as inspection gages, while the others should be used as working gages. In all cases the nominal sizes of the inspection limit gages should be identical with the limits of the component, and all tolerances should keep them within the limits of the component. Thus, the maximum gage may be smaller than its nominal size but never larger, while the minimum gage may be larger but never smaller.

Such a practice brings up two age-old arguments: First, that a 1-inch plug will not enter a 1-inch hole, and second, that the tolerances on the gages rob the manufacturer of some of the tolerances given on the drawing. The answer to these arguments depends upon the interpretation of the drawing. If this interpretation is that the dimensions and tolerances given on the drawing represent the extreme sizes of the limit gages, and all variations of whatever source must come within these limits, neither of the above arguments has any weight; and this is the only logical interpretation that can be used definitely and consistently. With this interpretation, it does not matter whether the hole is ever exactly one inch or not. As for the second argument, if the shop does not attempt to maintain its product within slightly smaller tolerances than the extreme tolerances, too large a percentage of parts will inevitably run outside of the tolerances and be rejected.

Gage Requirements Controlled by Ultimate Economy

A limit gage is one that measures both the maximum and minimum sizes of the component. Such gages usually check elementary surfaces, although they are at times provided for checking profiles and other composite surfaces. The most common types of limit gages are snap gages, plug gages, ring gages, depth gages, and length gages. A functional gage is one that checks primarily the functional operation of a component without strict adherence to its exact physical dimensions. Several types of these gages were discussed in "Component Drawings for Interchangeable Manufacture," published in the November and December, 1919, numbers of MACHINERY. The purpose of such a gage is to insure, as far as possible, the proper assembling and operation of all parts.

The extent to which gages should be employed depends on the product and the rate of production. If the rate of production is low, it is often possible to control the accuracy of the product with standard measuring instruments. As it increases, the time spent in using standard instruments reaches a point where the time saved by the use of gages more than pays for their cost. Gages should be provided for only those surfaces which it is essential to maintain within certain dimensions. Each gage should have its definite purpose just as any other piece of manufacturing equipment has some definite duty to perform. A gage is a preventive and not a cure. Gages are required wherever their use will tend to prevent the production of faulty work. Thus a more complete system of gages is necessary in a shop that employs a large percentage of semi-skilled labor than in a shop employing highly skilled operatives.

Interchangeability between Parts Made in Different Shops

Experience has shown it to be difficult to obtain interchangeable parts from several independent plants producing a common product unless great precaution is taken at the outset to insure this result. Under these conditions the most certain method is to maintain identical working and gaging points at the various plants for all functional surfaces.

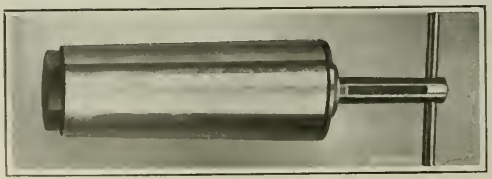


Fig. 9. Taper Plug Gage provided with Groove between the Edges of which the Face of the Work must be Flush



Fig. 10. Combination Plug and Snap Gege used for Such Purposes as testing the Concentricity of a Hub with a Hole

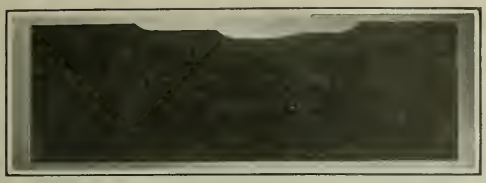


Fig. 11. Simple Type of Contour Gage for checking the Uniformity of Contours or Profiles

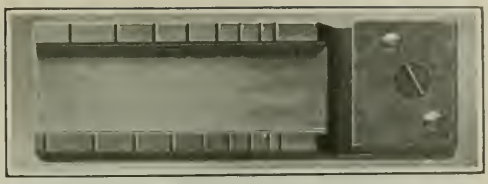


Fig. 12. Matching Gage used in testing the Positions of Graduations on a Part

Component drawings, properly dimensioned, assist greatly in accomplishing this end. This does not necessarily mean that the design of the gages must be identical. The exact design of a gage is never in itself a matter of great importance. The effectiveness and economy of the results obtained are the important considerations. Usually the gaging equipment must be very complete to meet successfully the requirements of interchangeability between independent plants.

For the further discussion of gages, they will be classified according to their type, such as snap gages, ring gages, plug gages, profile gages, thread gages, flush-pin gages, functional gages, etc. Many of the gages considered in this article were also described and illustrated in five articles dealing with gages and the development of a gaging system, which were published consecutively in MACHINERY beginning with the October, 1918, number. For this reason illustrations and lengthy descriptions of the gages previously treated are deemed unnecessary. By referring to these articles, other gages of an interesting character will also be noted.

Snap Gages

Gages were first developed as part of the equipment necessary for manufacturing large numbers of duplicate parts. Now gages are used to a large extent in the production of smaller numbers of parts. In this case, however, many modifications in the design, such as adjustable features, have been developed to keep the cost within reasonable limits. Snap gages for use in the manufacture of large numbers of interchangeable parts will be discussed first. The earliest form of snap gage was the "one-size" type; that is, a gage to measure one flat dimension only. This type is still used to a large extent in tool-rooms and machine shops when limits are not expressed on the drawings and when the clearances for the different fits are left to the judgment of the workmen.

The limit gage with two steps was later developed, one step being provided for measuring the maximum limit, and the other for measuring the minimum limit. For small parts produced in large quantities the non-adjustable gages are most satisfactory. Formerly a number of gage slots were cut in one piece of steel to permit a combination of gages in one piece, but the disadvantage of this design was that when one gage became worn the whole gage was lost. One method of overcoming this disadvantage is to have a filler block inserted on one side of the gage jaw which can be replaced when the gage becomes worn. Sometimes a combination of gages is mounted on a ring similar to a key ring. In a later snap gage construction, individual gages are assembled in convenient units and held together by clamping strips and screws. This construction permits the easy removal of a gage when necessary.

Various Other Types of Snap Gages

One type of snap gage has an intermediate step between the two limit steps, to aid the machine operator in setting up and adjusting the tools. In setting up a machine for repetition work, the object is to set the tools so as to have the maximum time between adjustments. When a circular part is machined with a form tool or a box-tool, the piece becomes larger as the tool wears. Therefore, the initial setting should be as near the minimum or "Not Go" limit as other conditions will permit. The intermediate step on these working snap gages is made to approximately the mean dimension. Thus, if the operator sets the machine to produce work between the minimum limit of the gage and the intermediate step, the life of the tool, as regards wear at the particular setting, is equal to at least half of the working tolerance. These intermediate steps are not used on inspection gages, as they would serve no purpose there.

There are two general types of snap gages, those with deep throats for measuring diameters and those with shallow throats as illustrated in Fig. 1, for measuring lengths. When the gage slot is very narrow, snap gages are frequently made with a removable strip serving as one side of the gage slot. This construction permits the gaging surfaces to be readily ground.

For larger pieces and for smaller rates of production, adjustable snap gages have been developed. Gages of this type are shown in Fig. 2. In common with other types of adjustable tools, these should be adjustable in the tool-room and fixed in the manufacturing departments. This result is obtained by providing a place for a seal which must be broken before the gage can be adjusted, thus preventing the adjustment from being tampered with. These gages may be readily adjusted in the tool-room to any desired limits, so that a few sets of them provide a flexible and economical equipment of gages for checking elementary dimensions, such as external diameters, thicknesses, and lengths.

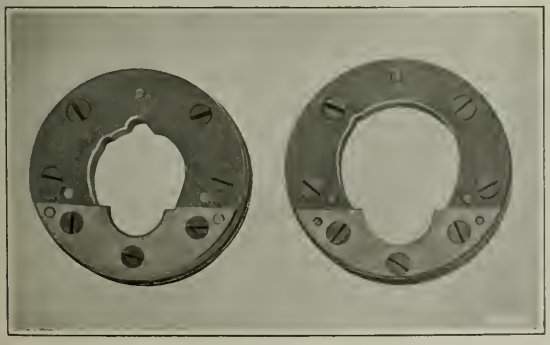


Fig. 13. Receiving Gages having Holes or Openings corresponding to the Shape of the Part inspected by them

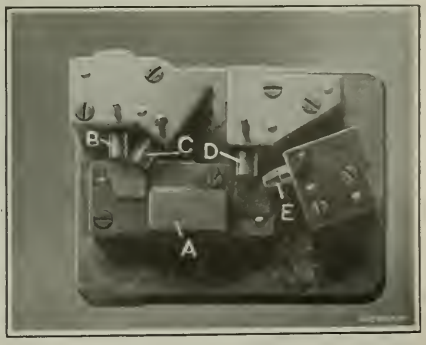


Fig. 14. Profile Gage which checks the Contour of the Work by Flush Pins

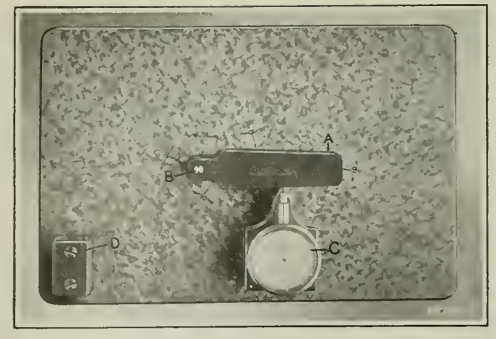


Fig. 15. Dial Indicator Contour Gage having a Baseplate, the Point of which is in Contact with a Master Form, while the Point of the Indicator is in Contact with the Work

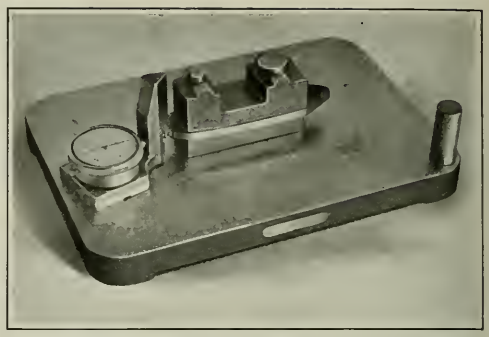


Fig. 16. Type of Dial Indicator Contour Gage on which the Point of the Indicator is in Contact with the Master Form while a Projection on the Baseplate registers against the Work

Ring Gages

Under some conditions, the use of a snap gage for testing diameters is not sufficient, and in such cases ring gages are employed. Wherever possible, however, snap gages should be employed, as they are more economical to use. A snap gage can be used more rapidly than a ring gage. Furthermore, on many parts, a machine operator cannot use a ring gage without removing the work from the machine. The extent of the tolerance required to manufacture a part economically depends in a large measure on the type of gage employed. For example, if a ring gage is used in place of a snap gage, any departure from rotundity or from size affects the acceptance of the part by the gage. Thus, in effect, a snap gage checks an elementary surface while a ring gage checks a composite one.

The severest possible inspection of a cylindrical surface is obtained by the use of "Go" ring gages and "Not Go" snap gages. It is therefore evident that a description of the gaging and inspection methods is essential in the specifications to avoid misunderstandings. The larger ring gages are made as individual gages, as shown in Fig. 4, and are sometimes provided with handles. Several small ring gages are often inserted into a soft holder which keeps them together.

Plug Gages

Plain plug gages are old and simple forms. Standard plug gages, as with standard snap gages, are largely used in toolrooms and general machine shops. A "Not Go" gage was a later development and is attached either to the other end of the same handle as the "Go" gage or is a separate gage. It is common practice to make standard handles and standard plug gage blanks, later finishing these blanks to the size required and assembling them into the standard handles. Solid double-ended plug gages are open to the same objections as solid combined snap gages. If one end becomes unserviceable, the whole gage must often be discarded. The heading illustration shows a set of standard limit plug gages ranging from $\frac{3}{4}$ to 3 inches in diameter. The minimum or "Go" ends are made longer than the maximum or "Not Go" ends; this practice is followed in order to make the "Go" end readily distinguishable from the "Not Go" end, and, furthermore, as the "Not Go" end is subject to little wear, there is no necessity for making it very long.

When a through hole is to be gaged, it is customary to make a two-step plug gage such as shown in Fig. 5. This permits rapid inspection, but the gage cost is greater than when two separate ends are used. Often, however, the saving in inspection costs will greatly exceed the additional expense of this type of gage, so that the practice is economical in the long run.

The Pratt & Whitney Co. manufactures a gage known as the "star" gage, which is of the expansion type, having four movable measuring ends. This gage is used for measuring the bores of tubes and jackets for large guns, the bores of engine cylinders, etc. Plug gages made from flat stock are often used to measure the width or length of slots or grooves. These gages are frequently rounded at the end and used for measuring the length of a splined slot.

Plug Gages for Several Surfaces and Taper Surfaces

Thus far only gages for elementary surfaces have been considered. The dimensions for such gages are readily determined from the limits expressed on the component drawings. To test concentricity, however, the assembly requirements of the mating parts must be considered. This has been previously discussed in the articles mentioned in the foregoing. A gage of this type for testing the concentricity of the bore and counterbore of the main bearing of an automobile transmission case is shown in Fig. 6. Plug gages are often made with steps on the end to gage both the diameter and the depth of a hole at the same time. At other times a sliding collar is provided which saves the use of a straightedge if the hole to be gaged is either countersunk or counterbored.

Taper plug gages are usually provided with either lines or steps to gage not only the diameters of the tapered hole, but also their locations. A taper gage is shown in Fig. 9. A groove is cut near the large end of this gage and the width

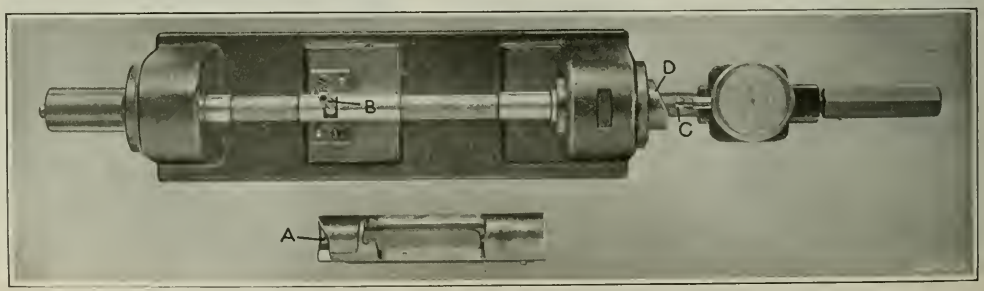


Fig. 17. Application of the Dial Indicator Contour Gage in inspecting the Cam Surface of a Part

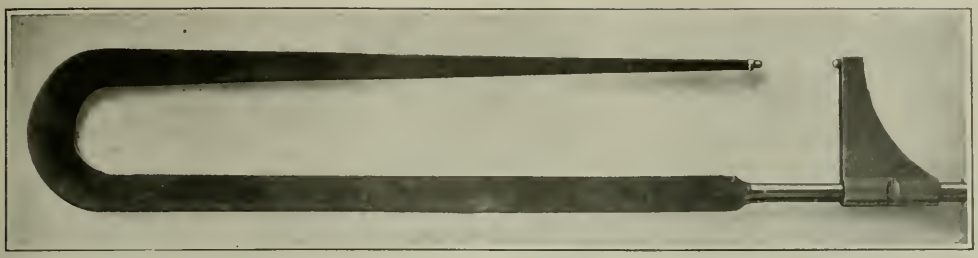


Fig. 18. Sliding-bar Gage used in testing the Thickness of the Bottom of a Shell, and provided with an Arm which can be swung out of the Way to permit the Gage to enter the Work

of this groove indicates the limits. The gage must go into the work until one edge of the groove is flush with or below the face of the part, while the other edge must never go in beyond the face of the part. Sometimes steps are provided to indicate the limits and at other times, lines are graved to serve the same purpose. If the tapered hole is properly dimensioned on the component drawing so that no compound tolerances exist, the correct dimensions of the gage are readily determined. If compound tolerances exist on the drawing, however, some arbitrary method of interpretation must be promulgated or else endless arguments will ensue about the proper gage sizes. This subject has also been discussed in the articles previously referred to.

Application of Combination Plug and Snap Gages

A combination plug and snap gage is illustrated in Fig. 10. Such gages may be required for several purposes. They may be used to test the concentricity of a hub with a hole, the location of a hole from the edge of a part, the depth of a slot in relation to a hole, etc. In determining the dimensions of such gages, compound tolerances are almost inevitably present. Therefore, some arbitrary method of interpreting the drawing must be established. A gage for testing the concentricity of the hub with a hole will be considered first.

Assume that the hub and hole represented at *A* in Fig. 7, must be gaged. The diameter of the plug in this case will be taken as the minimum size of the hole or 1.500 inches. If it is considered that the limits given for the hole and hub establish parallel zones of permissible variations, as shown at *B*, there will be a minimum distance of 0.738 inch between the gaging parts of the combination gage shown at *C*, and a maximum distance of 0.745 inch. The use of this gage will then permit the extreme condition of eccentricity which is shown at *D*. If the diameter of the hole is maximum and the eccentricity is at this extreme, the size of the hub will be 2.987 inches. If the diameter of the hole is minimum, the size of the hub will be 2.983 inches. The more nearly concentric the hole and hub are maintained, the greater the amount of tolerance which remains for their diameters. The full tolerance on these diameters becomes available only when they are concentric with each other. It may be pointed out that the condition shown at *D* does not keep the parts within the parallel zones shown at *B*. This is true, and will be found to be true wherever compound tolerances are involved. It is this condition that makes it necessary to establish some arbitrary interpretation of the drawings.

The next example will be of a combination plug and snap gage used to test the location of a hole from the edge of a part. The procedure to determine the gage sizes is identical with the foregoing. A part having a hole which is to be gaged from an edge is shown at *A*, in Fig. 8. The parallel zones of variation given on the drawing are shown at *B*, and the gage is shown at *C*. The diameter of the plug is shown as the minimum size of the hole. As a matter of fact, the diameter of the plug may be any size smaller than the hole in these cases, as the gaging dimension is controlled by the gap between the edge of the plug and the steps of the arm. A plug of minimum size is generally used so that it may also be employed as the "Go" gage for the hole. A modification of this gage is used to test the position of a hole that must be carefully located between two edges. One side of the snap gage part is made longer than the other to detect the side at fault in case the gage does not go on.

Contour or Profile Gages

Contours or profiles are among the most difficult surfaces to gage properly. A contour gage of the earliest type is shown in Fig. 11, but this type should be used only when accuracy is not important. The main objection to this form is that it measures only the shape of the work and not the location of the contour. A gage designed to overcome this objection has guides for the contour and locating points for the work. This type of gage was illustrated and described in an article entitled "Contour or Profile Gages," in the December, 1918, number of MACHINERY.

Contour gages of the matching type are sometimes used when great accuracy is not required. The part is placed on the gage and its outline compared, either visually or by a straightedge, with the outline of the gage. In Fig. 12 is shown one type of matching gage. This is used to test the



Fig. 19. Simple Form of Flush-pin Gage, consisting of a Plunger which slides in a Sleeve

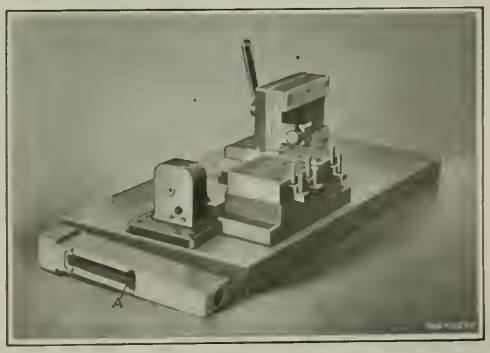


Fig. 20. Gages with Three Sets of Double Flush Pins for measuring an Irregular Slot in a Part

position of graduations on a part. The work is inserted in the gage and the graduations are compared visually. Similar gages are often used for checking the shape of springs made from flat stock and also for checking the graduations on dials, etc.

Receiving Gages

The simplest form of receiving gage is a flat templet in which a hole or opening is cut corresponding to the form of the part to be inspected. Such gages do little more than insure interchangeability. If the part enters, it is not too large, but it is impossible to determine from such a gage if the piece is too small. If the piece does not enter, it is too large. It is difficult to find the exact location and amount of the error. Gages of this type are shown in Fig. 13. In an improved type of receiving gage the work is inserted in the opening of the gage and properly located there. This opening is a uniform distance from the work so that maximum and minimum plug gages may be inserted between the work and the gaging surfaces.

This same principle may be applied to the gaging of irregular openings by making a male profile a uniform amount under size and using limit plug gages to check for errors. Fig. 14 shows another type of profile gage which checks the contour to definite limits. In this case the contour consists of several flat surfaces cut at different angles. The part is located by block *A*. The flush pins *B*, *C*, *D*, and *E* check the various faces on the piece.

Dial Indicator Contour Gages

The highest development in gages for formed surfaces is doubtless the dial indicator contour gage, a simple example of which is shown in Fig. 15. This type of gage consists of a baseplate which has mounted on it means for holding the piece to be gaged as well as the master form with which the piece being gaged is compared. The piece to be gaged is shown in position at *A*, and the master form is directly beneath it. The stud *B* is used to locate the work. The dial indicator *C* is mounted on a baseplate of its own and slides on the baseplate of the gage. The point on the baseplate of the indicator is brought in contact with the master form, while the point of the indicator itself is in contact with the piece to be gaged. The amount and direction of the tolerance is stamped on the face of the gage baseplate. At *D* is shown a setting block which is used to set the indicator to zero.

This type of gage makes it possible to determine quickly and accurately whether the work is within the prescribed limits. The tolerances on the work may be varied along the contour, and the indicator will show the variations at any point. The wear on these gages is almost negligible, as the master form is in contact only with the small hardened point of the block on which the dial is mounted. These gages are very convenient for gaging slots having irregular bottoms.

Sometimes these gages are made so that the point of the dial indicator follows around the master form, while a projection on the baseplate registers against the work. Such a gage is shown in Fig. 16. Otherwise its operation is the same as in the previous example. This type of gage lends itself readily to the inspection of work having many difficult and exacting requirements. A modification is shown in Fig. 17. The piece to be gaged is shown below the gaging fixture. This gage is used for inspecting the cam surface *A*. In operation, the pin *B* follows the cam surface *A*, while the point *C* on the dial indicator follows the master cam *D*. Any variations are thus readily and accurately detected. This type of gage is not limited to the gaging of contours, but may also be used for testing depths, steps, recesses, etc., much more readily than a great number of snap, plug and depth gages.

Flush-pin Gages

Flush-pin gages are generally used for tolerances over 0.002 inch, especially in cases where snap gages cannot be applied conveniently. It is possible to use them for smaller tolerances, but it is seldom practicable in such cases to depend on the sense of touch. The flush-pin gage in its simplest form, as shown in Fig. 19, consists of a plunger which slides in a sleeve. Steps are provided, sometimes on the top of the plunger and other times on the sleeve, which agree with the specified tolerances. The dimension to be gaged is represented by the projection of the plunger beyond the bottom of the sleeve. The same principle may be applied in a great variety of ways. Fig. 14 shows its application to a contour gage.

The advantages of flush-pin gages may be briefly summarized as follows: The flush-pin gage is the simplest form of gage for measuring the position of one surface with reference to a locating point, when the relation is such that a snap gage cannot be used. Flush-pin gages are subject to a comparatively small amount of wear, and repairs are simple. Mistakes in reading the indications on them are rare.

Sliding-bar Gages

Among the gages made with sliding members, the sliding-bar gages occupy an important place. In principle, they are similar to flush-pin gages, but differ in the method of taking the readings or indications. A common type is similar to a micrometer in general construction. On the sliding bar is engraved a line, which must be between two steps on the frame if the part being measured is acceptable. Another similar example is shown in Fig. 18. Two lines are engraved on the cylindrical part of the frame, while a single line is engraved on the slotted surface of the sliding arm. The arm swings out of the way to allow the gage to enter the work. This gage is used to measure the thickness of the bottom of a shell, and is made light for ease of operation, as the work itself is too heavy to be handled rapidly.

Fig. 20 shows a gage with three sets of double flush pins for measuring the irregular slot in the piece shown at *A*. On sliding-bar gages where the tolerance is too small to be read from lines engraved on the plunger, the movement of the bar is multiplied by a lever which points to a graduated scale on the side of the gage. In this way it is possible to note quickly whether the work is machined within the requirements or not.

The next installment of this article, which will be published in the August number of MACHINERY, will illustrate and describe flat-depth and length gages; hole gages; thread gages; wing and indicator gages; functional gages; gear gaging machines; special gages; and master and reference gages.

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EXTENDED USE OF HYDRO-ELECTRIC POWER

Under the heading "America's Electrical Opportunity," the *Scientific American* calls attention to the great scarcity of coal in many countries of Europe. This has focussed the attention on the advantages of electricity derived through water-power development. There was never a time when so much business was available to American manufacturers, provided some means for extending credits can be devised. In Italy, for instance, the authorities are planning the electrification of 3700 miles of railroad. Portugal plans to electrify all its railroads. France is casting about for water-power development projects. Nineteen large generating stations are planned in the Rhone valley, which will furnish 12,000 to over 70,000 horsepower each. The entire project will probably mean 760,000 horsepower. South America is also interested in hydro-electric developments.

* * *

It has been announced that at the annual meeting of the American Foundrymen's Association, to be held in Columbus, Ohio, October 4 to 8, a non-ferrous casting section will be added to the program. At the meetings of this section, papers and discussions of interest to the practical brass and aluminum foundrymen will be presented. The Institute of Metals division of the American Institute of Mining and Metallurgical Engineers will hold a convention in Columbus during the same week, and it is proposed to have joint sessions of this body with the new non-ferrous section.

Hardening Shop Costs

A Review of Methods for Estimating Costs in the Hardening Room, Including All the Elements Involved in Carburization and Casehardening

By S. P. ROCKWELL, Metallurgist, Weekes-Hoffman Co., Syracuse, N. Y.

OFTEN it is desired to know the cost of hardening certain classes of work going through the shop, or work which may be submitted for a price estimate. The following is a quick method of determining costs, and answers the purpose very satisfactorily: Assume that the costs of building, equipping, and running a hardening shop are as follows: Building, $12,000; oil-fired carburizing furnace, three chambers, eighteen pots each, $2500; two oil-fired hardening furnaces, each $800; tempering furnace, $200; special hardening machine, $1500; straightening machine, $200; hardness testing machine, $285; pumps, oil tanks, etc., $3000; malleable iron pots, per pot $9.375; carburizing material, per ton, $75; fuel oil, per gallon, 7 cents; quenching oil per gallon, 30 cents; tempering oil, per gallon, 40 cents; power, per kilowatt-hour, 4 cents; superintendence and laboratory, per year, $3000; foreman, per day, $8; labor, per hour, 45 cents; and miscellaneous expenses, such as office stationery, light, heat, water, insurance, per year, $3000.

For convenience, the costs of the hardening shop are divided among the three following operations: (1) Carburizing, which includes the costs of packing, carburizing, cooling in the pot or quenching from the pot, unpacking and delivering to the hardening department. (2) Hardening, which includes the costs of heating for core and case refinements and delivering to tempering and inspection department. (3) Tempering and inspecting. On account of the floor space and labor required in carburizing, 50 per cent of the total sum of such items as building, superintendence, equipment, etc., is charged to this operation. Of the remaining cost of these items, 25 per cent is charged to hardening, allowing 12.5 per cent for hardening for core refinement, and 12.5 per cent for hardening for case refinement; and the remainder, or 25 per cent, is charged to tempering and inspecting. It is assumed that the shop is operated 10 hours per day or approximately 3000 hours per year.

Carburizing Costs

The method of figuring the carburizing costs of the various items per pot per hour, is as follows:

Building—If 10 per cent of $12,000, or $1200, is allowed for interest and depreciation per year, then 50 per cent of this amount, or $600, should be charged to carburizing. Allowing 3000 working hours per year, the cost per hour is $600 ÷ 3000 = 20 cents. By dividing this amount by 54 (the pot capacity of the carburizing furnace), the building expense per pot per hour is 20 ÷ 54 = 0.37 cent.

Carburizing Furnace—If 6 per cent of the cost is allowed for interest and 12 per cent for depreciation per year, this will amount to 18 per cent of $2500, or $450, and $450 ÷ 3000 = 15 cents, the furnace cost per hour. The cost per pot per hour, equals 15 ÷ 54 = 0.277 cent.

Pumps, Oil Tanks, etc.—Allowing 20 per cent for interest and depreciation per year, this would amount to 20 per cent of $3000, or $600; but only 50 per cent of this, or $300, is chargeable to carburizing. The total cost per hour equals $300 ÷ 3000 = 10 cents, and the cost per pot per hour, equals 10 ÷ 54 = 0.185 cent.

Malleable Iron Pots—Considering the average life as 500 hours, the pot cost per hour is $9.375 ÷ 500 = 1.875 cents.

Carburizing Material—If it has been determined that the material can be used four times, the cost per useful ton is $75 ÷ 4 = $18.75. The cost per pound is $18.75 ÷ 2000 = 0.937 cent. If 30 pounds is used per pot and the material is good for a ten-hour heat, the cost of the material per pot per hour is 0.937 × 30 ÷ 10 = 2.81 cents.

Fuel—If one chamber of the furnace uses 3 gallons of oil per hour the cost is 3 × 7 = 21 cents. This amount divided by 18, the number of pots in one chamber, gives the cost per pot per hour as 1.167 cents.

Power—If 4 horsepower is required for the air blast, at 4 cents per kilowatt-hour this cost equals 2.983 × 4 = 11.932 cents, and the cost per pot per hour equals 11.932 ÷ 54 = 0.221 cent.

Foreman and Superintendence—Fifty per cent of the foreman's salary or $4 per day should be charged to carburizing. Likewise, 50 per cent of superintendence and laboratory costs, or $1500 per year, should be charged to this work. This amounts to $5 per day, so that the costs of both these items per day is $9 or 90 cents per hour and 90 ÷ 54 = 1.667 cents, the cost per pot per hour.

Labor—The cost for three laborers at 45 cents per hour brings this expense to $1.35 per hour, and $1.35 ÷ 54 = 2.5 cents, the labor cost per pot per hour.

Miscellaneous Expenses—Fifty per cent of this item, or $1500 per year, is chargeable to carburizing, so that $1500 ÷ 3000 = 50 cents, the cost per hour. The cost per pot per hour equals 50 ÷ 54 = 0.926 cent.

The following is a summary of the costs per hour, in cents of the various items for carburizing one pot of work:

Building	0.370
Carburizing furnace	0.277
Pumps, oil tanks, etc	0.185
Malleable iron pots	1.875
Carburizing material	2.810
Fuel	1.167
Power	0.221
Foreman and superintendence	1.667
Labor	2.500
Miscellaneous expenses	0.926
Total cost per pot per hour	11.998

In order to find the cost per piece or pound of work for carburizing, it is necessary to divide 11.998 cents by the number of pieces or pounds that may be packed in a pot and multiply this amount by the number of hours in the heat. Assuming that 6 ring gears requiring an 8-hour heat can be packed in 1 pot, the cost per piece would equal 11.998 × 8 ÷ 6 = 16 cents.

Cost of Hardening for Core Refinement

In estimating the cost of hardening for core refinement, 12.5 per cent of the total costs of such items as building, superintendence, etc., is chargeable to this operation, as previously mentioned. As 50 per cent of this cost was charged to carburizing, the amount to be charged to hardening for core refinement will be 25 per cent of the amount charged to carburizing. The method of finding the hardening for core refinement costs per day of the various items is as follows:

Building—Twenty-five per cent of 20 cents (the cost charged to carburizing) = 5 cents, the cost per hour. The cost per day equals 10 × 5 = 50 cents.

Furnace—If 6 per cent is allowed for interest and 18 per cent for depreciation, this cost will equal 24 per cent of $800 or $192 per year. The cost per day equals $192 ÷ 300 = 64 cents.

Pumps, Oil Tanks, etc.—As this equipment is not used in tempering, the cost chargeable to hardening for core refine-

ment is equal to 50 per cent of 10 cents (the cost charged to carburizing) = 5 cents or the cost per hour. As this equipment is used 13 hours per day the cost per day is 13 × 5 = €5 cents.

Fuel—If 2.5 gallons of oil is used per hour and the furnaces are operated 13 hours per day, the cost of fuel per day equals 2.5 × 13 × 7 = $2.275.

Quenching Oil—If 2 gallons is used per day, 2 × 30 = 60 cents, the cost per day.

Power—If 2 horsepower or 1.49 kilowatts is used per hour for 13 hours, the cost per day equals 1.49 × 13 × 4 = 78 cents.

Foreman and Superintendence—Twenty-five per cent of $9 (the cost charged to carburizing) = $2.25, the cost per day.

Labor—If one man is employed for this work, the cost is 10 × 45 = $4.50 per day.

Miscellaneous Expenses—Twenty-five per cent of 50 cents (the cost charged to carburizing) = 12.5 cents, the cost per hour. The cost per day equals 10 × 12.5 = $1.25.

The following is a summary of the various costs per day of hardening for core refinement:

Building	$0.50
Furnace	0.64
Pumps, oil tanks, etc.	0.65
Fuel	2.28
Quenching oil	0.60
Power	0.78
Foreman and superintendence	2.25
Labor	4.50
Miscellaneous expenses	1.25
Total cost per day	$13.45

The total cost per hour would equal $13.45 ÷ 10 = $1.34. In order to find the cost of core refinement per piece or pound of work, divide $1.34 by the number of pieces or pounds that can be hardened in one hour. Assume that it is desired to harden, for core refinement, the ring gears that were carburized, and that the time required for heating each gear is 15 minutes. If 25 gears can be laid on the floor of the furnace and after being heated for 15 minutes can be quenched in 5 minutes, the total time required for hardening 25 gears is 20 minutes, so that the output per hour would be 75 gears. If the cost per hour of operating the shop is $1.34 the cost per piece is $1.34 ÷ 75 = 1.79 cents.

Cost of Hardening for Case Refinement

Many of the costs of hardening for case refinement are identical with those charged to hardening for core refinement, so that it is unnecessary to show how these values are obtained. If two laborers are used in this process, this cost is double the cost in hardening for core refinement. If 10 per cent is allowed for interest and depreciation of the special hardening machine, this cost will equal 10 per cent of $1500, or $150, so that $150 ÷ 300 = 50 cents or the cost per day. The following is a summary of the costs der day of refining for core refinement.

Building	$0.50
Furnace	0.64
Pumps, oil tanks, etc.	0.65
Special hardening machine	0.50
Fuel	2.28
Quenching oil (if used)	0.60
Power	0.78
Foreman and superintendence	2.25
Labor	9.00
Miscellaneous expenses	1.25
Total cost per day	$18.45

The total cost per hour would equal $18.45 ÷ 10 = $1.85. In order to find the cost of case refinement hardening per piece or pound, divide $1.85 by the number of pieces or pounds of work that can be hardened per hour. Assuming that 300 of the ring gears previously carburized and hardened for core refinement are treated per day in one furnace, and that the hardening is done in a Gleason machine using oil for quenching, the output per hour is 30 gears. Then if the cost of hardening for case refinement is $1.85 per hour, the cost per gear is $1.85 ÷ 30 = 6.17 cents.

Costs of Tempering and Inspecting

In estimating the costs of tempering and inspecting, 25 per cent of such items as building, superintendence, etc., are chargeable to these operations and as 50 per cent of these items was charged to carburizing, the amount to be charged to tempering and inspecting will be 50 per cent of the amount charged to carburizing. The method of finding the costs of the various items is as follows:

Building—Fifty per cent of 20 cents (the cost charged to carburizing) = 10 cents, the cost per hour. The cost per day equals 10 × 10 = $1.

Tempering Furnace—If 20 per cent of the cost is allowed for interest and depreciation, this cost per year is 20 per cent of $200, or $40, and the cost per day equals $40 ÷ 300 = 13.33 cents.

Straightening Machine—If 10 per cent of the cost is allowed for interest and depreciation per year, this equals 10 per cent of $200, or $20, and the cost per day equals $20 ÷ 300 = 6.67 cents.

Hardness Testing Machine—If 10 per cent of the cost is allowed for interest and depreciation per year, this equals 10 per cent of $285, or $28.50, and the cost per day equals $28.50 ÷ 300 = 9.5 cents.

Fuel—If 1 gallon is used per hour, the cost per day is 10 × 7 = 70 cents.

Tempering Oil—If 4 gallons is used per day this cost equals 4 × 40 = $1.60.

Foreman and Superintendence—Fifty per cent of $9 (the amount charged to carburizing) = $4.50, the cost per day.

Labor—Two men employed for this work would cost 2 × 45 × 10 = $9.

Miscellaneous Expenses—Fifty per cent of 50 cents (the cost charged to carburizing) = 25 cents, the cost per hour, and 25 × 10 = $2.50, the cost per day.

The following is a summary of the various costs per day, for tempering and inspecting.

Building	$1.00
Tempering furnace	0.13
Straightening machine	0.07
Hardening testing machine	0.10
Fuel	0.70
Tempering oil	1.60
Foreman and superintendence	4.50
Labor	9.00
Miscellaneous expenses	2.50
Total cost per day	$19.60

The total cost per hour will equal $19.60 ÷ 10 = $1.96, and in order to find the cost per piece or pound of work for tempering and inspecting, divide $1.96 by the number of pieces or pounds that can be tempered and inspected per hour, assuming that thirty of the gears that have been given the preceding heat-treatments are tempered and inspected per hour, the cost per gear is $1.96 ÷ 30 = 6.53 cents. The total cost of performing the various operations on each gear can then be summed up as follows.

Carburizing, in cents	16.00
Hardening for core refinement, in cents	1.79
Hardening for case refinement, in cents	6.17
Tempering and inspecting, in cents	6.53
Total cost per gear, in cents	30.49

This article is the last one in the series relating to carburizing and casehardening which began in the January number of MACHINERY, and which has dealt with the various matters relating to this work that must be considered in a practical hardening department.

* * *

According to the National Automobile Chamber of Commerce, this country exported 67,106 passenger cars, valued at $73,642,035 in 1919, as against 36,936 cars, valued at $36,278,292 in 1918. The heaviest increases were shown in the South American trade. Canada, the largest buyer of American cars, took 8222 passenger cars and 1596 trucks. Truck exports numbered 15,467, valued at $35,099,079, as against 10,308, valued at $26,814,952 in 1918.

Modern Broaching Practice

Second of Two Articles Describing Methods and Fixtures Used in Performing Broaching Operations

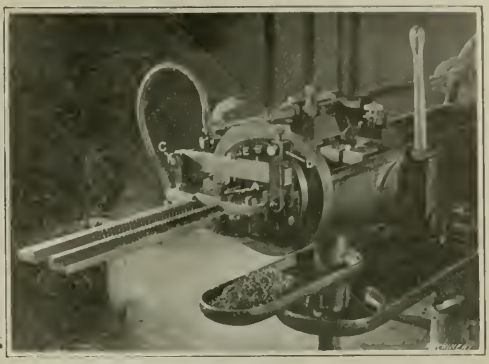


Fig. 14. External Broaching Operation

THE first article on this subject, published in the June number of MACHINERY, discussed general classes of work that can be broached; accuracy attained in broaching; coolants used for broaching; and procedure in ordering broaches. Broaching methods and fixtures employed for specific jobs, were described and illustrated. In the following article, the description of broaching methods and fixtures for holding and locating the work is continued.

Broaching Operation as a Substitute for Milling

In the general discussion of the range of work that can be handled on broaching machines in the June number, mention was made of the fact that it is often possible to broach certain classes of work which might ordinarily be regarded as typical jobs for a milling machine. An example of this kind is illustrated in Fig. 14, where it will be seen that the work *A* is to have a portion of the metal cut away along each edge of its under side. A job of this kind could quite well be handled on a milling machine equipped with two form cutters to straddle-mill the work, and by making a suitable string fixture a very satisfactory rate of output would be secured. Experienced milling machine operators can draw their own conclusions as to the relative merits of milling or broaching these pieces, when it is known that on the broaching machine ten of these cast-steel parts are completed per hour. Very little discussion of the work-holding fixture is necessary. It will be seen that strap *B* is pivoted at *C* and provided with a clamping member *D*. After strap *B* has been secured in place, nut *E* is tightened to hold the work in place on the fixture. Of course, it will be evident that each of the broaches is formed to remove a segment of metal of desired shape.

Broaching out the Center of a Small Casting

Fig. 15 shows the equipment utilized for broaching small castings which constitute parts of one of the equipments made by the Cleveland Dental Mfg. Co., Cleveland, Ohio. The job consists of broaching out a cored opening in the work. A simple form of fixture is used for this purpose, and reference to the illustration will show that it has a fixed jaw *A* and an adjustable jaw *B* that grip the edges of a flange *C* at the base of the casting, the movable jaw being manipulated by two adjusting screws *D* and then clamped in place by tightening two screws *E*. It will be apparent, that the work is of considerable height and that this overhang would be sufficient to cause an objectionable amount of springing and vibration if an adequate upper support were not provided. This support consists of a block *F* mounted on the vertical slide, so that it can be lowered into place against the work, after which binding screws *G* are tightened to maintain a permanent location. From the front view of the casting held in place in the fixture, it will be apparent that the opening to be broached is shown at *H*, and the broach used for this fixture is of a narrow rectangular cross-section. Following the usual practice, the work-holding fix-

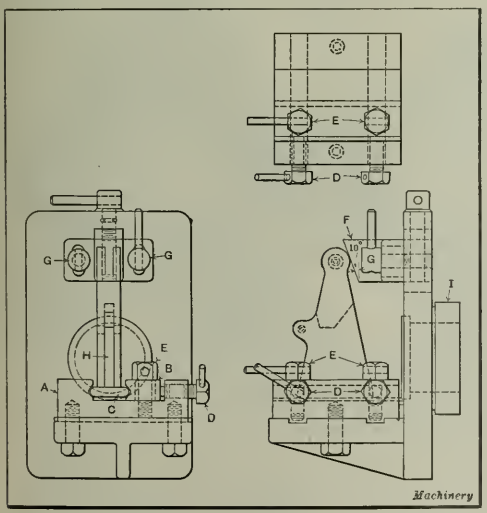


Fig. 15. Work-holding Fixture used for broaching out the Cored Hole shown at H

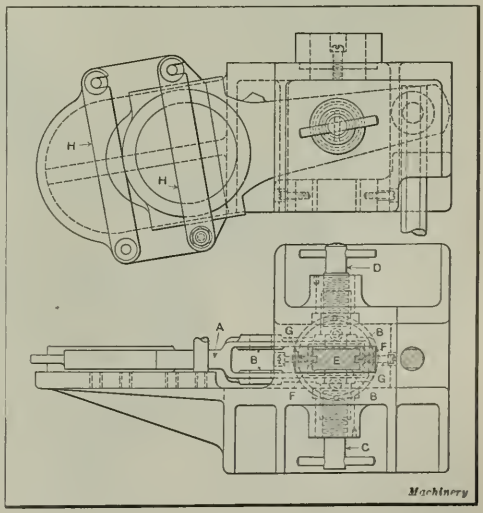


Fig. 16. Finishing the Inside Surfaces of Bosses B on the Broaching Machine

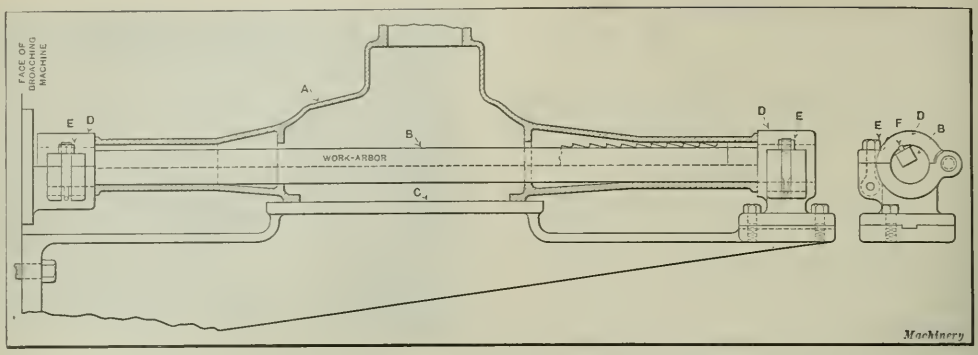


Fig. 17. Reo Rear Axle Housing A is held by Arbor B on Fixture C while broaching a Keyway

ture is secured to the faceplate on the machine by means of a boss *I* that enters a hole in the faceplate.

Broaching Inner Faces of Bosses on Eccentric Straps

Another application of a broaching machine for the performance of what might ordinarily be regarded as a milling operation is illustrated in Fig. 16, which shows the work-holding fixture for use on a J. N. Lapointe machine used for broaching the inner surface of bosses on eccentric straps. Referring to this illustration it will be seen that the work is shown at *A* and that there are two pairs of bosses *B*, the faces of which have to be broached. Two settings of the work are required to complete this job. Owing to the form of the work it is of particular importance to afford a means of support which will adequately prevent the surfaces to be broached from springing away from the tool. On the fixture for handling this job, such provision was made by means of two heavy screws *C* and *D*. With the work in place in the fixture, screw *C* is first turned until its end engages the under side of the work; then screw *D* is tightened down on the upper surface. In this way two thrust members are applied to opposite sides of the bosses from those which are to be broached, and there is no possibility of the pressure of the cut causing the work to spring out of place.

The broach is shown at *E*, and there is a guide member *F* at each side of the broach, which is held in the desired position by a screw *G*. After the first pair of bosses has been broached, the work is released and reset in the fixture to bring the second pair of bosses into the operating position. Aside from the location of the work, the method of broaching is identical in each case. So far as clamping the work in the fixture is concerned, this is quite simply accomplished by means of two clamping bars *H*, which are pivoted at one end, and provided with C-shaped latches at the other, which makes it necessary only to slightly loosen the binding nuts in order to allow the latches to be swung back to lift the work out of the fixture. The fixture itself is secured in the faceplate of the broaching machine by the familiar method of having a boss on the fixture enter a hole in the faceplate. On this job the work is cast steel, and ten eccentric straps are completely broached per hour.

Broaching Keyways in Reo Rear Axle Housings

Rear axle housings which have to be machined at the plant of the Reo Motor Car Co., Lansing, Mich., require a keyway to be cut that extends the entire length of the work. A broaching machine is used for this job, and Fig. 17 illustrates the work, work-holding fixture, and broach that are

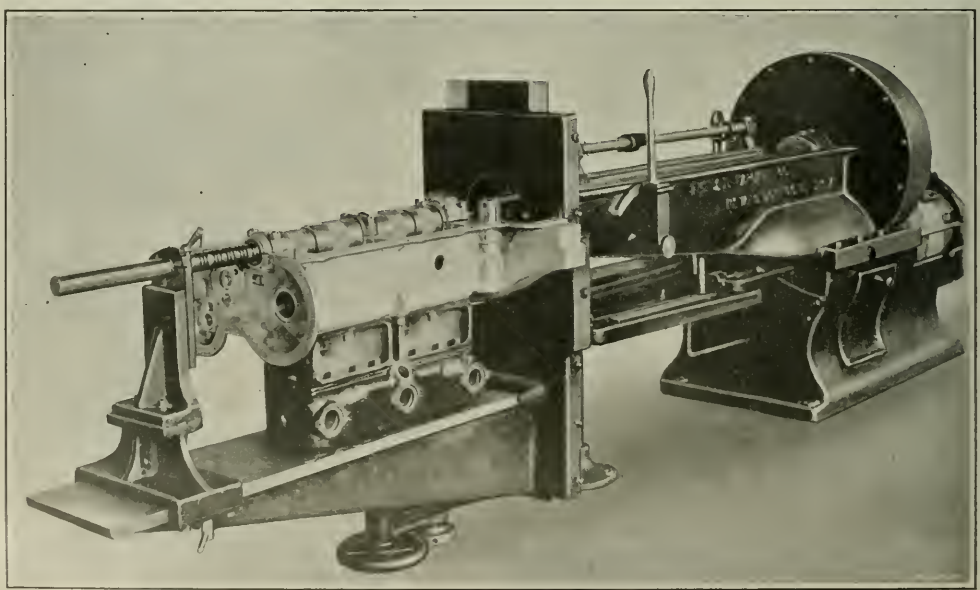


Fig. 18. Machine equipped for broaching the Camshaft Bearings in the Crankcase of a Motor Car Engine

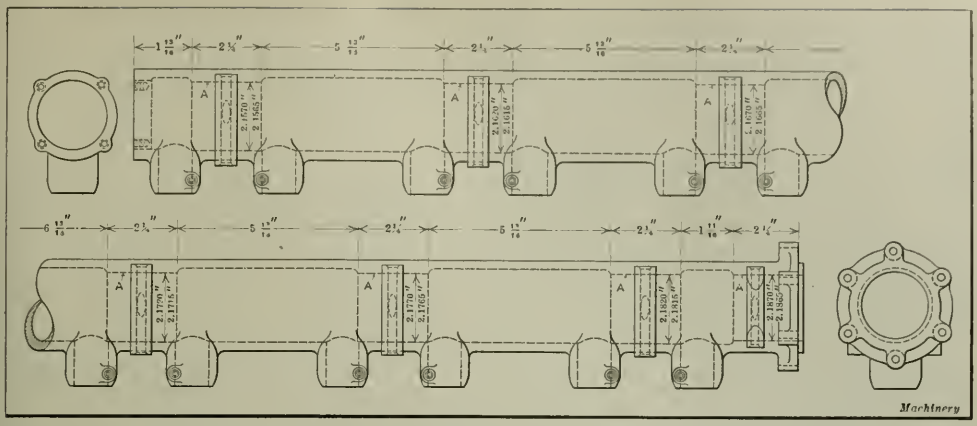


Fig. 19. Cam Frame of a Murray & Tregurtha Engine in which Seven Bearings A are finished by broaching

used. The rear axle housing *A* is shown in cross-section, and it will be apparent that a work-supporting arbor *B* is utilized to assist in holding the piece on the platen *C* of the fixture. In loading the fixture, the work *A* is first put into place on platen *C* after which the arbor *B* is slipped through the end brackets *D* and the hole in the work, and secured in place by tightening the binding nuts *E*. Reference to the end view of the fixture will make it apparent that arbor *B* is provided with a guide slot to receive broach *F*. On this job the rate of production is twelve housings per hour.

Broaching the Bearings in a Camshaft Case

Fig. 19 illustrates the camshaft case of an engine built by the Murray & Tregurtha Co., Boston, Mass., this illustration showing the work divided at the center and the two halves placed one beneath the other. Reference to the illustration will make it apparent that there are seven bearings *A* to be broached, the diameters of which range from 2.1570 to 2.1870 inches, each adjacent bearing being 0.005 inch larger than the preceding one. Quite obviously this difference in the size of the bearings introduces a complication in broaching, because of the impossibility of pulling a single broach right through the work. The very small difference in size between bearings that are located adjacent to each other makes it a profitable procedure to first broach all of the bearings to a standard size equal to that of the smallest bearing to be broached, namely 2.157 inches. After this has been done, a broach with a pilot 2.157 inches in diameter is used to broach all of the bearings except the one at the left-hand end of the work. The pilot on this broach enters the left-hand bearing which has already been finished to the desired size, and the teeth of this broach are so located that they come into engagement with the last of the bearings that they are to broach immediately after the pilot has entered the finished bearing at the left-hand end.

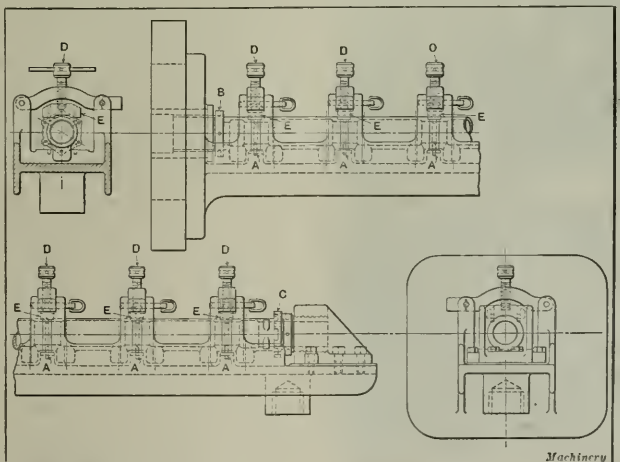


Fig. 20. Work-holding Fixture used on the Broaching Machine for finishing Bearings of the Cam Frame shown in Fig. 19

When the second bearing has been broached in this way, a broach is used for finishing the third bearing from the left-hand end of the work, which has a pilot 2.162 inches in diameter. Similarly, the broaches for finishing the remaining bearings have pilots 2.167, 2.172, 2.177 and 2.182 inches in diameter, respectively.

Fig. 20 illustrates the work-holding fixture that is utilized to support the camshaft case shown in Fig. 19, while the bearings are being broached. In a general way, this fixture is quite similar to the one described for use in cutting the keyway in Reo rear axle housings, except that no work-holding arbor is employed. Located at the top of each bearing there is an oil-hole, and with the work in the inverted position which it occupies in the fixture, a pin *A* enters each of these oil-holes to locate the work in the desired longitudinal position. After this result has been accomplished, two threaded collars *B* and *C* are tightened up to engage opposite ends of the camshaft case and prevent longitudinal movement while the pressure of the cut is effective. As in the case of the eccentric straps shown in Fig. 16, it is necessary to provide means of supporting the work so that it will not spring away from the broach while the operation is being performed. In the present case this result is accomplished by means of clamping screws *D*, each of which carries a yoke *E* that embraces the upper surface of each bearing, while the lower surface is similarly held by its seat in the fixture. With the work secured in this way, there is very little chance for the amount of pressure developed by the broach to cause it to expand sufficiently to introduce a serious error. On this job the material to be broached is lynite, and the rate of production attained is four completely broached camshaft cases per hour.

Suggestions for Overcoming Broaching Troubles

In setting up a broaching machine for cutting any shape of hole, care should be taken to ascertain

that the center of the pull bushing or broach holder is in line with the center of the faceplate hole. If the broach holder is slightly above or below the proper position, it will cock the work out of place, and even if the broach is not broken, the hole cut by it will not be perpendicular to the sides of the work. Should it happen that trouble is experienced through tearing the material, or that there is a tendency for the metal to break out around the end of the hole adjacent to the faceplate of the broaching machine, either of the following remedies may be applied; namely, the metal may be heat-treated to bring it to a scleroscope hardness of from 30 to 35. In some cases this trouble can be eliminated by grinding a 10- to 15-degree rake on the face of the broach teeth or by backing the metal up with a ¼-inch collar between the work and faceplate, so that this collar will be broached out to the shape of the finished hole. For broaching bronze or other non-ferrous metals, a straight-faced tooth with about ½-degree top clearance will usually be found to give the most satisfactory results. In broaching square or hexagonal holes, if the broach tends to drift to one side owing to lack of provision for grinding it, two or three very light lengthwise rubs of an oilstone on the side of the broach teeth which cut fastest, will often remove the cause of trouble. As in other methods of machining, accidents are bound to occur in the performance of broaching operations; and if one or two teeth of a broach are broken, stoning or restepping the following two or three teeth will put the tool in good condition for subsequent use. In shops where broaching machines have been recently adopted and only a limited amount of experience has been obtained in their use, careful attention paid to the preceding recommendations will often be the means of substantially improving the rates of production and the quality of workmanship attained.

* * *

MILLING DOVETAIL SLOTS IN ARMATURE SPIDERS

The accompanying illustration Fig. 1 shows a No. 5 Cincinnati milling machine of the column and knee type, which is equipped with a special cross-rail attached to the over-arm, on which two special cutter-heads are mounted. The operation upon which this machine is employed is that of milling the dovetail slots in armature spiders for electric motors. The work is being done in the General Electric Co.'s shop at Schenectady, N. Y. The cutter-heads are adjustably mounted on the special cross-rail so that various sizes of spiders can be machined by setting the heads to accommodate the spacing of the lugs in which the slots are milled. The fixture upon which the work is mounted consists of a cast-iron base with a center post which fits the bore of the spider. Suitable means are provided for indexing and locking the fixture in position after taking each cut.

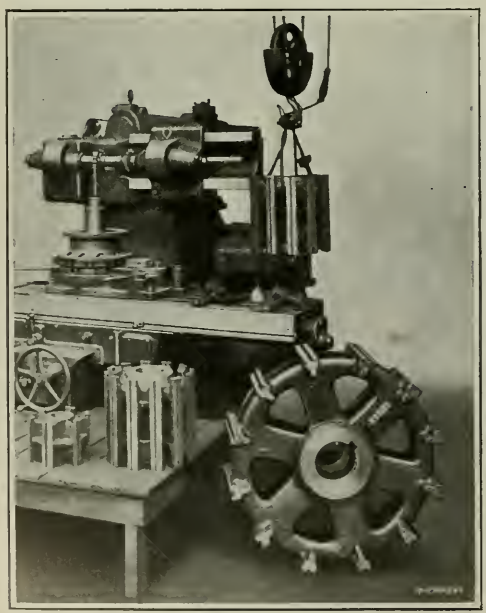


Fig. 1. Milling Machine equipped with Special Cutter-heads for milling Dovetail Slots in Armature Spiders

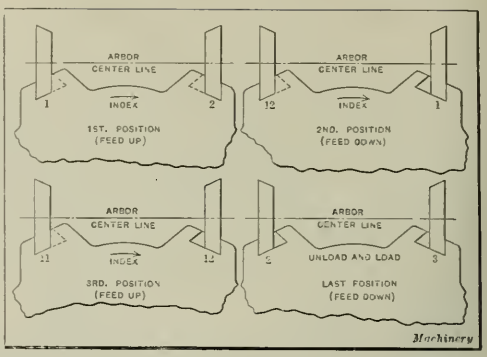


Fig. 2. Diagrammatic View of Sequence of Cuts taken in milling the Dovetail Slots in Armature Spiders

The work is swung from the floor to the machine table by means of a hoist as may be clearly seen in Fig. 1, which also shows a number of spiders of various sizes. Castings ranging from 9½ to 33 inches in diameter are handled on the milling machine shown, equipped with fixtures of this type. The spiders that are machined on the fixture illustrated require twelve slots, each 10¼ inches long, extending the entire length of the casting. When the slots in the spider have been completely machined, the table is in the low position as shown in the illustration, so that when a new casting is mounted, the first two cuts will be taken on the upward travel of the table. The cutters employed are single-angle cutters and are so set in relation to the lugs on the outside of the casting being milled, that the proper angle of the slots relative to the face of the lugs will be obtained.

At the completion of the upward traverse of the table, one-half a slot will be milled by each cutter; the fixture is then indexed to the next position, and the direction of feed reversed while the remaining half of one of the slots and the first half of the next slot are milled. The idea is diagrammatically shown in Fig. 2, in which the first three positions and the final position of the indexing fixture may be seen. A little thought will make it clear that the sequence of cuts, during which no interruption is caused by returning the table for starting each cut, enables the work to be machined with a minimum amount of lost time or motion. The procedure of traversing the table up and down without changing the direction of the cutter rotation, continues until the work is finished, there being as many traverses required to finish a casting as there are slots to be milled in it. It will be observed that this method of milling out the dovetailed slots is somewhat similar to that employed in milling straight-tooth clutches.

* * *

Consul Harry Campbell reports from Java that American machine tools are rapidly gaining in favor in that market. One of the largest and most successful machine shops in Soerabaya is completely equipped with modern American machine tools. It is announced that this concern has recently been awarded the contract for the iron and steel work of a new government railway terminal at Tandjong Priok, the port of Batavia. This speaks well for the Soerabaya shop, with its American equipment, in view of the competition of Batavia firms located much nearer the work.

Reducing the Labor Turnover

By WILLIAM A. ROCKENFIELD, General Manager, Baldwin Chain & Mfg. Co., Worcester, Mass.

In the present article Mr. Rockenfield deals with some of the questions involved in the reduction of labor turnover. He points out the importance of making some active efforts to educate industrial workers in regard to their relation to the industries in which they are employed and the relation of the industries to the community. He advocates a proper conception of the term "labor," and deals with some of the problems met with in the handling of both native and foreign-born workers. He discusses the subject of welfare work and paternalism, and points out how many difficulties can be avoided and harmony promoted if more careful attention is given to what at first may appear to be minor matters in labor management.

WHENEVER an employment manager rises to talk today, he speaks about the "labor turnover," the "human element," etc., as if he had made some new discovery or invented a new philosophy. As a matter of fact, there is nothing new about it. It is only that it is becoming more and more evident that managements have neglected the most valuable part of their equipment and allowed it to depreciate faster than need be. There is but one science necessary to deal with these problems—the science of common sense. Because a problem is a large one, it does not necessarily mean that it calls for the application of extraordinary treatment. However, there are a number of things that will improve the situation, some of which are simple and elementary in their nature even if difficult to achieve in practice.

Relation of Industrial Workers to the Industries

One of the most important things is the education of workmen in regard to their relation to the industries and the relation of the industries to the community. If it were possible to indicate clearly how through the chain of industrial enterprises we all work mainly to produce things that we each need in our daily life, much would be achieved. Men work in industries because they can produce more in that manner than by working individually. The industries work to produce goods for the community and the community, in turn, is composed of the men who work in the industries. So that, after all, the whole thing is a circle in which men supply work to supply their own needs and produce the things that they themselves require.

This education should preferably begin in the public schools where it should be made evident to the children that the one great fact upon which industry is built, and upon which it stands or falls, is reasonable profit and reasonable returns to those whose initiative have made the industry possible. An understanding of this on the part of the children would tend to prevent unreasonable demands in the future. Labor could even be trusted to set its own wage scale and help production efficiency, if men were taught early that they finally pay their own wages, and that "what the dollar will buy" is the real measure of its value, and that that value depends directly upon the amount that is produced for a dollar's worth of wages in goods for consumption.

It is a mistake to believe that skilled workmen could not understand many of the problems of the employer, provided these problems were clearly and openly laid before them. Skilled workmen do not want revolution. At most, they want a little faster evolution.

A Broad Conception of the Word "Labor" is Needed

Many of the misunderstandings now arising between employers and employes are due to misapplication of the word "labor." Simple things are befogged and made hard to understand by employing unusual words and involved sentences. Such expressions as "the understanding of the psychology of labor" may look well in print, but mean little. In the first place, all effort, mental or physical, directed toward producing things that give happiness and comfort to life, is labor. To simply call physical effort "labor" is erroneous and creates the idea that "labor" is something to be disliked. On the other hand, if labor—work—is properly understood to include all useful effort, it acquires the dignity that is so much spoken of. If each of us were taught this simple principle in school, and if all of us would live up to this principle as well as preach it, it would aid a great deal in lessening the rift between capital and labor. If a man's value could be measured by his contribution to the world's useful work, it would probably be found that a first-class laborer contributes more to the community than the average clerk, even though the latter has been taught to think that by our present code he is on a higher social rung. When employers and employes thoroughly appreciate these facts, there will be less antagonism, less friction, and consequently less labor turnover.

Monotonous Work as a Cause of Unrest

The monotonous character of much of the work in the modern industrial plant is one of the real underlying causes of unrest and uneasiness on the part of employes. When a man becomes so accustomed to a job that he can do it without mental effort, his mind is free to interest itself in something outside of his job. The obvious remedy for this state of affairs would be to change the jobs frequently; but this is difficult, if not impossible, to do in present factory organizations. Nevertheless, the management should attempt to create some condition that would add the required stimulus to the work, and this can often be done in various ways if the will to do it is there. One of the reasons why office workers do not strike nor affiliate with unions is that their minds are kept busy and the nature of their work is more interesting, requiring more exercise of their mental faculties. The man who is placed where his work becomes too monotonous naturally will seek a change, and this is one of the causes of a large labor turnover. It is one of the most difficult causes to deal with, but the problem can doubtless be partially solved if executives will study the conditions of this problem as it appears in their particular plant.

Dealing with the Foreign-born Worker

Another problem in the question of labor turnover is the foreign-born worker. He ordinarily has no particular attachment to any plant or town, and it is more necessary to make him feel at home in the factory than in the case of a native-born American. Many schemes for Americanization have been put forward, but one fundamental fact stands out clearly, and yet it is the one most frequently overlooked. The most direct and the easiest way in which to make an American out of a foreigner is to "treat him like one."

In addition to this, there are a few minor rules that ought to be observed. Do not segregate foreign-born workers into groups of one nationality and language, as this does not promote their desire to learn English. Mix them with other nationalities, especially with Americans. This prevents undesirable race characteristics from cropping out and bearing fruit, and it destroys the opportunity for the unscrupu-

lous foreign language agitator to give to the foreign-born worker distorted views and ideas of the management.

Welfare Work and Paternalism

Much has been done to reduce the labor turnover by means of welfare work, and within limits, much that has been done is commendable. But it should always be remembered that it is not paternalism but the treating of workers like human beings that is the key to efficiency. Most men resent paternal care and do not like to be "nursed." They want to develop themselves and feel fully capable of working out their own destiny. Many welfare workers have observed that in any scheme of welfare work in which the worker does not voluntarily make some part of the sacrifice, or contribute, at least partially, his time, money, or energy, the efforts of the management usually fail in their object. On the other hand, every man appreciates knowing that unselfish aid will be quietly given, without advice or strings attached, in case of misfortune or need.

First Impression in Hiring Men Reduces Labor Turnover

Labor turnover could be largely reduced if men were hired with greater care and given a good impression of the firm for which they come to work, from the beginning. Ordinarily, the man applying for a position is asked numerous questions as to where he worked before and why he left his last job, but little is told him about the conditions of the job which he is expected to take. The wise employment manager sells the job to the man in the same way as a good salesman sells a machine to a customer. He impresses the man with the good points of the firm for which he is going to work and of the advantages of the job that he is taking. He gives him the right impressions of the conditions, tells him fairly what he is to expect, the kind of conduct that will be expected from him, and the advancement that he, in turn, may expect if he meets the requirements. Personal interest is shown in his affairs from the beginning, with a view to creating a good impression. First impressions are usually lasting, and this point has proved valuable in reducing labor turnover. Any other methods employed are good, bad, or indifferent according to the account they take of the peculiarity of human nature. No device or system will ever take the place of common understanding and mutual respect, and any scheme which does not work toward these things is only a makeshift.

Dismissing Men

The wise manager never discharges a man when either of the two is angry. If matters do not adjust themselves within the following twenty-four hours, it is time enough to take the required steps in a calm and sensible manner.

The problem of the elderly man in the industry is considered a difficult one and yet, as long as he is in good health, it should not be so difficult after all. The fact that a man has worked for one concern for a great many years is assurance of his loyalty and staying qualities. His loyalty and the example that he sets are worth a great deal to a business, and it is generally possible to find the kind of job that will meet the requirements, as he becomes older, both as regards his working ability and his personal pride. The knowledge that these men have of the factory and its traditions and the thousand and one things that one can learn only by years of experience in the same place, fit them for many positions which a younger man without this experience would not be so well able to fill.

Attitude toward the Labor Movement

In a properly managed factory, the attitude toward the labor movement is really of secondary importance. If the management does not believe in collective bargaining, it will never let any conditions come to that stage. Men do not resort to collective methods until they find it impossible to get satisfaction individually. The collective method really is against the natural inclinations of most men. This is the reason why cooperative stores and similar enterprises have never succeeded in the United States to any appreciable extent, and they never will unless the consumer is absolutely forced into cooperative buying through the coercion of profiteering on the part of wholesalers and retailers. In the same way, discontent and strikes are stopped before they start in factories where the individual workman knows that he will receive consideration and fair treatment upon individual application.

The Labor Turnover Record

In studying the question of labor turnover in connection with production, the monthly production record should contain, in addition to the figures stating output, cost, labor turnover, etc., such information as the number of men injured, and the reasons for the injuries; the number of men sick, and the reasons why. By a careful study of questions of this kind it is often possible to remove some of the reasons for a high labor turnover that may not previously have been suspected. As a rule, the manager must entrust many of the mechanical details to subordinates, but he cannot afford to entrust facts relating to the human side to minor executives. The human factor pays the largest dividend and contributes most largely to the efficiency of the plant. That is the part of the machinery to which he must give his first and most careful attention.

In conclusion, my experience has been that too strict a manager cannot obtain any more cooperation than too easy a one—neither extreme produces harmony nor creates the conditions under which efficiency and production are the result. Men with initiative do not seem to be able to adjust themselves properly to either kind of manager. The best means for securing the cooperation of employes is expressed in the old saying, "If you want a friend, be one." You will get out of your plant just exactly what you put into it. If you put into your plant confidence, fairness, and loyalty, you will find in time, that these same qualities will return to you through your employes.

* * *

THERMOMETER SYSTEM FOR PREVENTING SPONTANEOUS COMBUSTION

It is necessary for large industrial plants, railroads, etc., to store immense quantities of coal, which is often a serious and expensive problem. The great danger resulting from the storing of coal is the slow combustion which takes place and which is not detected until the odor becomes noticeable. When this happens, the coal should be redistributed so as to remove pressure on the heated layer, and in some cases the entire coal pile must be turned over, requiring quick action and resulting in great expense.

In order to detect any increase of temperature in the coal pile of one large plant, an electrical thermometer system was installed having the temperature indicating instrument or pyrometer in the engineer's office. The switches were so arranged that the temperature of predetermined locations in the coal pile could be obtained, and coal could then be removed from necessary points. A temperature of 250 degrees F. was considered to be the safe internal temperature. Portable receptacles for thermo-couples were placed in rows in the pile. These receptacles were constructed of 1-inch wrought-iron pipe, welded to a point at the end which entered the coal pile. The exposed end was fitted with a self-closing cap to prevent the entrance of anything that would interfere with the insertion of the thermo-couples. The wiring to the engineer's office was of a permanent nature from a central location of the coal pile and from this point lines radiated to the thermo-couples. The thermo-couple receptacles were numbered, and each row had a distinguishing letter. The switches in the engineer's office were numbered and lettered in a manner to correspond with these receptacles. This plan permitted the thermo-couples to be placed in the desired receptacles and the engineer to observe the temperature readings of the coal at the different points, and thus detect dangerous increases of temperature.



Turret Lathe Practice

Description of Tooling Equipment for Turret Lathe Operations—Based on Practice of the Foster Machine Co., Elkhart, Ind.

IN the first installment of this article, published in the June number of MACHINERY, tooling equipments required for finishing gear blanks, friction cones, and automobile pistons were dealt with. The present article, which is the second and last installment, describes tooling equipments employed on turret lathes for machining automobile differential gear cases, chuck bodies, semi-steel castings, friction pulleys, and bar stock parts.

Finishing Automobile Differential Gear Cases

The differential gear case illustrated in Fig. 16 is machined on a No. 1-B universal turret lathe as indicated by the heavy lines. This part is made of malleable iron and is machined in 6.4 minutes. A machine equipped for the performance of this operation is shown in Figs. 18 and 19, from which a good idea of the set-up may be obtained. Fig. 18 shows a view of the front of the machine, while Fig. 19 presents a close-up view of the work and some of the tools, this photograph being taken from the rear of the machine. The various steps in the operation are as follows: (1) The casting is placed in a three-jaw air chuck provided with special jaws that grip the work along the periphery of the flange. The chuck is also provided with a guiding bushing to suit the pilots of the various tools mounted in the turret. (2) Holes *A*, Fig. 16, are rough-bored and surface *B* is turned by the tools held in a double-cutter piloted boring-bar mounted in a turning slide tool in the turret; surface *C* is rough-turned by a tool held in the square turret, and surface *D* is rough-faced by another tool held in the square turret. (3) Holes *A* are finish-bored and surface *E* is faced by a double-cutter piloted boring-bar held in a turning slide tool mounted in the turret. (4) Surface *F* is rough-faced by a tool mounted in a piloted bar which is held in the turret. (5) Surface *F* is finish-faced by a tool mounted in another piloted bar, which is also held in the turret. (6) Holes *A* are reamed by an expansion reamer mounted in the turret.

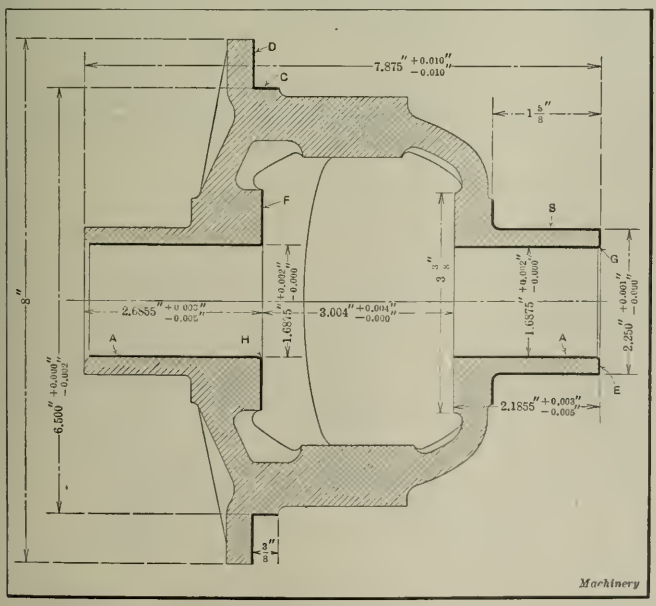


Fig. 16. Drawing of Automobile Differential Gear Case

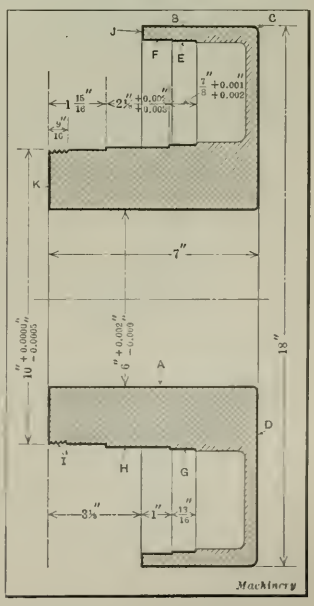


Fig. 17. Cast-steel Chuck Body

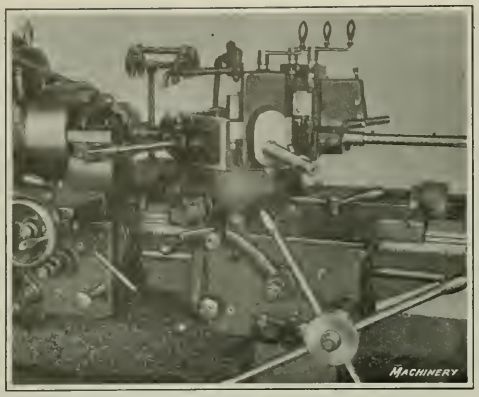


Fig. 18. Machine equipped with Tools required in finishing the Differential Gear Case

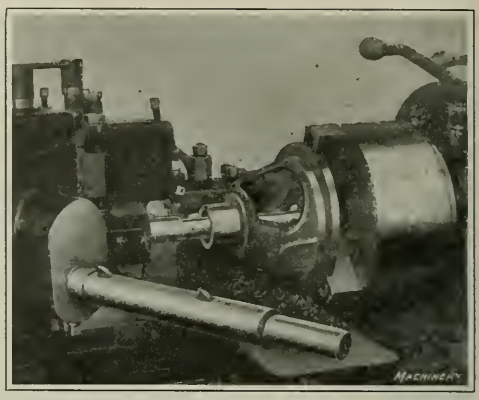


Fig. 19. Rear of Machine illustrated in Fig. 18, showing a Close View of the Work

(7) Chamfer *G* is formed and corner *H* is rounded by tools mounted in a piloted bar held in a sliding tool in the turret. (8) The casting is removed from the machine. This completes the operations on the differential gear case.

Equipments Used in Machining Cast-steel Chuck Bodies

The cast-steel chuck body illustrated in Fig. 17 is machined in two operations as indicated by the heavy lines, in 1 hour 21.8 minutes on No. 3-B universal turret lathes. A

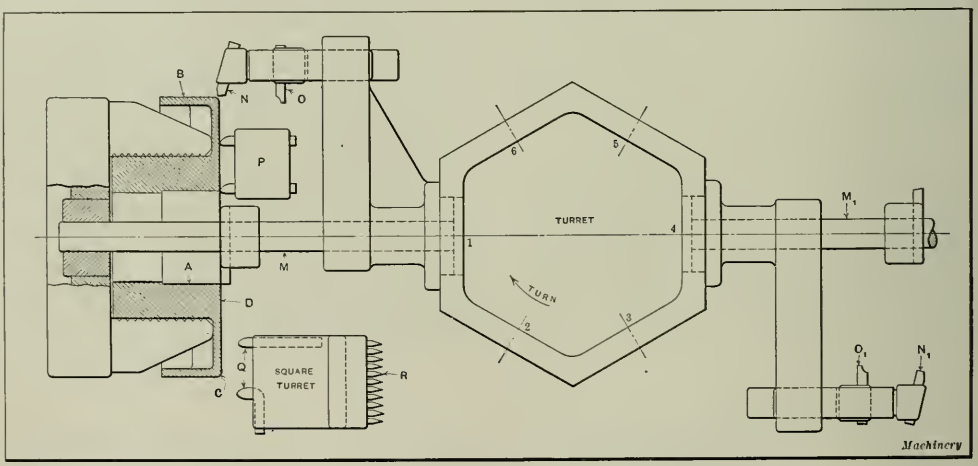


Fig. 20. Equipment used in the First Operation on the Chuck Body shown in Fig. 17

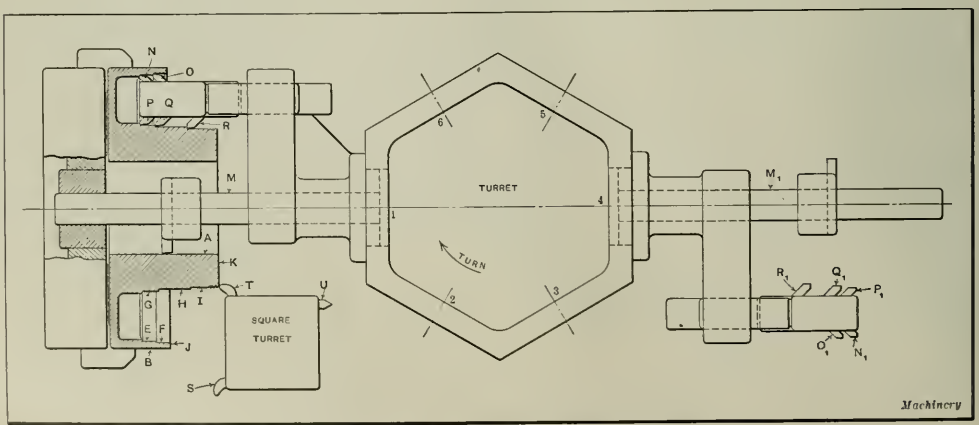


Fig. 21. Lay-out of the Tools used in the Final Operation on the Chuck Body

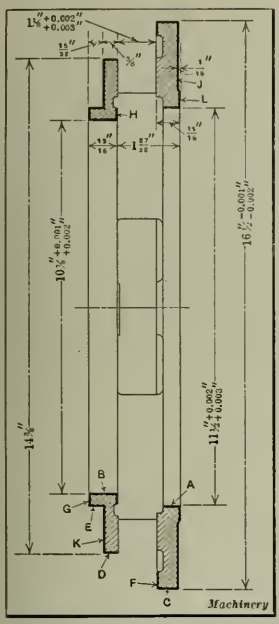


Fig. 22. Semi-steel Casting

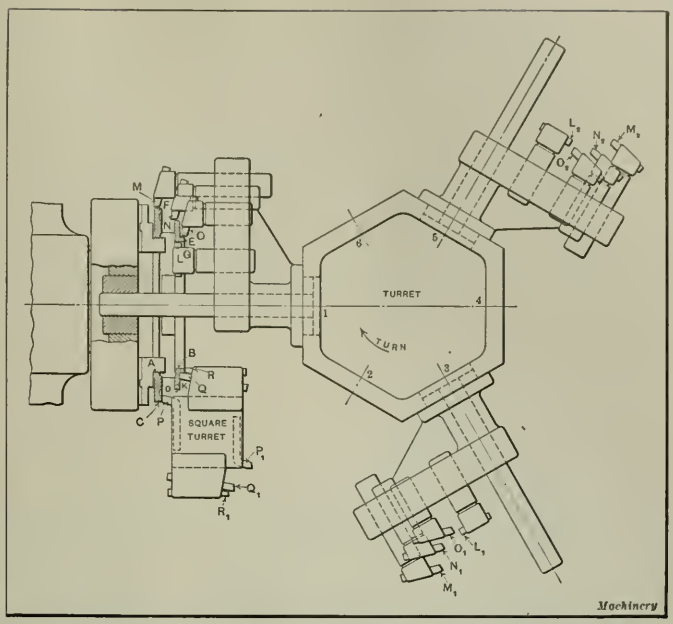


Fig. 23. Tool Lay-out used in the First Operation on the Casting illustrated in Fig. 22

lay-out of the tooling equipment used in the first operation is shown in Fig. 20; this operation requires 42.2 minutes. The series of steps is taken in the following order: (1) The work is mounted on a chuck equipped with three corrugated and hardened jaws that grip it on the rough surface of the hub. (2) One-half the length of hole *A* is rough-bored by the cutter held in the piloted boring-bar *M*; surface *B* is rough-turned by tool *N*, and corner *C* is rough-turned by tool *O*, these tools and boring-bars being held in the multiple turning head in Side 1 of the turret. Surface *D* is rough-faced by the tools in toolpost *P* on the rear of the cross-slide. (3) The part of hole *A* rough-bored in the second step is now finish-bored by the cutter held in boring-bar M_1; surface *B* is finish-turned by tool N_1, and corner *C* is finish-formed by tool O_1, these tools and the boring-bar being mounted in the multiple turning head in Side 4 of the turret. At the same time, surface *D* is finish-faced by tools *Q* which are held in the square turret. (4) Concentric grooves are cut on surface *D* by tools *R* which are mounted in the square turret. (5) The casting is removed from the chuck, completing the operation.

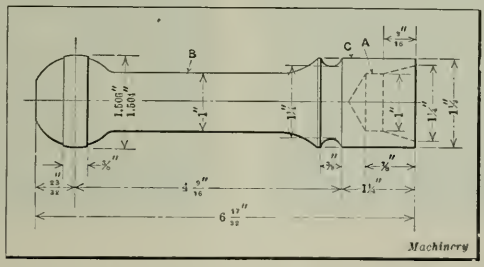


Fig. 24. Bar Stock Part, with Contour formed by Special Tool

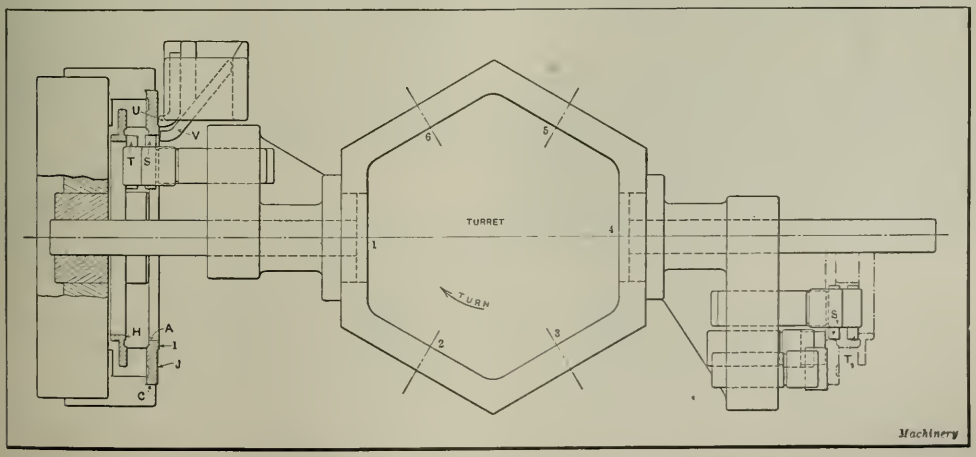


Fig. 25. Tooling Equipment required in the Second Operation on the Part shown in Fig. 22

The second operation on the chuck body is performed in 39.6 minutes. A lay-out of the tooling equipment used in this operation is shown in Fig. 21. The successive steps are as follows: (1) The work is mounted in a three-jaw chuck which grips it on the previously finished surface *B*. (2) The half of hole *A* that is still unfinished is rough-bored by the cutter held in boring-bar *M;* surface *E* is rough-bored by tool *N*, surface *F* is rough-bored by tool *O*, surface *G* is rough-turned by tool *P*, surface *H* is rough-turned by tool *Q*, and surface *I* is rough-turned by tool *R*, all of these tools and boring-bar *M* being mounted in the multiple turning head in Side 1 of the turret. At the same time surfaces *K* and *J* are rough-faced by tool *S*, which is held in the square turret. (3) The portion of hole *A* rough-bored in the preceding step is now finish-bored by the cutter held in the piloted boring-bar M_1. Surface *E* is finish-bored by tool N_1, surface *F* is finish-bored by tool O_1, surface *G* is finish-turned by tool P_1, surface *H* is finish-turned by tool Q_1, and surface *I* is finish-turned by tool R_1, all of these tools and boring-bar M_1 being held in the multiple turning head mounted in Side 4 of the turret. At the same time, surfaces *K* and *J* are finish-faced by tool *T*, which is held in the square turret. (4) The threads on surface *I* are cut by tool *U* mounted in the square turret, which is used in conjunction with the screw-cutting attachment. (5) The finished part is removed from the chuck.

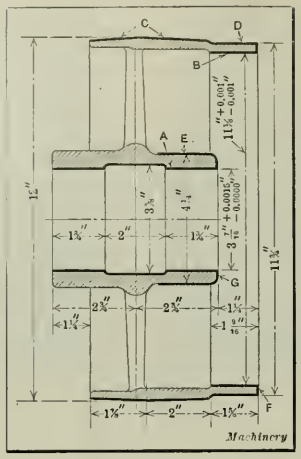


Fig. 26. Drawing of Friction Pulley

Tooling Equipment Employed in Machining Semi-steel Casting

Fig. 22 shows a semi-steel casting which is machined in two operations on No. 3-B universal turret lathes. Both operations are performed in 16.5 minutes. A lay-out of the tooling equipment used in the first operation is illustrated in Fig. 23. The sequence of the various steps is as follows: (1) The work is placed in a three-jaw chuck equipped with corrugated and hardened false jaws that hold the work by bearing against hole *A*. (2) The hole *B* is rough-bored by tool *L*, the surface *C* is rough-turned by tool *M*, the surface *D* is rough-turned by tool *N*, and the surface *E* is rough-turned by tool *O*, all of these tools being mounted in the piloted multiple turning head held in Side 1 of the turret. At the same time surface *F* is rough-faced by tool *P*, surface *K* is rough-faced by tool *Q*, and surface *G* is rough-faced by tool *R*, these tools being held in the square turret. (3) Hole *B* is again bored by tool L_1, and surfaces *C*, *D*, and *E* are again turned by tools M_1, N_1, and O_1, respectively, all of these tools being mounted in the piloted multiple turning head in Side 3 of the turret. At the same time surface *F* is finish-faced by tool P_1, surface *K* is finish-faced by tool Q_1, and surface *G* is finish-faced by tool R_1, these tools being mounted in the square turret. (4) Hole *B* is finish-bored by tool L_2, and surfaces *C*, *D*, and *E* are finish-turned by tools M_2, N_2, and O_2, respectively, all of which are mounted in the turning head in Side 5 of the turret. (5) The casting is removed from the chuck.

The tooling equipment used in machining the remaining surfaces on the casting is shown in Fig. 25. This operation is completed in 6.6 minutes. The series of steps is as follows: (1) The work is mounted in a three-jaw chuck that grips it along the previously finished surface *C*. (2) Hole *A* is rough-bored by tool *S*, and surface *H* is rough-faced by tool *T*, these tools being mounted in the piloted multiple turning head held in Side 1 of the turret. The surfaces *J* and *I* are rough-faced at the same time by tools *U* and *V*, which are mounted on a tool-block on the rear of the cross-slide. (3) Hole *A* is finish-bored by tool S_1, and surface *H* is finish-faced by tool T_1, these tools being mounted on the piloted multiple turning head held in Side 4 of the turret. The work is indicated on this head by dot-and-dash lines. (4) The finished casting is removed from the machine.

Machining Operations on Friction Pulleys

The cast-iron friction pulley shown in Fig. 26 is machined in one operation on a No. 2-B universal turret lathe. A machine provided with the tooling equipment used in machining

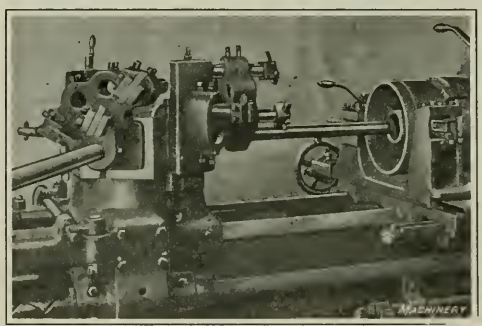


Fig. 27. Machine engaged in finishing the Friction Pulley illustrated in Fig. 26

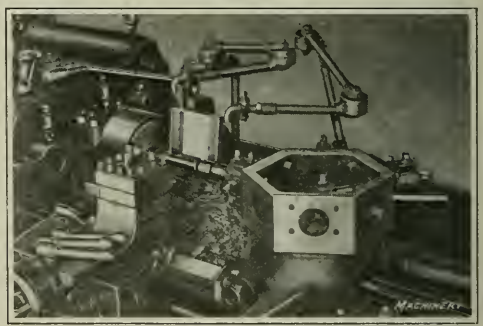


Fig. 28. Machine Set-up employed in manufacturing Part shown in Fig. 24

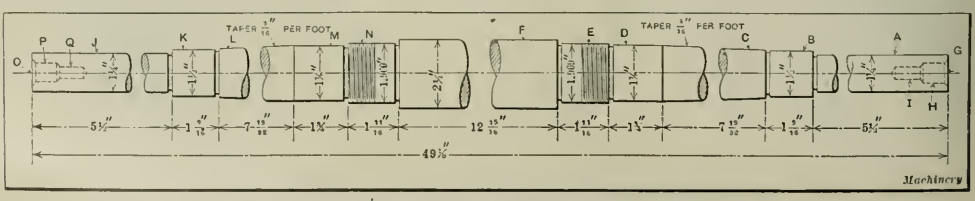


Fig. 29. Long Steel Spindle machined from Bar Stock on No. 2-B Universal Turret Lathes

this piece is shown in Fig. 27. This illustration shows the rear of the machine, and the photograph was taken after the pulley mounted on the lathe had been partially machined. The series of steps in this operation is taken in the following order: (1) The pulley is placed in a three-jaw Barker chuck, equipped with special jaws that bear against the inside of the pulley rim. This chuck is also provided with a guiding bushing to suit the pilots on the various tools mounted in the turret. (2) Hole *A* and surface *B*, Fig. 26, are rough-bored, and surfaces *C*, *D*, and *E* are rough-turned by tools mounted in a multiple turning head which is held in the turret, while surfaces *F* and *G* are rough-faced by tools mounted in the square turret. (3) Hole *A* and surface *B* are finish-bored and surface *D* is finish-bored by tools mounted in a multiple turning head held in the turret, while crown *C* is finish-turned by a tool held in the square turret and a tool mounted on a tool-holder on the rear of the cross-slide, these tools being operated in conjunction with a taper attachment on the rear of the lathe. (4) The relief in hole *A* is bored by a cutter held in a boring-bar which is mounted in a sliding tool attached to the turret. (5) Hole *A* and surface *B* are reamed by a special combination expansion reamer mounted in the turret. (6) The finished pulley is removed from the lathe.

Producing a Part from Bar Stock

Fig. 24 shows the drawing of a part machined from bar stock in one operation on a No. 1-B universal turret lathe. A machine engaged in producing one of these pieces is shown in Fig. 28. This illustration shows quite clearly the method employed in the manufacture of this part. The steps in this operation are taken as follows: (1) The stock is fed to a stop on the turret and then held by means of an automatic chuck. (2) Hole *A*, Fig. 24, is drilled by a drill mounted in a flanged tool-holder held in the turret. (3) Hole *A* is chamfered as shown, by means of a taper reamer mounted in a flanged tool-holder held in the turret. (4) Surface *B* is rough-turned by a tool held in the square turret. A revolving center which is mounted in the turret is placed in hole *A* during this and the succeeding operation so as to support the work adequately during these operations. (5) All the remaining unfinished surfaces except surface *C* (which is not finished, the part being made from cold-rolled steel) and the surface produced when the piece is cut from the stock, are finish-formed by means of a special forming tool that is held in the rear tool-holder. (6) The completed piece is cut off from the stock by a tool held in the square turret.

Equipment Used in Machining a Long Steel Spindle

The steel spindle illustrated in Fig. 29 is machined in two chuckings on No. 2-B universal turret lathes. It will be noted that this piece is over 4 feet long, while the greatest diameter is only 2¼ inches. Both operations on this spindle are performed in 35.7 minutes. A lay-out of the tooling equipment used in the first operation is shown in Fig. 30,

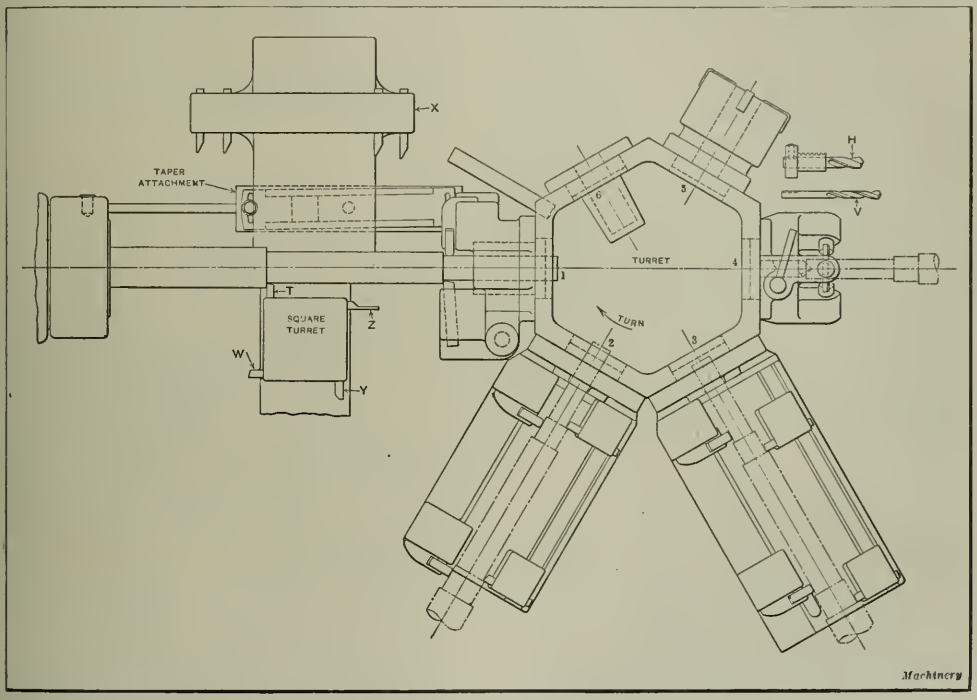


Fig. 30. Lay-out of Tooling Equipment used for machining the Steel Spindle illustrated in Fig. 29, in Two Chuckings

this operation being performed in 19.9 minutes. There are no reference letters shown on the various surfaces of the work in Fig. 30, and so Fig. 29 must be referred to in following the method of manufacturing this part. The various steps in the operation are taken in the following order: (1) The stock is fed up to the stop on the turret corner between Sides 1 and 6, which permits somewhat more than one-half of the length of the piece to project beyond the chuck. (2) Surfaces *A* and *B* are rough-turned by the tool held in the single cutter turner in Side 1 of the turret, and surfaces *C*, *D*, and *E* are rough-turned by tool *T*, which is held in the square turret. (3) Surfaces *A* and *D* are finish-turned and surface *C* is finish-straight-turned by the tools held in the multiple cutter turner in Side 2 of the turret. The work is indicated in this turning fixture by dot-and-dash lines. At the same time, surface *F* is turned by tool *T*. (4) Surfaces *B* and *E* are finish-turned by the tools held in the multiple cutter turner mounted in Side 3 of the turret. The work is also indicated in this fixture by dot-and-dash lines. (5) A center is drilled in end *G* by the roller-rest centering tool in Side 4 of the turret. Then the centering tool is replaced by

drill *H* and hole *H* is drilled, after which drill *H* is replaced by the tap drill *V* and hole *I* is drilled in preparation for a tapping operation which is performed in this end by hand. The centering tool is then replaced in the fixture. While the centering holes are being drilled, surface *C* is rough-taper-turned by tool *W* mounted in the square turret, which is used in conjunction with a taper attachment. (6) While end *G* of the shaft is still supported by the centering tool in Side 4 of the turret, the necking tools mounted on fixture *X* on the rear of the cross-slide are first located, and then the four grooves between the various surfaces on the right-hand end of the spindle are turned by these tools. (7) The threads on surface *E* are cut by the self-opening floating die-head mounted in Side 5 of the turret. (8) The stock is fed up to the special stop in Side 6 of the turret, which permits slightly more than the total length of the spindle to project beyond the chuck. (9) While the stock is supported in the stop just mentioned, the shaft is chamfered at end *O* by tool *Y*, which is held in the square turret, so that the single cutter turner which turns surface *J* in the succeeding operation can be properly started. (10) While the piece is still supported in the stop in Side 6 of the turret, the spindle is cut off from the stock by tool *Z*, which is also held in the square turret. The projecting end of the stock is chamfered at the same time by tool *Z*, so that the single cutter turner used to turn this end of the succeeding spindle can be correctly started.

The second operation on the spindle consists in machining the left-hand end, and is performed in 15.8 minutes. The work is held in a chuck equipped with a collet bushing that grips the work around the previously finished surface *F*. The tooling equipment used in the second operation is identical with that shown in Fig. 30, because surfaces *J*, *K*, *L*, *M*, and *N* and holes *P* and *Q*, respectively, are of the same dimensions as surfaces *A*, *B*, *C*, *D*, and *E* and holes *H* and *I* which were machined by means of this tooling equipment. The only difference between the two operations is the machining of surface *F*, which is performed in the first operation, and for this reason a detailed description of the steps in the second operation is not considered necessary.

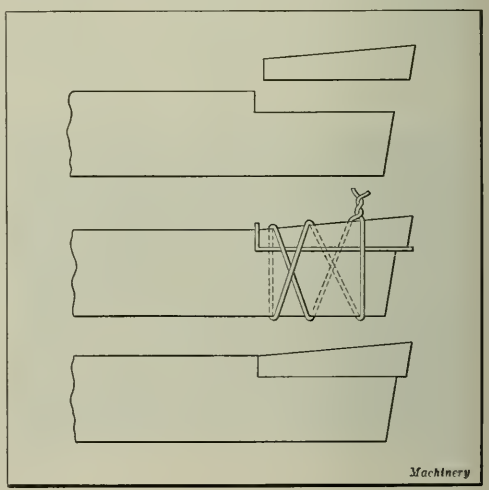
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MAKING TIPPED TOOLS

Owing to the high prices which have been commanded by high-speed tool steel during the past few years, it has become a matter of more than ordinary importance to conserve the use of this material as far as possible. Even when low selling prices prevailed, the use of a tool-holder for supporting a piece of this high-priced steel in a shank made of less expensive metal fully demonstrated its practicability. However, a tool-holder is not applicable on some classes of work, and in cases where it would otherwise be necessary to employ a solid forged tool, very satisfactory results can be obtained by forging a shank from inexpensive machine steel and welding or brazing a cutting tip made of high-speed steel to this holder. The desirability of such a method of "tipping" a tool has been apparent for many years, but until recently difficulties were encountered in securing a firm union between the shank and high-speed steel tip by either welding or brazing.

Descriptions of welded tools have been published in previous numbers of MACHINERY, so that no further discussion of their features is required. The following explanation of the way in which toolmakers employed by the Nash Motors Co., Kenosha, Wis., proceed to braze high-speed steel or stellite cutting tips to low-carbon steel shanks will prove of interest. The method of procedure is to form the tool shank with a seat for the high-speed steel tip which is usually made of the required width and form at the front edge, and about ⅛ inch thick by ½ inch long in the case of medium sized tools. The tip is made to project out at the front and sides of its seat on the shank, so that it may be ground to the desired form after being brazed in place. The machine steel shank extends under or behind this piece of high-speed steel, so that plenty of support is provided for the thrust of the cut. A strip of thin brass or copper is next cut out, which is of the same width and length as the developed area of the under side and the back end of the high-speed steel tip, that is to say, the copper covers the area of the bottom and back of the tool steel that comes into contact with the seat cut into the machine steel shank. This copper is bent to conform to the seat and is put into place between the tip and the shank with a coating of borax to serve as a flux.

After this has been done, the tip is secured in place on its seat on the shank by twisting a piece of wire tightly around it, as shown in the illustration. The tool is then placed in a heating furnace, where it is left for a sufficient time to raise its temperature to about 2400 degrees F., the exact figure being determined by the proper quenching temperature for hardening the high-speed steel of which the tip is made; and as copper starts to melt at 1940 degrees F., the strip of copper placed between the two pieces of steel will have been brought into a fluid condition. When the desired temperature is attained, the tool is removed from the furnace and first struck a moderate blow with a hammer to force the high-speed steel tip down on its seat in the shank and distribute the brazing material uniformly over the joint. The tool is then plunged into a suitable quenching bath to harden the high-speed steel tip. At the same time the copper solidifies and effectually brazes the high-speed steel cutting tip to the machine shank, thus producing an efficient tool at a relatively low cost.



Successive Steps in making a Tipped Tool

* * *

At a meeting of the executive board of the National Automobile Chamber of Commerce, held on March 3, 1920, the following resolution was adopted: "Whereas, efforts are being made to require by congressional legislation the use of the metric system of weights and measures in this country, and whereas, a canvass of motor car manufacturers, members of this organization, has failed to develop that any of them is in favor of such legislation, owing particularly to the difficulty at this time of changing dies, factory equipment, and mechanism and the great cost of same; also because of the confusion that would be created among workmen who have not been educated in the metric system, be it resolved, that this board is opposed to legislation making the use of the metric system of weights and measures obligatory, and recommends that members of the National Automobile Chamber of Commerce lend their support to the American Institute of Weights and Measures, which is actively opposing this movement."

CAST-IRON MOLDS FOR BAKELITE PRODUCTS

By LEONARD C. LOTZ

The expense connected with the manufacture of polished steels molds for producing bakelite or condensite articles has led to the frequent use of cast-iron molds in the production of many of these parts. When using molds of this type, satisfactory results will be obtained if the article is buffed after it leaves the mold. Some of the most common

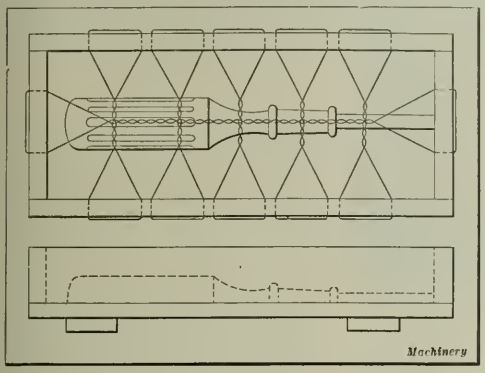


Fig. 1. Mold for producing Plaster Patterns

articles that can be successfully produced in cast-iron molds are screwdriver and knife handles, electrical insulators, surgical appliances, and various other similar articles. In the making of these cast-iron molds, plaster patterns are employed, the procedure being carried out in the following manner:

A split master wood pattern of the article is made, each half being fastened to a board, and a flask frame for holding the plaster built around each half of the pattern, as shown in Fig. 1. The frame, it will be noticed, is strengthened by reinforcing wires arranged as shown, the idea being to support the plaster and make a stronger cast. The plaster casts which are made from the wooden pattern when completed form the mold from which duplicate pattern models of plaster can be made. In using the wooden master pattern, Albany grease should be employed to prevent the pattern from sticking in the mold. The mold shown in Fig. 1 is used in the manner just described, for producing plaster patterns for a screwdriver handle. The frame should be well shellacked before pouring the plaster; otherwise, it will swell and twist out of shape.

After these plaster patterns have been made, they are ar-

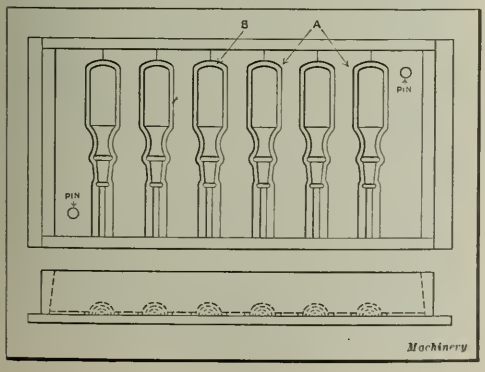


Fig. 2. Arrangement of Plaster Patterns

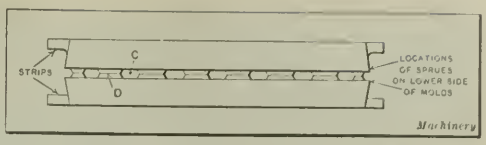


Fig. 3. Appearance of Assembled Top and Bottom of Mold, showing Finish Strips

ranged on a board, as shown in Fig. 2, and are built up so as to provide for finishing the face of the cast-iron mold. A thickness of heavy wrapping paper may be used for this purpose. Wood strips *A* are then arranged between the plaster patterns so as to provide spaces *B* around each pattern. These spaces form the finish strips in the cast-iron mold, and the strips *A* form the spaces *C*, Fig. 3, into which the excess material may overflow when using the cast-iron molds in the production of the various bakelite articles. The faces *D* should be ground or milled, so as to permit the mold to be securely closed on all points. In finishing the surfaces, grinding is preferable to milling because in grinding the possibility of chipping the edge of the mold is very slight. Dowel-pins should be provided in the lower part of the cast-iron mold, as shown in Fig. 4. The foundryman should be cautioned to exercise care in producing the castings so that very little scraping will be required to finish the mold. It is advisable to pour the cast-iron mold from sprues placed as shown in Fig. 3. Fig. 3 shows the mold assembled and also the strips provided as handles for the pressman, so that he can more easily separate the molds.

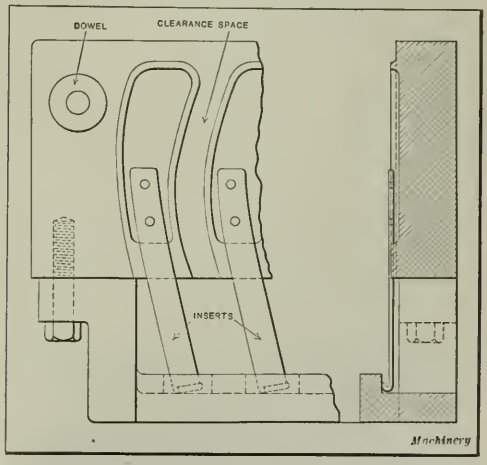


Fig. 4. Method of preventing Laid-in Blades from becoming displaced by the Plastic Material

Fig. 4 shows the method of inserting and holding a horse-hoof knife blade, which when molding the handle, is laid on the material in the drag of the mold, on which the remainder of the material is pressed. There is always a tendency for the bakelite or condensite to tip or push the insert from the mold, and for this reason stops such as shown are provided. The material, when laid in these molds, is in a plastic state and it is well to provide a liberal clearance space for the overflow. This will allow the mold to close tight, and the slight fin or seam caused by the overflowing of the material can be easily buffed off.

* * *

The U. S. Commerce Reports, in a summary of industrial and trade conditions in Bavaria, says that labor conditions are rapidly improving, the working classes showing a tendency toward greater willingness to do a fair day's work in return for their wages.

Manufacturing Ball Casters



Methods Employed in the Plant of the Schatz Mfg. Co., Poughkeepsie, New York, in the Quantity Production of "Acme" Ball-bearing Casters

By FRED R. DANIELS

THE ball-bearing caster, the manufacture of which is described in this article, is made entirely of strip stock, and no fastenings, such as rivets or pins are employed in its construction; the processes used in its manufacture, therefore, offer a great deal of interest to the mechanical mind. This caster is made by the Schatz Mfg. Co. of Poughkeepsie, N. Y., and is known by the trade name "Acme." The characteristic of this caster is universal rolling action. As may be seen by referring to the sectional view, Fig. 5, the caster consists of a large surface ball, which is retained in a cup or shell and which revolves upon a number of small antifriction balls that travel on a steel cup-shaped disk, or raceway, within the outside shell. The action of the large ball causes the smaller bearing balls to roll between the raceway and the large ball so that all the bearing balls are kept circulating in the bearing and coming into contact with the surface ball as it revolves. In this way the load is distributed over all the bearing balls, although all are not so burdened at one time. An inspection of the construction as shown in Fig. 5 will clearly indicate the arrangement and will also make it apparent that very little friction can be produced.

Drawing the Retainer Shell

The manufacture of the caster parts represents mainly a series of punch press operations. The shell is made from cold-rolled strip stock, 0.032 inch thick, and is formed in four major press operations, the first of which is shown in Fig. 1. This is a blanking and drawing operation and is performed on a Ferracute inclined press, fitted with a combination blanking and drawing punch and die of standard construction, employing the usual rubber buffer attachment. The various stages in the development of the shell are shown in Fig. 4, the appearance of the shell after the completion of the first press operation being shown in the view at *A*.

The second operation consists of drawing the shell to the shape shown at *B*, the set-up for which is shown in Fig. 2. This is a plain drawing operation, the construction of the equipment employed embodying no special features. A tray of shells that have come from the machine employed in the first press operation may be clearly seen, as well as some of the parts after the second drawing operation. Attention is called to the flaring edge of the shell produced in this operation and to the irregularities which are quite noticeable in the edge of the shell. The following operation consists of trimming the flared edge, using an ordinary trimming die. As a result of this the correct height of the shell is established which, for this particular finished shell will be 1⅛ inches. As will be apparent later, when the assembly of the caster is described, the trimming of the shell at this stage of the manufacture produces a tapering edge which improves the appearance after the shell has been closed over the assembled ball.

The next operation consists of finish-drawing the shell, and is performed on an inclined Ferracute press, so that when the work is ejected from the die it will fall from the press into a suitable receptacle, thus eliminating unnecessary handling. The result of this operation is to straighten the flaring edge of the shell and to size and form it to the shape shown at *D*, Fig. 4. The large outside diameter of the size of the caster shell illustrated is 1⅛ inches.

Up to this stage of manufacture the work performed on all sizes and styles of shells is the same. There are various styles of casters manufactured by the Schatz Mfg. Co., the distinguishing characteristics of which are the methods employed in attaching the caster to the articles for which they are intended. Special designs are not considered here, but the two regular types, flange and stem, are illustrated and described. The operation following the finish-forming of the shell is that of punching a hole in the top. For the flange



Fig. 1. Blanking and First Forming Operation on Ball Caster, performed on Ferracute Inclined Press



Fig. 2. Second Drawing Operation on Ball Caster Shells. Note Irregular Edges of Shells



Fig. 3. Punch and Die employed in blanking and piercing the Holes in Flanges on a Double-action Press

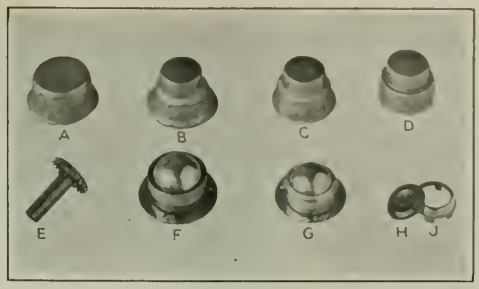


Fig. 4. Various Steps in forming the Shells; also Condition before and after Shell is closed about the Ball

type, see Fig. 5, this hole *A* is merely for the purpose of stringing the shells during the subsequent cleaning and electroplating operations; for the stem type, the hole is punched large enough to enable the stem to be assembled and riveted over on the inside. The stems are purchased from an outside concern and are swaged into the shells on a power press. After the holes have been punched, the shells are stamped with the trademark and taken to the soda kettles and cleaned, and thence to the tumbling barrels where they are tumbled in dry sawdust for one hour. The shells are next electroplated with either nickel or brass, as required. They receive a final dry tumbling to produce a polish after being plated, and the brass plated parts are lacquered to prevent oxidation. The stem or flange, as the case may be, is then assembled. The production time for each press operation on the shell is 1500 pieces per hour.

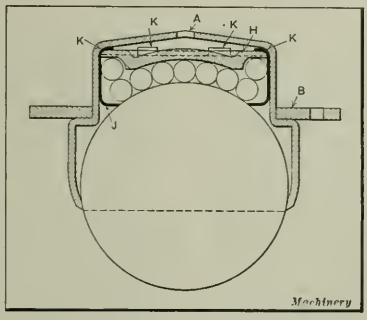


Fig. 5. Sectional View of Flange Type Ball Caster

Making and Assembling the Flange

The caster flanges may be made to any size or shape, but for the purpose of description, the work done on a circular flange is representative of all flange operations and this style only will be dealt with. A circular flange for the size of caster described in this article is made of three-quarter hard cold-rolled strip steel, 1⅞ inches wide and 0.065 inch thick, and is shown at *F*, Fig. 3. In a single operation the flange is blanked out, punched to fit the outside of the shell, and pierced for receiving the rivets by means of which the caster is attached. The operation is performed on a double-action press, and the punch and die used in punching out the parts are also shown in Fig. 3. As the stock is fed into the press, the center punch *A* descends on the stock and holds it, while three small piercing punches within holes *B* descend through ring *C* and produce the rivet holes in the flange. Immediately following this operation, the center and blanking punch *D* is brought into operation, punching out the hole and blanking the flange. Between the three holes in ring *C* through which the piercing punches operate, three other holes are located, as shown, in each of which a light coil spring is carried for the purpose of forcing the completed flange from ring *C* after it has been made. By this arrangement ring *C* is provided with a yielding construction so that the flanges will be prevented from adhering to the ring through films of oil, burrs, or other causes. A knock-out is also provided in the die, in the form of the two plunger-pins *E*. In other respects, the construction of both the punch and the die does not contain any special features.



Fig. 6. Punch Press equipped with Indenting Tool used in assembling Caster Flanges



Fig. 7. Punch and Die employed in blanking the Hemispheres from which the Ball is made

The next step is to clean, tumble, and electroplate the flanges in the manner outlined in the description of the manufacture of the shell, after which a punch press equipped with a special indenting tool *A*, Fig. 6, is employed for assembling the flange to the shell. The illustration shows a view taken from below the platen level to enable the tool to be more clearly seen. The flanges are pressed firmly against the shoulder of the shell, as may be seen by referring to Fig. 5, and at the completion of the press stroke are pinched on by means of the special tool. This tool is similar in arrangement to a hollow mill having three inserted cutting tools with cutting edges on the end arranged so that the three indentations made in the flange will wedge the metal against the body of the shell, thus securely holding it in place.

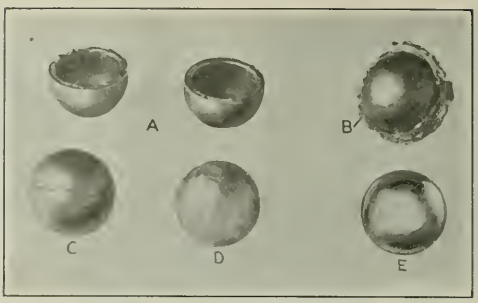


Fig. 8. Various Stages in the Manufacture of the Caster Hollow Ball

On the stem type caster a two-piece socket, shown at *E*, Fig. 4, is employed for the purpose of attaching it to the leg of the furniture. This socket, or grip neck, consists of a serrated tooth grip washer which is first blanked from 1⅜- by 0.035-inch hot-rolled stock and then cupped to the shape shown. The sleeve member of the socket is blanked from cold-rolled stock, 1 7/16 inches wide, 0.022 inch thick, and formed in two subsequent operations. The details of the punch press operations required to make this holding member are not shown, since no equipment or methods of special interest are involved. When this socket is driven into a hole in the leg of the furniture, it is held securely by the gripping member. The hole should be drilled somewhat deeper than the length of the sleeve part, so as to enable the knob on the end of the stem to be driven through the sleeve. The sleeve is designed to expand at its upper end, when the knob is driven through, so that when it is fully assembled the sleeve will contract to its normal diameter and hold the caster in place by closing around the neck under the knob of the stem. The flange and the sleeve are finally riveted together, after which they are tumbled.

Construction of Caster Bearing

The ball bearing on which the main caster ball bears consists of a saucer *J* and a disk or ball race *H*, Fig. 4. These two members form a housing for the small alloy steel bearing balls, the location and arrangement of which may be seen by inspecting the sectional view of the caster, Fig. 5, in which the parts are designated by the same reference letters. The saucer is blanked, pierced and drawn in one operation, a combination punch and die being employed. The material from which the saucer is made is cold-rolled strip stock, 1 9/16 inches wide by 0.015 inch thick. The ball race is blanked and drawn in two press operations, the second of which is a finish-forming operation. The material from which the race is made is cold-rolled chrome steel, 1⅞ inches wide by 0.055 inch thick, and is carburized in an oil-burning furnace at 1750 degrees F. for three hours and then pot-cooled. A charcoal-base carburizer is used, the parts being packed and sealed in nichrome carburizing pots. After carburizing, the races are reheated to 1550 degrees F., preparatory to hardening and are afterward tempered in oil at 375 degrees F. Finally the race and the saucer are pickled and rustproofed by the galvanizing process.

Making the Hollow Surface Ball

The manufacture of the hollow surface ball, which takes the place of the roll in an ordinary caster, is a rather unique process, various stages in its evolution being shown in Fig. 8. Briefly, these balls are made from two hollow hemispheres welded together. The hemispheres *A*, Fig. 8, are blanked and formed in one operation, a double-action press equipped with the combination blanking and drawing die shown in Fig. 7 being employed. The diameter of the punch is 15/16

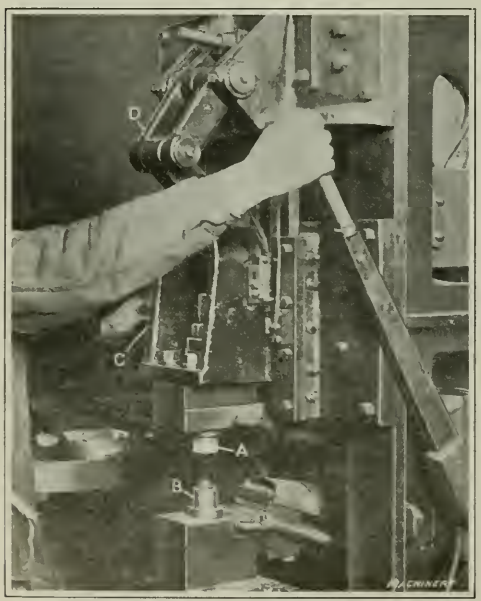


Fig. 9. Operation of Butt-welding the Two Hemispheres from which the Hollow Caster Ball is made



Fig. 10. Specially Designed Ball Grinding Machine, showing a Row of Balls after being rough-ground

inch, which for drawing a hemisphere requires that the blank diameter should be 1 5/16 inches. The punch enters far into the central hole in the die, so that the hemisphere is pushed through the die. The stock is 1¾ inches wide by 0.109 inch thick, hot-rolled, and the two hemispheres are electrically welded together on a National Electric Welder Co.'s alternating-current 60-kilowatt butt welder which delivers current to the work at a voltage of about 5 volts from a 220-volt, 60-cycle power supply.

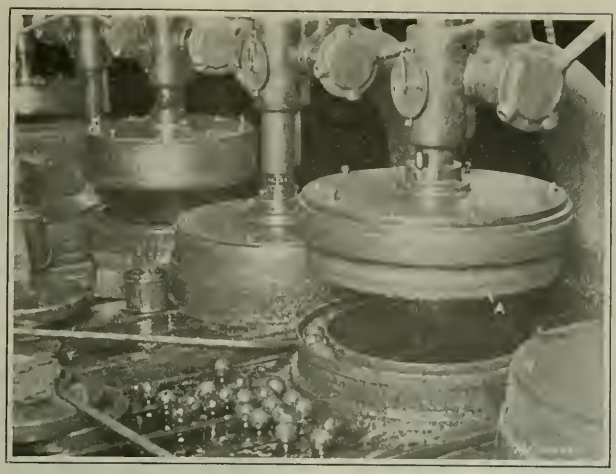


Fig. 11. A Battery of Vertical Rotary Lapping Machines especially designed for Use in the Manufacture of Hollow Caster Balls

This operation and the specially equipped welding machine is shown in Fig. 9. The machine is equipped with two copper cup dies *A* and *B*, of special design, which are connected directly with the source of power supply as clearly shown in the illustration. The length of traverse of the upper die-head *C* is controlled by means of the operating lever and produces the desired amount of pressure, when making the weld, through the medium of the toggle-jointed link *D*. In the illustration a ball is shown after being welded, seated in the lower die, from which the flash produced at the weld may be seen. A better idea of the appearance of the two welded hemispheres may be had by referring to Fig. 8 at *B*. The members before being welded are not true hemispheres, and consequently after the ball has been welded, it is slightly elliptical in shape. In performing the weld, the operator simply places one hemisphere in the lower die, lays its mate on it, switches on the current, and operates the hand-lever until the upper die closes over and aligns the two parts, thus completing the weld. The production time is 400 welded balls per hour.

After welding, the next operation consists of trimming the flash from the ball, and the tooling equipment used is shown in Fig. 12. The operation is performed on a Ferracute press, on the table of which, in back of the trimming die, may be seen a pile of trimmings, from which a good idea of the size and nature of the fin can be had. The condition of the ball after this trimming operation is shown at *C*, Fig. 8. The trimming operation is followed by swaging the slightly elliptical balls in a power press, using the equipment shown in Fig. 13, preparatory to the finishing machine operations. The finishing operations consist of grinding and lapping; for the performance of these operations use is made of specially designed machines.

One of the special grinding machines employed in the manufacture of the balls is shown in Fig. 10 and consists simply of an annular channel or raceway in which the balls are placed and against which a horizontally mounted abrasive wheel revolves. The wheel is mounted eccentrically in relation to the annular raceway, both members revolving in the same direction, but with the grinding wheel traveling at a greater velocity. With this arrangement the balls are ground to the desired degree of roundness. It will be fully appreciated that the service required of caster balls does not demand the same degree of perfection as regards roundness that the commercial solid steel ball does, such as is used in high-grade bearings and for gage inspection purposes. Therefore, the close limits usually maintained in steel ball manufacture are not essential. This statement should not be construed to mean that the process employed by the Schatz Mfg. Co. does not, to all intents and purposes, produce round balls, for on the contrary, a very satisfactory product is obtained. However, the painstaking inspection for roundness which is necessary in the manufacture of high-grade solid steel balls is not, in this case, required.

The balls are first wet rough-ground, their appearance after this operation being shown at *D*, Fig. 8. They are next heat-treated in the same manner as are the ball races, except that in carburizing, the parts are left in the furnace eight hours instead of three on account of the greater thickness of the stock from which the balls are made. After heat-treating, the hardened balls are returned to the ball grinding machine and are finish-ground to within lapping limits, after which they are ready to be lapped to size.

The lapping operation is performed on specially designed machines, a battery of which may be seen in Fig. 11. The

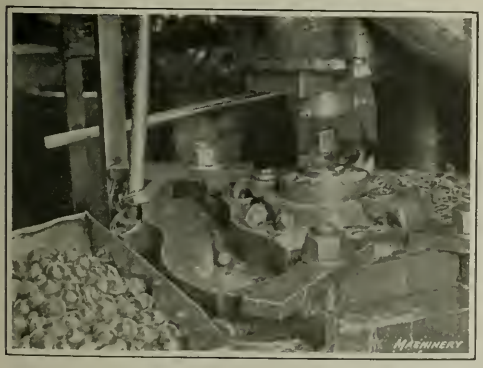


Fig. 12. Set-up employed in removing the Flash produced in welding the Balls. Note Pile of Trimmings back of Die



Fig. 13. The Ellipticity of the Balls is reduced to Approximate Roundness in Swaging Dies on a Ferracute Press

balls are placed in an annular channel, and liberally treated to a mixture of oil and fine emery. A revolving cast-iron lap or disk *A*, held in the vertical spindle of the machine, is then lowered into contact with the balls, and abrasions caused by the grinding wheel and all other surface defects are gradually lapped away. It will be noticed that the lapping machines are equipped with a dial gage for determining the proper finished diameter of the balls. This completes the machining operations employed in manufacturing the ball, and the next operations are those confined to the electroplating department, where the balls are cleaned in soda, tumbled in sawdust, and nickel-plated by the electro process. The appearance of the finished ball is shown at *E*, Fig. 8.

Assembling and Inspecting the Casters

The assembled caster, shown in section in Fig. 5, gives a very good idea of the caster construction. This is the flange

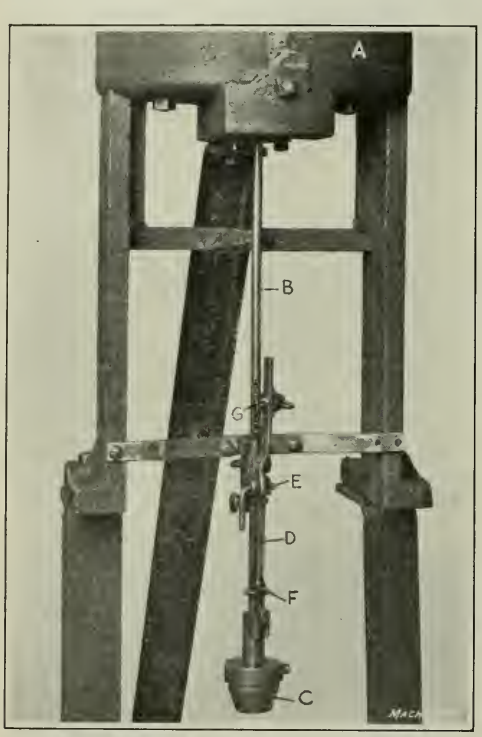


Fig. 14. Loading Machine for depositing Caster Bearing Balls in the Shell



Fig. 15. Operator holding a Shell in the Thimble, preparatory to releasing the Ball

type. For casters having a stem, this part is riveted into hole *A*, as previously stated, and no flange *B* is required. When the shells are delivered to the assembling room with their flanges or stems assembled, as the case may be, they are set into boards which are drilled for receiving five dozen shells. One of these boards is shown in the heading illustration. In assembling, the chrome-steel bearing raceway *H* is first dropped into the saucer *J*, Figs. 4 and 5, and the projecting lugs *K* on the saucer are bent over so as to keep the race intact. These two parts, thus assembled, are then put into the shell and a quantity of ⅛-inch alloy steel balls dropped into the housing, in which they become seated in the raceway within the saucer.

For loading the balls into the caster ball bearing, a special machine is employed as shown in Fig. 14. This machine delivers thirty-five ⅛-inch balls from the hopper *A* through the brass feeding tube *B* into the caster shell which is held under the thimble *C* in the manner shown in Fig. 15. By pressing up on this thimble the lever *D*, Fig. 14, which fulcrums at *E* is forced outward, withdrawing pin *F* from a slot in the feeding tube. While this pin is being withdrawn, the pin *G* at the upper end of the lever enters a slot in the tube and prevents more than a predetermined number of balls from being released when the shell is being loaded. The balls are kept circulating in the hopper, so that the tube is always loaded with balls. The slot in which the upper pin enters the feeding tube can be clearly seen in the illustration Fig. 14, as well as the balls which have just been released and which are being supported by the lower pin. By this simple arrangement means are provided by which 1200 shells may be loaded per hour, and each loading is mechanically sure of containing the correct number of balls. Another view of one of the loading machines, in which the actual operation of loading a shell may be seen, is shown in Fig. 15.

The large balls are now dropped in the shells which have previously been placed in the assembling board, and are taken to a machine such as shown in the heading illustration. This is a Ferracute press, equipped with a simple closing punch and die by means of which the shell is closed around the ball. It will be remembered that in describing the trimming operation on the shell special mention was made of the fact that the edge was given a bevel in trimming and that this bevel was made for the purpose of improving the appearance of the assembled caster. By inspecting views *F* and *G* in Fig. 4 a good idea of the appearance of the caster before and after the final closing operation may be had, in which it will be seen that this bevel, when the shell is closed, is formed nicely over the curvature of the ball (see also Fig. 5) and leaves no abrupt sharp surface change.

The casters receive a final visual inspection in which all those having surface defects are rejected. A running test is also given the caster, and if the ball binds in the shell or does not function properly the caster is rejected. The casters are finally carefully packed in sets of four casters to a box.

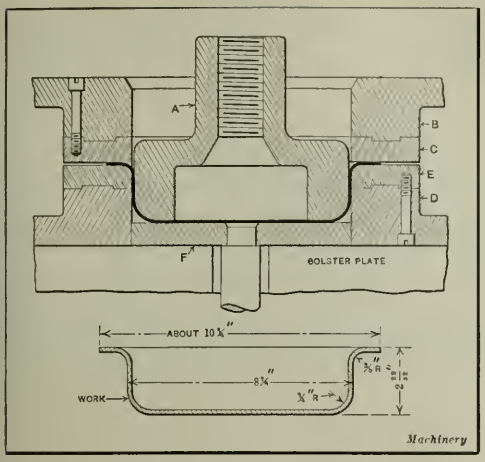


Fig. 1. Double-action Die employed in First Drawing Operation on Blank

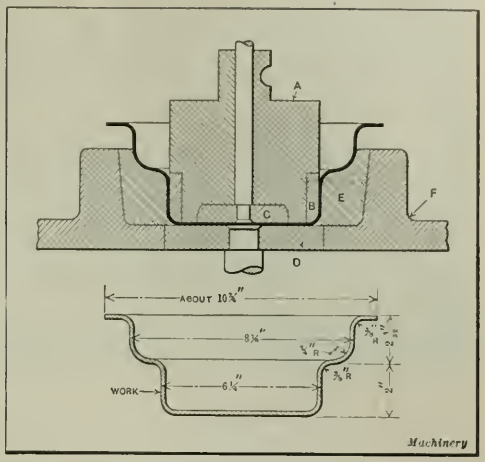


Fig. 2. Die that is employed in lengthening the Shell and reducing the Diameter

Dies for Automobile Rear Axle Housings

By J. BINGHAM, President, The B. J. Stamping Co., Toledo, Ohio

THE drawing and forming dies employed in the manufacture of rear axle housings for a certain type of automobile are here illustrated and described. These dies have worked very satisfactorily, having produced thousands of these housings. By the methods followed in the production of this part, various taper shells can be readily produced which, as a rule, are difficult to manufacture. Each illustration shows one of the dies and a dimensioned drawing of the housing or shell as it appears after having been operated upon by that particular die. The description of the dies is given in the order in which they are used. The first operation consists of cutting a blank 14 inches in diameter from sheet steel, 5/32 inch thick. This operation is performed on a plain blanking die, which is of standard construction and is therefore not illustrated in this article.

The first shaping operation is performed by the double-action drawing die illustrated in Fig. 1, which is used on a double-action press. In the operation of this die, blank-holder *B*, which has a hardened and ground steel ring *C* on its lower face, descends and exerts pressure on the blank that has previously been placed on the hardened and ground steel die ring *E*, which is mounted on the die-block *D*. Then punch *A* descends and forces the blank into the cavity of the die, thus drawing it to the desired shape. Punch *A* is an iron casting, cored out at the center in order to make it lighter. By this means a closer-grained metal than would be possible if the punch were cast solid is obtained, so that this type of punch has proved more satisfactory in several ways than a solid one. Rings *C* and *E* are ground on both sides to eliminate all tendency of spring in the blank-holder

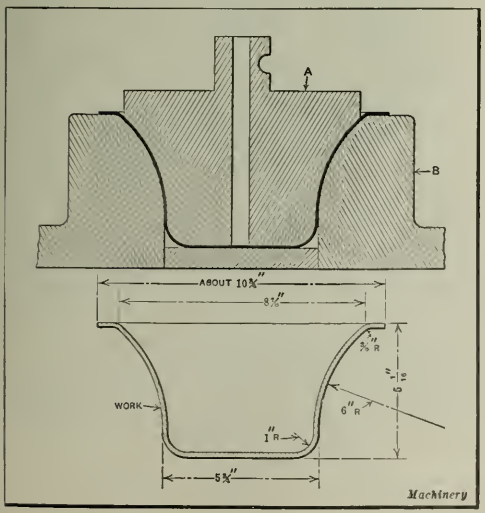


Fig. 3. Forming Die which reshapes the Shell Body without changing the Length

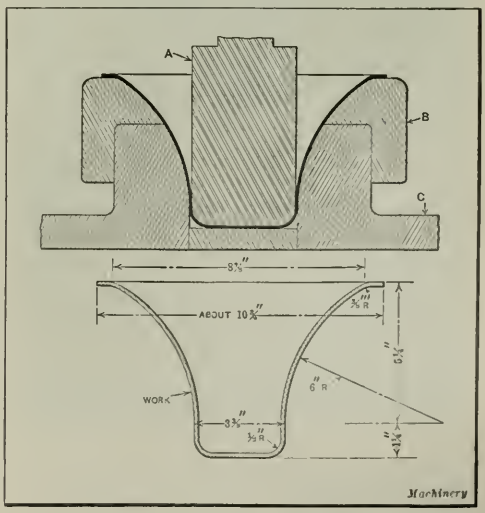


Fig. 4. Drawing Die used to still further reduce the Shell Diameter and increase the Length

or die-block. In dies of this kind the faces of these rings should be ground flat unless the metal is of such thickness that the exposed surface of the rings must taper toward the center of the die in order to permit the metal of the blank to thicken as the diameter is reduced. The machine screws which secure these rings to their respective holders are staggered in circles concentric with the hole in each ring; this tends to eliminate spring in the blank-holder and die-block. The die is equipped with a knock-out pad *F* for removing the shell from the die after the punch has ascended, while the blank-holder serves as a stripper for forcing the shell from the punch on the return stroke of the press ram.

Dies Employed in Reducing the Shell Diameter and Increasing its Length

The die illustrated in Fig. 2 is employed to lengthen the shell and reduce the diameter of the closed end. The shell as produced in the preceding operation is placed in the recess of die ring *E*, the contour of which is similar to that of the bottom of the shell, so that the shell is correctly located for

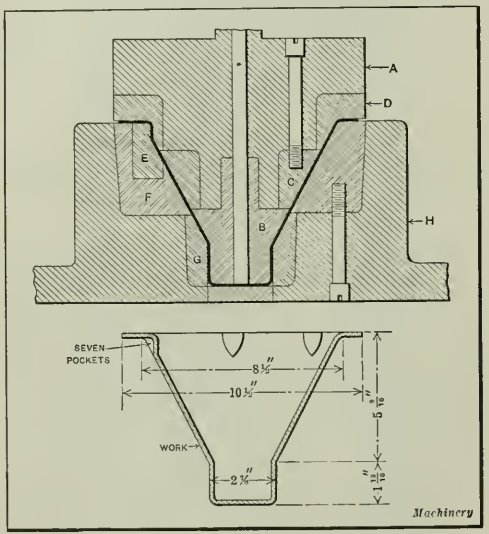


Fig. 5. Die employed in Final Shaping Operation on Housing

this operation. As punch *A* descends, the closed end is drawn to the dimensions given, while the portion of the shell remaining in the recess of the die ring at the completion of the operation, assumes approximately the same shape as the recess. Punch *A* is also made of cast iron, but a hardened and ground steel ring *B* is provided for contact with the shell. This ring is pressed on the punch. The punch is also furnished with a knock-out pad *C*, which forces the shell from the punch on the return stroke of the press ram, while knock-out pad *D* removes the shell from the die. Die ring *E* is hardened and ground, and its circumferential surface has a taper of 1.5 degrees. It is secured in die-holder *F* by means of bolts.

The forming die illustrated in Fig. 3 reduces the diameter of the body of the shell although the diameter of the flange remains the same as produced in the first drawing operation. In this operation, punch *A* forces the shell into die *B* until the flange of the shell comes in contact with the upper surface of the die. The punch and die are both made of cast iron and are equipped with devices for removing the shell from each respective part after the performance of the operation.

Fig. 4 illustrates a die that is used to still further reduce the shell body diameter, at the same time increasing the length. At the beginning of the operation, die ring *B* is in a raised position relative to die-block *C*, which permits it to locate the shell properly for the operation. The raising of the die ring is accomplished by means of springs and bolts, which are not shown in the illustration. During this operation the shell and die ring are pulled down by punch *A* as it descends, until the inner surface of the die ring comes in contact with the upper surface of the die-block as shown in the illustration, at which time the shell has been drawn to the desired shape. The die is provided with a knock-out pad for forcing the shell from the die after the performance of the operation. There is no tendency for the shell to adhere to the punch in this operation, and for this reason no knock-out device has been provided for the punch.

Die Used in Final Shaping Operation on Shell

The final drawing operation on the shell is performed by the die illustrated in Fig. 5. In this operation the main body of the shell is drawn to a taper, the surface of the body adjacent to the closed end is straightened, and seven pockets are formed close to the flange. Punch *A* is also made of cast iron, but pieces *B*, *C*, and *D* which come in contact with the shell are hardened and ground steel pieces, secured to the punch. By constructing the punch in this manner, the hardening and grinding of the various parts were greatly facilitated. It will be noticed that the die is constructed in a similar manner, the die-block *H* being an iron casting, and parts *F* and *G*, which are inserted in it, being hardened and ground steel pieces. The pockets are formed in the shell by means of seven hardened and ground steel pieces *E*, inserted in die ring *F*. By having these pieces made separate from ring *F*, the manufacture of the die was a more simple proposition, and as these pieces wear more rapidly than the remaining die parts, they can be readily replaced when necessary. Both the punch and die are provided with knockout devices for removing the shell from the respective parts after the operation has been performed. The illustration shows the flange diameter reduced to 10½ inches, but this is performed in a later operation on a trimming die which is not illustrated.

Two more operations are performed on the shell before the part is finally completed. The first of these consists of punching holes around the flange, which is done by a piercing die of standard construction. The final operation consists of cutting a hole in the closed end of the shell to permit the housing to be fitted over the axle tube of the automobile. Neither of these dies is illustrated.

* * *

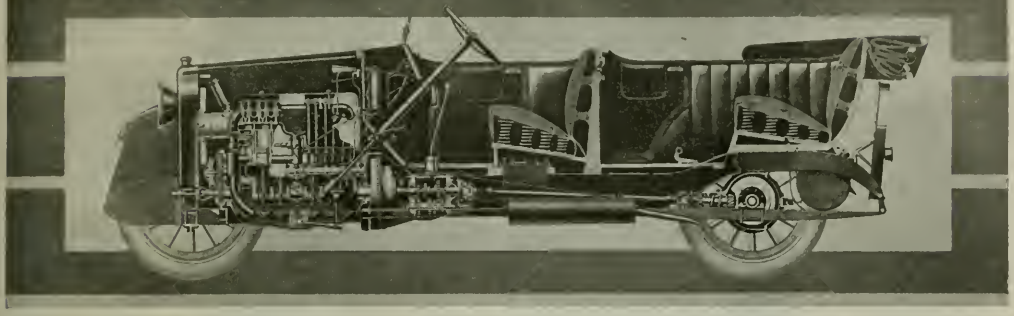
HARDNESS TESTING BY MAGNETIC QUALITIES

A British firm has developed an apparatus for testing the physical qualities of steel after heat-treatment by means of the magnetic method. The principle on which this instrument is based is that magnetic retentivity of a steel is a function of its hardness. The method of using this apparatus is as follows: First a specimen (usually a turned piece 3 inches long by 1½ inches in diameter) is subjected to the heat-treatment required to be investigated. It is then tested for magnetic hardness by being laid inside a standard magnetizing coil, while a direct current from the mains is flashed on the coil, which magnetizes the steel to saturation. The specimen is then removed from the magnetizing coil and is placed in a small search coil, which is directly connected to a Grassot fluxmeter, after which it is removed from the ballistic coil and a reading is obtained on the fluxmeter, which represents the hardness of the specimen.

* * *

An interesting diagram has been prepared by *Safety News*, showing the position of ladders of various lengths to insure safe use. The angle of 75 degrees has been found, through a series of experiments, to give the greatest degree of safety, and to secure this angle, all that is necessary is to place the foot of the ladder a distance approximating one quarter of the length of the ladder away from the vertical. This angle will prevent undue straining of the ladder, or slipping.

Machining Operations on the Nash Motor



Use of Special Machines, and Interesting Methods of Equipping Standard Machine Tools

By EDWARD K. HAMMOND

IN every industrial plant in which there are large numbers of parts to be machined, local conditions or peculiar requirements of the work may call for the use of special methods of handling the product and for performing machining operations. Such methods may be of a character which makes them special in the sense that while being well suited to the requirements of the job on which they are employed, they are not likely to be applicable in many other cases; or it may happen that methods which have provided a satisfactory solution of local problems in one shop could be applied with satisfactory results on many other classes of work. The description of purely special methods of machining parts or handling raw material and finished pieces may be of considerable interest to mechanical men, but their practical value is negligible, and for that reason the selection of subject matter to form the basis of articles published in MACHINERY is usually made with a view to describing interesting production methods that can be applied, with suitable modifications, in handling the work in various shops.

Where large numbers of parts have to be carried about a manufacturing plant on trucks, the maintenance of open aisle space will usually be found to overcome delays caused by the blocking of trucks while in transit from one department to another; but where trucks have to be taken from floor to floor on an elevator, trouble is likely to be experienced in the gathering of trucks at the elevator shaft more rapidly than they can be handled. Engines of motor cars built by The Nash Motors Co., in Kenosha, Wis., have the cylinder block and crankcase cast integral, and in laying out the departments in which machining operations are done on these parts, it was desired to utilize a portion of the second floor for this part of the work. To overcome difficulties which would have been likely to arise in trucking these bulky castings from floor to floor, a conveyor system is util-

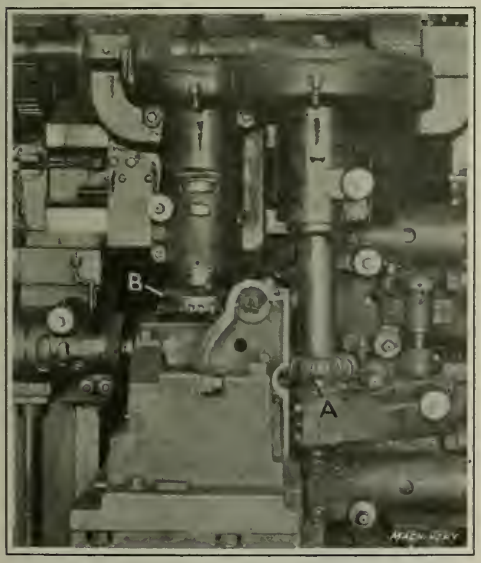


Fig. 1. Multiple-spindle Milling Machine provided with Cutter A for milling Crankshaft Bearings in Crankcases, and Cutter B that recedes to clear the Timing Gear Case; the Usual Arrangement of Facing Heads is also provided

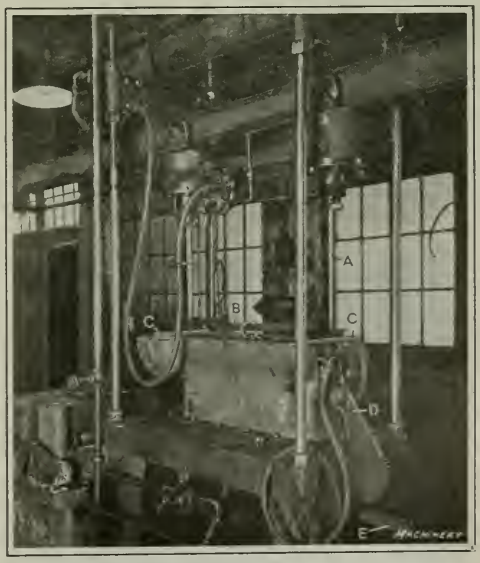


Fig. 2. Table on which Cylinder Blocks are given a Water Test. Air-actuated Plungers A hold the Work down and an Air-actuated Lever holds a Gasket over the Water Pump Connection while testing the Water Jacket

ized which carries the pieces vertically upward to the second floor, and then deposits them on a horizontal conveyor system running from machine to machine. After the operations done on this floor are all completed, the castings run on an inclined gravity carrier down which they roll to the line of machines in the main crankcase department on the ground floor.

Milling Crankcase Castings

As the castings run off the gravity carrier, they are first set up on a nine-spindle planer type milling machine, Fig. 1, built by the Ingersoll Milling Machine Co., Rockford, Ill., which has been designed to do its work in a somewhat different manner from that ordinarily employed for machining cylinder blocks or crankcases of motor cars. There is nothing of special interest in regard to the work-holding fixtures or provision made for milling flat surfaces, but it is not common practice to use form cutters on a machine of this type for milling out the crankshaft bearings at the same time that the facing operations are performed. One of the cutters for performing such an operation on the Nash crankcase will be seen at *A* in Fig. 1.

Attention is called to the fact that on this Ingersoll milling machine there is a set of cutter-heads provided at both the front and rear of the housings, so that as the string of castings is carried through on the table, one set of cutters takes a roughing cut while the others are set to provide for finish-milling the same surfaces. Another interesting feature of this machine is the provision made for rough-milling the motor cover flange. To provide for the simultaneous performance of this operation on the same machine that performs other operations on the cylinder block and crankcase castings, it was necessary to provide the cutter-head with an automatic feed movement on the rail, so that the cutter carried by this head is able to recede sufficiently to clear the timing gear case on each casting. After completing this movement, the head again moves forward to perform its operation on the next motor cover flange. The milling cutter used for handling this part of the work is shown at *B*. Of course the possibility of building a machine for operation along these lines presented itself through having the crankcase and cylinder block cast integral. On this job the rate of production is sixty castings in a ten-hour day.

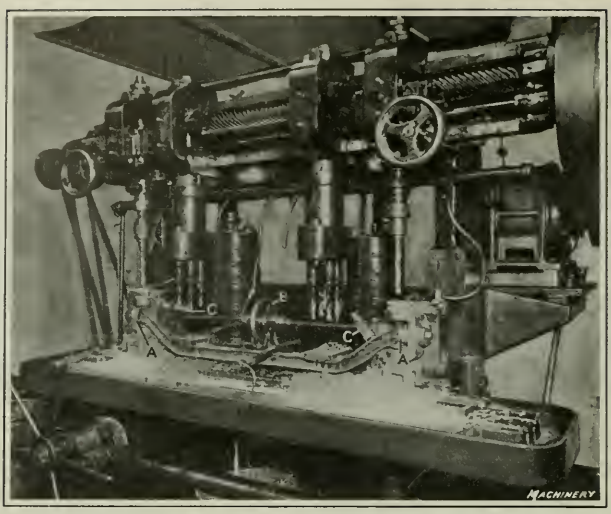


Fig. 3. Multiple Drilling Machine equipped with Two Single Drills and Two Cluster Heads for simultaneously drilling Twelve Holes in Front Axles

Water Test for Cylinder Blocks

For testing the water jacket on cylinder blocks to see that it is leakproof, use is made of the special apparatus shown in Fig. 2. It consists of a table with a rubber gasket on which the cylinder block is placed, as shown in this illustration, and held down by air pressure. Quite an interesting application of an air-operated trolley hoist has been made for serving the double purpose of carrying these castings and providing for clamping them down while the water test is being conducted. By referring to the illustration it will be seen that running on the usual form of I-beam track there is a trolley provided with two air hoists, each of which is furnished with a rod *A* that extends right down to the casting, connection between the air hoist and work being made by a chain passing over cross-rod *B*. The two air hoists provide for lifting the casting off the previous machine on which an operation has been performed, so that the trolleys may run along their rail and deposit the casting on this table where the water test is conducted.

Two flat bars *C* are next placed on top of the casting under the ends of rods *A*, after which the air valve is manipulated so that air enters the cylinders to force rods *A* against the work and hold it down tightly on the rubber gasket. It is then necessary to block the water pump connection with a gasket carried at the end of lever *D*. It will be seen that this lever constitutes an extension of a segment gear meshing with rack *E*, and a longitudinal movement may be imparted to the rack by means of an air cylinder located beneath the testing table. The segment gear and lever *D* are carried on a pivotal support, so that when rack *E* moves toward the right, lever *D* forces the gasket against the water pump

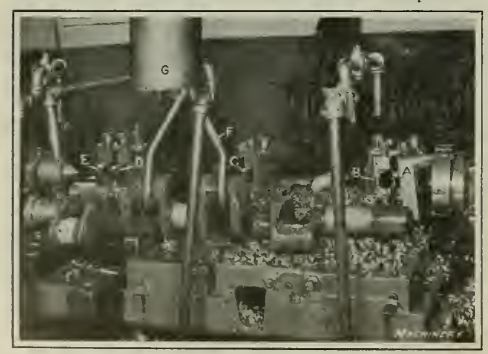


Fig. 4. Engine Lathe equipped with Double Carriages and Five Cutting Tools for simultaneously rough-turning All Line Bearings on Crankshafts

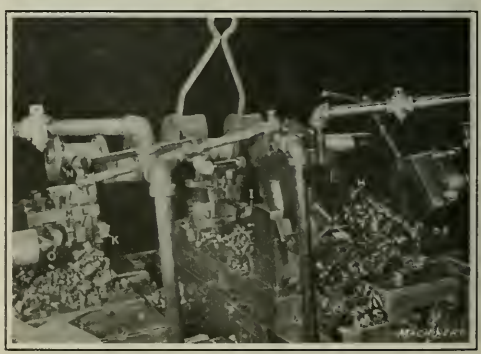


Fig. 5. Double-carriage Lathe equipped with Seven Tools for simultaneously filleting Line Bearings, straddle-facing Flange, and turning Oil Sling

connection, which securely closes it. After this, the water jacket is filled in order to test it for the presence of any leaks which may be due to defects in the casting. With this equipment it is possible for one operator to test 120 water jackets per day.

Drilling Holes in Front Axles

On the Nash front axle, it is necessary to drill a hole at each end for the steering knuckle pin, which is later reamed to a diameter of 0.860 inch; and also to drill in each of the spring pad seats four 11/16-inch holes, and one 9/16-inch hole. For the performance of this work, use is made of a special multiple-spindle drilling machine shown in Fig. 3, which provides for simultaneously drilling all twelve holes. This machine was built by the Moline Tool Co., Moline, Ill. The work-holding fixture consists of two V-blocks *A*, which are moved inward to engage opposite ends of the work by a right- and left-hand screw turned by a handwheel *B*. After location and a preliminary clamping of the work has been accomplished in this manner, straps *C* are clamped down on the forging to assure having it rigidly held while the drilling operation is performed.

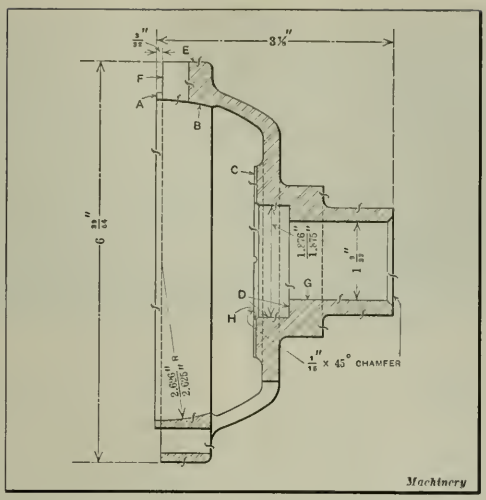


Fig. 6. Cross-sectional View of Male Half of Differential Gear Case, showing Surfaces that are machined on Flat Turret Lathe

It will be apparent to all mechanics who are familiar with the Moline drilling machines, that they are not adapted for drilling clusters of holes such as those which have to be drilled in each of the spring pad seats. To adapt the Moline drilling machine for the performance of these operations, two of the spindles are equipped with multiple auxiliary drill heads of the type made by the Hoefer Mfg. Co., of Freeport, Ill. Set up in this way, a combination straight-line and cluster type multiple-spindle drilling machine is provided that enables the Nash front axles to be drilled at the rate of ninety per day. It will be apparent from the illustration that on this machine, the table feeds the work up to the drills instead of having the spindle heads move down to the work.

Rough-turning Operations on Crankshafts

As the Nash crankshaft forgings are received in the machine shop, the first step is to perform a rough-turning operation on the line bearings. This work is done on two heavy-duty lathes built by the Greaves-Klusman Tool Co. of Cincinnati, Ohio, on which the forgings are set up successively. These two operations are noteworthy on account of the large number of turning tools that are operating simultaneously, and in order to more clearly illustrate the arrangement of the tools, it was necessary to take photographs with the forgings removed from the lathe centers. However, it will be apparent from Figs. 4 and 5 that each forging is shown lying in a position quite close to that which it actually occupies when held on the centers, and in this way the reader will gather an accurate idea of the actual relationship of the respective tools to the surfaces which they machine on the work.

Referring first to Fig. 4, it will be seen that two tools *A* and *B* turn the right-hand line bearing; a tool *C* turns the center bearing; and two tools *D* and *E* turn the left-hand line bearing, the outside diameter of the flange to which the flywheel is bolted, and the oil sling. This oil sling is an annular projection located at the left-hand side of the left-hand line bearing; it is shown in its finished form in Fig. 5. The use of such a large number of tools is made possible by the special construction of the machine which is furnished with one carriage of rather unusual length, on which two toolposts can readily be mounted through the provision of a double cross-slide. Then the tools *D* and *E* are carried by a toolpost on the cross-slide of a second carriage. Evidently the possibility of using such a large number of tools enables the work to be performed at a very satisfactory rate of output, the actual production on this job being ninety crankshafts per day. Owing to the heavy weight of these forgings, it was considered advisable to furnish a hoist *F* and counterweight *G*, which enables a forging to be easily lifted into place on the machine or removed after the turning operation has been completed.

An even better idea of the possibilities of one of these double-carriage lathes for obtaining a high rate of production is shown in Fig. 5, which shows the machine equipped for performing a second operation on the crankshafts. Here it will be seen that there is a tool *H* which is employed for filleting the left-hand end of the right-hand line bearing.

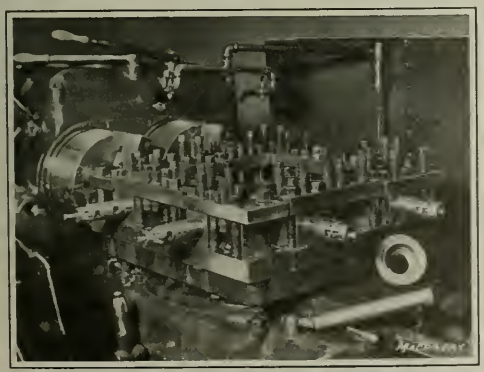


Fig. 7. Tooling of First and Second Turret Faces of Flat Turret Lathe used for machining Differential Gear Cases

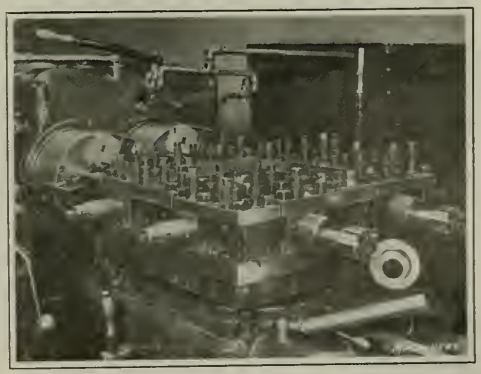


Fig. 8. Tooling of Third and Fourth Turret Faces of Flat Turret Lathe used for machining Differential Gear Cases

and two tools *I* and *J* that perform the same operation on the center bearing. At the left-hand end of the machine there is a group of four tools used for the following purposes: Tool *K* fillets the right-hand end of the left-hand line bearing, tools *L* and *M* form the oil sling shown at *N*, and tools *M* and *O* straddle-face the sides of the flywheel flange. On this job the rate of production obtained is eighty forgings per day.

Machining Differential Gear Case Castings on a Double-head Flat Turret Lathe

For machining the male half of the Nash differential gear case, use is made of a double-head flat turret lathe built by the Jones & Lamson Machine Co., of Springfield, Vt., which has cutting tools made by brazing stellite bits on machine steel shanks. This method of toolmaking enables a very efficient type of cutting tool to be produced at a relatively low cost. A feature of the tooling of the machine used for handling this work is the provision that has been made for performing operations at a single setting of the work on rather an unusually large number of surfaces. The following description will consider the four faces of the turret and explain in detail the exact nature of the machining operations that are performed by the various tools mounted at each station.

Attention is first directed to the fact that Fig. 7 shows the tools on the first and second faces of the turret, while Fig. 8 shows the third and fourth faces, and a cross-sectional view of the differential gear case casting to be machined is illustrated in Fig. 6. It will be apparent that each spindle of the double-head lathe carries one of the differential case castings, and that the turret tools are arranged in duplicate to simultaneously perform the same operation on each of these two pieces. On the first station of the turret each tool carries five cutter-bits that provide for facing surface *A*, Fig. 6, turning radius *B* and facing surface *C*, counterboring at *D*, turning the outside diameter *E*, and facing surface *F*. On the second face of the turret each tool is provided with four cutters, two of which finish-face surface *F* and the top of rib *A;* the third tool breaks the corner at the bottom of radius *B*, and the fourth tool finish-faces surface *C* at the top of the counterbore.

There is a combination of boring and turning tools on the third turret face which provides for boring hole *G*, cutting a chamfer at *H*, and taking a finishing cut on radius *B*, while a turning tool is finish-turning outside diameter *E*. Finally, there are two reamers on the fourth turret face which ream holes *G* in the two pieces of work, while auxiliary tools mounted at this station provide for taking a second finishing cut over radius *B* and for finish-turning the outside diameter of rib *A* at the top of the work. For a job of this kind, it will probably be generally conceded that a rate of production running from 180 to 200 of these castings for a ten-hour day is a very satisfactory output.

TABLE FOR THREE-WIRE THREAD MEASUREMENTS

By A. R. McCARTY

The accompanying table contains constants which may be used as a means of simplifying the calculations required when measuring threads of the U. S. form by the three-wire method. The formula for checking the measurement taken over the wires may be found on page 1032 of MACHINERY'S HANDBOOK in connection with which the constants given in the table are to be used. This formula, which is standard, is written

$$M = D - 1.5155P + 3W$$

in which

M = measurement over wires;
D = standard outside diameter of screw;
P = pitch of thread;
W = diameter of wires used.

In this equation the value $(-1.5155P + 3W)$ is replaced by a constant taken from the table, which should be added to the standard outside diameter of the screw in order to obtain the measurement over the wires. Thus, when measuring a standard ½-inch screw having 12 threads per inch, the diameter of wire recommended in the table is 0.050, and the constant for this combination is 0.0237 inch which, added to the outside diameter of the screw, gives 0.5237 inch, this being the correct measurement for these conditions. In instances where the recommended wire size cannot be obtained, the value of the constant used may be found by taking three times the difference between the recommended size and the size which is to be used and subtracting it from the constant given for the recommended size, if the wire is below the size given in the table, or by adding it to the constant given if the wire to be used is greater than that given in the table. Thus, for a screw having 10 threads per inch, if a wire 0.065 inch in diameter is used, the difference between this diameter and that of the wire in the table (0.070 inch), multiplied by 3 is 0.015; and this product subtracted from 0.0585 gives 0.0435, which is the correct constant for this size screw thread, using wires 0.005 inch under the recommended size. If the wire had been 0.005 inch greater instead of less than the size given in the table, 0.015 inch would have been added to 0.0585 inch, and the constant would then have been 0.0735 inch. From the foregoing it will be seen that the use of this table will reduce the time required for measuring screw threads by this system.

TABLE OF CONSTANTS USED IN MEASURING U. S. FORM THREADS—THREE-WIRE SYSTEM

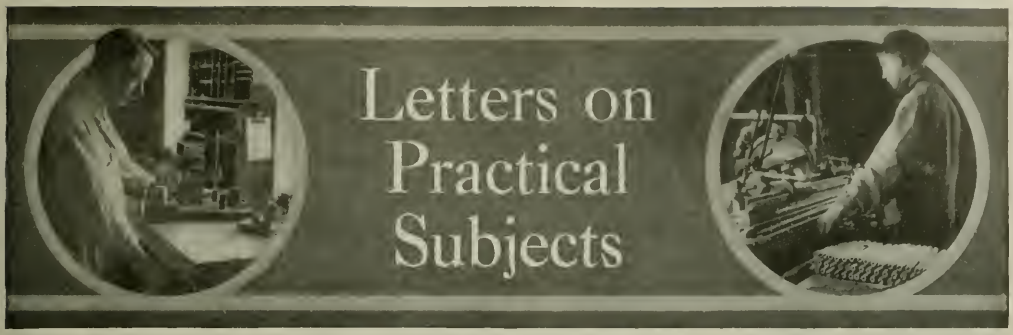
Micrometer measurement over wires = outside diameter + constant

Threads per Inch	Diameter of Wires W, Inch	Constant C, Inch	Threads per Inch	Diameter of Wires W, Inch	Constant C, Inch	Threads per Inch	Diameter of Wires W, Inch	Constant C, Inch
1	0.625	0.3595	7	0.090	0.0535	32	0.025	0.0276
1½	0.500	0.4897	8	0.090	0.0806	34	0.020	0.0154
2	0.3125	0.1798	9	0.070	0.0416	36	0.020	0.0179
2¼	0.3125	0.2639	10	0.070	0.0585	38	0.020	0.0201
2⅝	0.250	0.1119	11	0.070	0.0722	40	0.018	0.0161
2½	0.250	0.1438	12	0.050	0.0237	42	0.016	0.0119
2⅝	0.250	0.1727	13	0.050	0.0334	44	0.015	0.0106
2¾	0.250	0.1989	14	0.050	0.0418	46	0.014	0.0091
2⅞	0.250	0.2229	15	0.050	0.0490	48	0.0135	0.0089
3	0.250	0.2448	16	0.040	0.0253	50	0.013	0.0087
3¼	0.250	0.2837	18	0.040	0.0358	52	0.012	0.0069
3½	0.200	0.1670	20	0.035	0.0292	56	0.012	0.0089
4	0.150	0.0711	22	0.035	0.0361	60	0.011	0.0078
4½	0.150	0.1132	24	0.035	0.0419	64	0.010	0.0063
5	0.150	0.1469	26	0.030	0.0317	68	0.010	0.0077
5½	0.150	0.1745	28	0.030	0.0359	72	0.009	0.0060
6	0.150	0.1974	30	0.030	0.0395	80	0.008	0.0051

Machinery

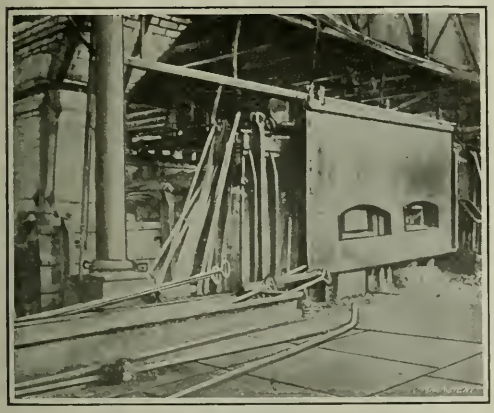
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The consolidation of nine steel, coal, and transportation companies of Canada to form a $500,000,000 corporation called the British Steel Corporation is reported; English capital is said to be prominent in the enterprise.



WATER CURTAIN FOR REHEATING FURNACES

Employers have found it good business policy to provide modern appliances for the safety and comfort of their workmen. Under such conditions an employe can better concentrate his mind and abilities upon his work, and consequently



Water Curtain hung in Front of Furnace Doors as a Protection for the Worker

can turn out more and better work when his mind is not disturbed or his attention diverted by outside influences, such as noise and excessive heat. All such efficiency measures aid in increasing the output, particularly in a shop where their absence is liable to affect the physical condition of the workmen. In rolling mills, the output naturally falls off in the summer, because the intense heat radiated by the furnace is augmented by that of the weather. Various means have been devised to keep the front of the furnaces as cool as possible so that the attendant will be able to maintain a maximum output, or as near maximum as possible.

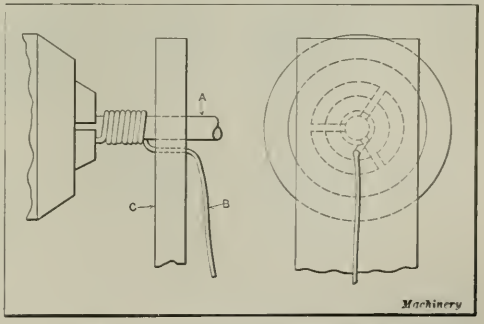
A water curtain such as shown in the illustration is employed in one mill as a protection to the worker. It consists of a rectangular sheet-metal screen suspended by three door hangers mounted on an iron track. Although the appliance illustrated is shown hung in front of a two-door heating furnace, it can be made of the proper size to fit furnaces of various sizes and designs. The oven-shaped openings in the screen are flanged by means of angle-iron, placed around the opening so as to keep the water from flowing into the furnace. A trough having a pipe attached is riveted to the bottom of the screen, and receives the water and conveys it to the trough shown at the left of the screen. At the top of the curtain and extending lengthwise is a spray pipe. The lower side of this pipe is perforated with small drilled holes so that the water is impinged against the sheet-metal screen. The spray pipe is capped at one end and connected with the water supply at the other.

The curtain is not necessary in winter, and may be easily removed by disconnecting the supply pipe and lifting the apparatus off the trolley track. Obviously the streams of running water on the side of the heated screen greatly reduce the temperature and permit the heater to give better attention to his work. In a rolling mill it is absolutely necessary that the billets or blooms be heated uniformly if the desired quality is to be maintained. It is well known that uniform heating of the material is an important factor in the rolling operation and that the output of the mill depends largely upon this condition. If the blooms are heated unevenly and have cold spots on their surfaces, they usually have to be sent back to the furnace after having been run through two passes in the roll, thus delaying the output of the mill. The type of water curtain described is a direct step toward placing the operation of a rolling mill on a more efficient basis. The conditions and methods of working in rolling mills are so different from those in other lines of manufacture that it is a very difficult matter to keep the output up to maximum, because not only the heat in the summer, but also the frost in the winter tends to check the output of the mill.

Youngstown, Ohio W. S. STANDIFORD

WINDING A COMPRESSION SPRING

Small music wire compression springs can be easily made by the method here illustrated and described. Having selected a mandrel *A*, the exact diameter of the interior of the desired spring, and wire *B*, obtain a piece of hard wood *C* (either maple or hickory is suitable), and through this piece of wood bore a hole in which the mandrel will fit, as shown in the illustration. Within 1/32 inch from this hole bore another hole, the size of the wire to be used for the spring.



Method of winding Small Compression Spring

Place the mandrel in the chuck of the lathe, slip the piece of wood over the mandrel, and insert the wire in the smaller hole, pushing it through until its end catches in the jaws of the chuck. Now press the piece of wood against the jaws of the chuck and commence winding the spring, first by pulling on the lathe belt, and then by throwing on the power when the coiling operation is well started. During the winding operation, the piece of wood should be pressed firmly against the coils so that the spring will have the appearance of being close wound. When the completed spring is removed from the mandrel, it will elongate or expand, thus forming a compression spring, that is the size of the mandrel on which it is wound.

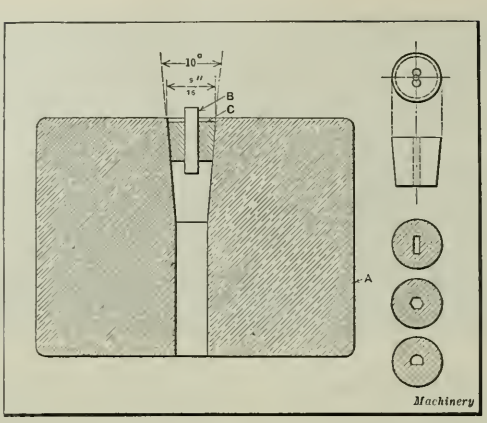
If instead of leading the wire through a small hole as described, a notch is cut in the hole which fits over the mandrel, and the wire fed through this, the inside diameter of the spring will be smaller than the outside diameter of the mandrel. To make the spring a loose fit on the mandrel, the wire should be led through a small hole located at a greater distance from the large hole. If the spring is straightened out by pulling it off from the mandrel, the wire will be badly kinked, but if rewound by the method described, a good spring will be produced. To remove the strains in the wire spring that result from the winding operation, it should be heated carefully, if made from steel, until it is a uniform blue color. If the spring is made of phosphor-bronze or brass wire, it should be covered with tallow or beeswax and heated until it smokes. This will remove the strains so that it will maintain its form. If the heating is done carefully, the spring will be stiffened.

Rochester, N. Y. J. H. Beebee

FORMING IRREGULAR-SHAPED HOLES IN DIE-BLOCK BUSHINGS

Die-blocks which are to be provided with irregularly shaped holes may be so made, if the bushed construction is permissible, by employing the following method. Much better results can be obtained by this method than by either filing or broaching and much time can be saved as well.

In brief, this method consists of compressing a bushing, which has been previously drilled through the center, against an inserted arbor of the proper shape until the metal becomes pressed around the arbor, thus forming a hole in the bushing of the required shape. The method of accomplishing this is shown in the illustration, in which a block of steel *A* is shown with the bushing and arbor inserted in a tapered hole. Bushings having holes such as shown in the three small sectional views in the lower right-hand corner of the illustration can readily be produced in this manner. In making a bushing having a rectangular center hole, the center would be drilled out as shown in the upper right-hand corner and an arbor inserted as at *B*. As the pressure is exerted, the tapered bushing *C* is forced down in the hole and the metal compressed around the arbor *B*. This method produces a nicely burnished hole, the exact duplicate of the shape of the arbor. After the hole has been made, the outside of the bushing must, of course, be finished straight so as to be a close fit in the die-block.



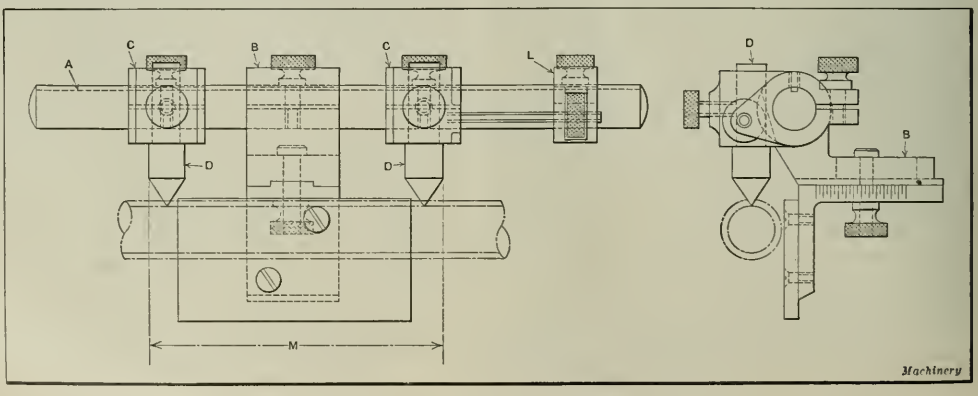
Method of producing Bushings having Holes of Special Shape

Bushings produced by the use of the block shown can be made having holes as large as ⅜ inch in diameter. For larger sizes, it is necessary, of course, to have a larger tapered hole in the block. The practice of bushing the die-block is recommended and should be done wherever possible. In nearly all such cases the method described will be found applicable.

Newark, N. J. John A. Shand

LEAD TESTING DEVICE

The device shown in the accompanying illustration is a convenient tool for testing the lead of screw threads. It consists of a ⅜-inch round bar *A* having a small splineway cut along its entire length, a back-rest *B*, which is mounted adjustably on a bracket, and two heads *C*, each of which carries a tool-steel test pin *D*. One of these heads is connected with an arrangement for obtaining close adjustments, consisting of a collar *L* secured to the shaft, which carries a knurled nut and a stop-pin as shown. The testing pins are held in the heads by means of small set-screws and can be replaced by pins to suit various thread shapes. The body of the testing pins should be turned true with the measuring points and should be ground to some convenient fractional size within



Simple Arrangement for testing Lead of Screw Threads

close limits, so as to make it easy to calculate the measurement taken over them. The device is used in the following manner: The back-rest is set on the bracket so as to bring the vertical center lines of the pins coincident with the center line of the work. Provision for obtaining this setting is made by graduating the bracket to which the back-rest is attached. The pins are set apart sufficiently to include the entire length of the threads of the piece, the work being held against the bracket, as shown by dotted lines in the end elevation of the illustration. Both pins should be brought into engagement with the thread in such a manner that daylight cannot be detected between the contacting surfaces of the pins and the thread. After the pins have thus been carefully located, a micrometer measurement is taken over the gaging points as indicated at *M* in the illustration. By deducting the diameter of the body of one of the test pins from this reading, the actual lead of the thread is found.

Plainfield, N. J. HENRY DAUT

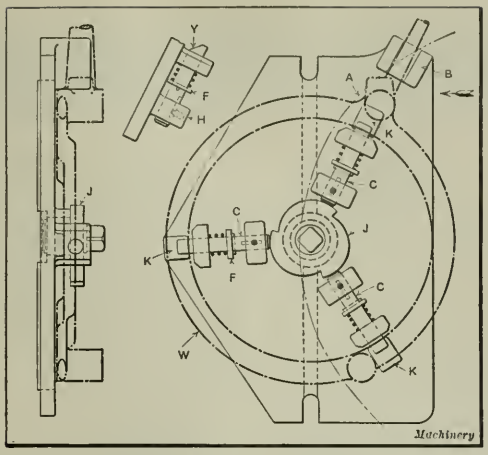
DRAFTSMAN'S FILLET RULER

Sometimes a fillet ruler may be used to good advantage by the draftsman when drawing small fillets. Such a ruler may be made from an old photographic film which should be treated in the following manner: First, wash off the sensitized emulsion in hot water, which will leave a clear and transparent piece of celluloid. Then cut to the desired size and, using a pair of sharp dividers or a belt punch, cut circles having radii corresponding to those of the fillets desired. Finally, the holes should be smoothed out with a piece of fine sandpaper, so as to remove all possibility of leaving rough edges. This simply made transparent fillet rule will save considerable time in the drafting-room. Such rules need not be confined to drawing fillets alone, but may be made for drawing hexagonal, oval, or for any other desired shape.

New York City HERBERT M. HILL

MILLING FIXTURE FOR SHIPPER YOKE

Simplicity of operation when it can be obtained without adding prohibitive expense or sacrificing rigidity is always a desirable feature for any fixture. This has been realized in the fixture illustrated, by incorporating three spring plungers and a cam in the design. The work for which this fixture was constructed is a shipper yoke for a drilling machine, which is shown in heavy broken lines as it appears when located on the fixture. This casting has two bosses which are milled in a vertical machine, the idea being to sweep across both bosses with a large surface mill as indicated by line *A*. The table of the machine is fed in the direction indicated by the arrow. The handle portion of the work is located between two lugs *B*, while three plungers *C* are employed to hold the yokes down against the three finished pads *K*. Two of these plungers are located near the bosses, while the third one is placed between them. Two lugs are provided in the base of the fixture for each of these plungers. Between each pair of these lugs, there is located on the plunger a coil spring, the function of which is to operate against the washer *F* for the purpose of withdrawing the plunger from the work as soon as cam *J* has been operated sufficiently to enable this movement to occur. It will be seen that there is a milled slot in the plungers in which the pilot-point set-screw *H* engages for the purpose of preventing them from turning. By this means the beveled surface *Y* on the under side of each plunger forms the proper contact necessary to force the work down against the pads *K*. Any suitable wrench may be employed to turn cam *J* for simultaneously operating the plungers, the effect being to centralize as well as to clamp the work securely in place. The fixture is attached to the table of the milling machine in the regular manner, there being a suitable tongue and two elongated slots provided for this purpose. H. M.



Cam-operated Milling Fixture for Shipper Yoke

PLANER CHUCK FOR LOCOMOTIVE SHOES

The chucks shown at *A* in Fig. 1, were designed and successfully used in gang planing locomotive shoes. With slight modifications, these chucks have also been found useful in machining other small parts for locomotives. The bodies of chucks *A* are made from either wrought iron or axle steel and are provided with inserted jaws *B*. These jaws are preferably made from tool steel and are hardened, grooves or serrations being cut across the gripping faces previous to the hardening operation. When employed for holding locomotive shoes, the grooved sides of the jaws are made to angles of 8 and 3 degrees, respectively, in order to conform to the shape of the shoes. A tongue planed on the base of the chucks to fit the groove in the planer bed serves to align and hold them in position when locating the work. When several pieces of work *C* are located, the nut at the end of the draw-bolt *D* is tightened, thereby clamping them together. Bolts *E* are primarily employed to hold the chucks to the planer bed. However, should the work buckle when bolt *D* is operated, these clamping bolts will, when tightened, increase the gripping power of the jaws.

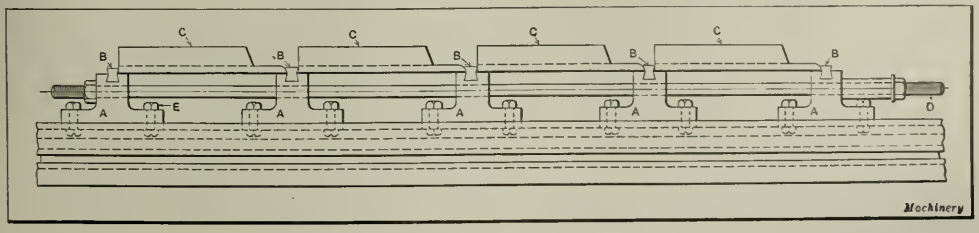


Fig. 1. Chucks employed to hold Locomotive Shoes on Planer Bed

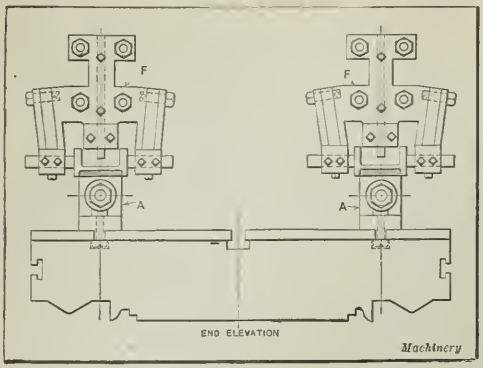


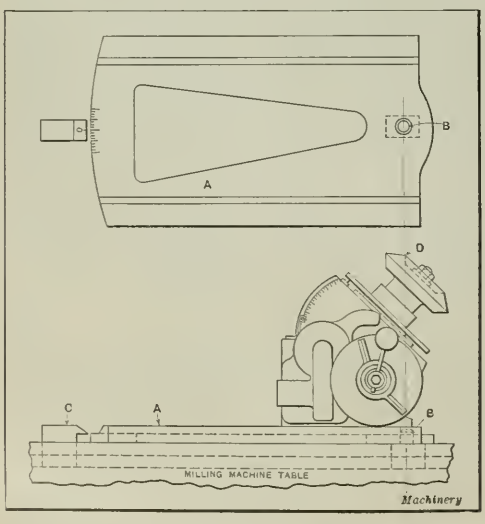
Fig. 2. Tool-holders for gang-planing Locomotive Shoes

The end elevation, Fig. 2, shows the method of mounting two rows of chucks on the planer bed. The special tool-holders *F* are employed when planing the shoes. These tool-holders are bolted to the cross-heads of the machine and have provision for throwing the side tools up out of the way while planing the trough of the shoes. While only four pieces of work are shown in Fig. 1, there is no reason why more could not be held in each row provided the length of the planer bed is sufficient to accommodate them. The chuck and tool-holder described were designed by Timothy C. Foley of Renovo, Pa., and arrangements are being made to have them patented.

NORMAN MCCLEOD

METHOD OF CUTTING BEVEL GEARS

The method of cutting bevel gears on a universal milling machine here described was seen by the writer in a railroad shop, and he has since made use of it with satisfactory results in the machine shop of a technical high school. It may prove of interest to others engaged in similar work. The method requires the use of a plate *A* shown in the accompanying illustration. The dividing head is mounted on this plate so that the plate and dividing head can be pivoted about pin *B*, which is fitted snugly into the slot of the machine table, as shown. The opposite end of the plate is graduated so that when set at zero it will be parallel with the table. Sixteenth-inch graduations are marked on each side of the center line. The index-finger *C* is fitted in the table slot as shown. With the arbor of the dividing head at the proper angle, and a cutter the exact width of the tooth space at the inner end, the head is moved along the plate until the inner end of the bevel on the gear blank is directly over the center line of the pivot pin *B* as shown at *D* in the illustration. Two cuts are taken producing one unfinished tooth, after which plate *A* is swung to the right and left, respectively, about pivot *B* for trial cuts until the outer end of the tooth is cut to the correct width.



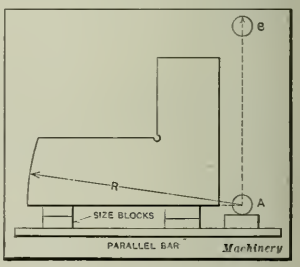
Dividing Head mounted on Special Plate used in cutting Bevel Gears

Having carefully noted the graduation at the left-hand end of the plate, all the teeth can now be cut alike by taking cuts with the plate swung the proper amount, as determined by the graduation reading obtained at the trial cuts. Should the cutter be thinner than the correct width of tooth space at the inner end, the dividing head must be moved slightly to the left of the center line of the pivot, thus allowing the inner end of the tooth to swing off center for the trial cuts.

Winnipeg, Canada W. K. MULOCK

TESTING THE RADIUS OF CURVATURE OF A GAGE

To test the radius of curvature *R* of a gage and also the location of the center of curvature, set up for the test as shown in the accompanying diagram. The center from which a given radius is generated quite often bears a certain relation to some working face of the gage, and the location of this center must be tested, as well as the radius.



Set-up for testing Radius of Curvature

Clamp a parallel bar near the edge of a surface plate and secure the disk *A* at some convenient distance from the parallel bar. Then clamp disk *B* so that the measurement taken from the extreme outside of disk *B* to the center of disk *A* will be equal to the desired radius. An indicator may be then swung from *A* by means of a V-block and an arm or bar clamped to it, the indicator being set so as to register zero at the extreme outside of disk *B*. Set the gage the correct distance from the parallel bar, so that the horizontal center line of the disk *A* will coincide with the surface upon which the gage rests, as shown in the sketch. Now set the indicator which is swung from *A*, so that it will bear on the curved surface of the gage, and adjust the position of the gage parallel with the parallel bar, until the indicator registers the same as it does when swung over the reference disk *B*. Finally, swing the indicator back and forth over the curved surface of the gage, and if any deviation from the correct radius exists the indicator will show it. It will also indicate whatever error there is in the position of the center of curvature.

Richmond College, Va. V. E. AYRE

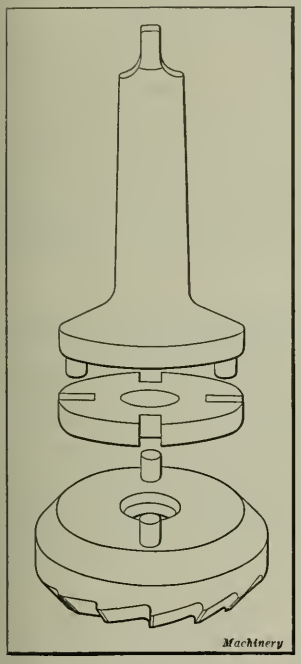
* * *

The question of whether the age of aluminum is to follow the age of iron is raised by *Industrial Management*. Our knowledge of bronze, iron, and steel is the heritage of the race, says this journal, for men have fashioned implements from these metals for generations. But aluminum belongs to this generation, and already we have alloys which equal mild steel in strength at the same time preserving that important property of aluminum—lightness. A recently discovered alloy has the property of responding to heat-treatment whereby its strength is greatly increased; as it can also be hot rolled, stamped, and forged it is adaptable to construction.

SHOP AND DRAFTING-ROOM KINKS

FLOATING COUNTERSINKS

In countersinking the edges of cylinder holes in airplane motor crankcases, much time is consumed in attempting to align the spindle with the center of the hole when the work is performed on a radial drilling machine. It is necessary that accurate alignment be attained, as otherwise poor work will result. The floating countersink shown in the accompanying illustration was used in this operation as a means of saving time in aligning the tool with the work. This tool will take care of the alignment regardless of the carelessness of the operator, and in addition will result in a considerable saving of time. The pins in the upper and lower members of the tool engage the four slots located 90 degrees apart on the periphery of the center piece, and give a positive drive even when the center of the lower member is ¼ inch out of line with the shank of the tool. A special shouldered machine screw holds the part together, being tapped into the shank from underneath. If desired, inserted steel bits may be used in place of the solid piece in the cutter. The tool may also be made with a pilot—a construction which is to be recommended wherever practicable. The construction might further be improved by making the pins with flat or slabbed sides where they engage the sides of the slots.



Floating Type of Countersink with Intermediate Driver

Rochester, N. Y. GEORGE C. HANNEMAN

REDESIGNING JOURNAL BRASSES TO FACILITATE MACHINING

The writer desires to call the attention particularly of draftsmen and machine designers to a simple change in the patterns for journal bearing brasses which will, in some cases, greatly facilitate the machining and finishing of these parts. In the shop where the writer is employed, a large number of machines are made with interchangeable journal brasses which require frequent renewal on account of the very heavy duty imposed upon them. These journals range in size from 3 to 10 inches in diameter. It had been the common practice to bore these brasses in pairs, but on account of the narrowness of the casting at *A*, as shown in the accompanying illustration, it was necessary to complete the machining operations on each half separately. Recently one of these machines was given a complete overhauling and among other changes that were made was the enlarging of the recess for the brasses to the size indicated by dimension *B*. This permitted the thin sections of the brasses to be increased in thickness to such an extent that they are now cast in pairs, gated or tied together, as shown by the wall or connecting portion at *D*. The two halves are thus held rigidly together while being bored and finished, after which they are separated by cutting away the joining metal with a hacksaw. It is often possible to effect a saving in time in machining castings for various parts, by giving attention to this point in designing the patterns.

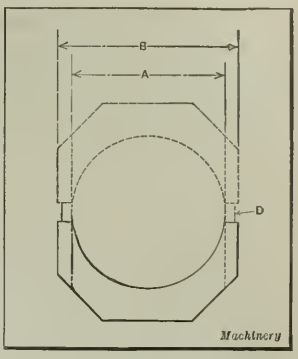
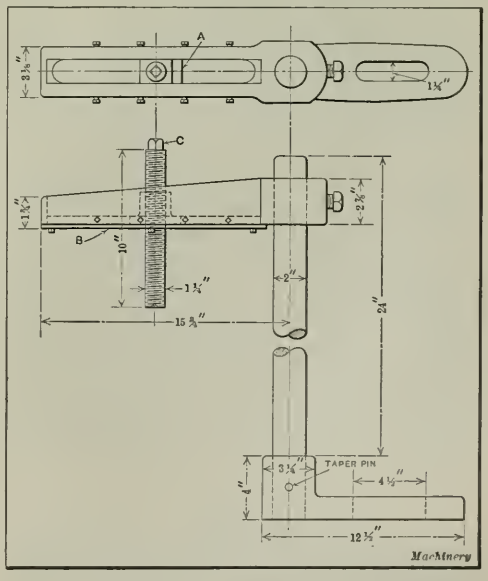


Diagram showing how Journal Brasses were redesigned to facilitate machining

Kenosha, Wis. M. E. DUGGAN

ARM FOR RATCHET DRILL

The accompanying illustration shows a special design of arm for the post of an "old man," which has a recess in which a special square-threaded nut is fitted, as shown at *A*. This recess is 7/16 inch deep and 13½ inches long and is covered by a plate *B*, which encloses the nut. The screw *C* operates in this nut for the purpose of holding the ratchet drill in a vertical position. An arm of this design provides a liberal radial adjustment. The cost of manufacturing this type of "old man" is about $8. NORMAN MCCLEOD



Improved Radial Arm for "Old Man" for Ratchet Drill

HOW AND WHY

QUESTIONS ON PRACTICAL SUBJECTS OF GENERAL INTEREST

PROBLEM IN MENSURATION

ANSWERED BY C. N. PICKWORTH, MANCHESTER, ENG.

The problem is to find the diameter of a circular disk which will be tangent to the surfaces ME, MN, and the point K of a gage-block. The known values are the height a of the block and the dimension b, as shown in the accompanying diagram. Previous solutions to this problem have appeared in MACHINERY which have required the solution of quadratic equations, squaring of binomials, etc., whereas the solution here submitted is very simple and should be handled by the average toolmaker without difficulty.

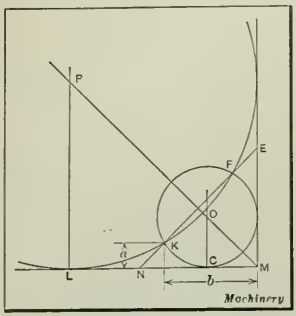


Diagram used in Solution of Mensuration Problem

Through point K draw NE at 45 degrees from surface NM. $KE = b\sqrt{2}$, and $NK = a\sqrt{2}$. It follows then that, since $KE = NF$,

$$NC = \sqrt{b\sqrt{2} \times a\sqrt{2}} = \sqrt{2ab}$$

If, as in the previous examples, $a = \frac{1}{4}$ inch and $b = 1$ inch, then

$$NC = \sqrt{0.5} = 0.707106 \text{ inch}$$
$$CM = 1.25 - 0.707106 = 0.542894 \text{ inch}$$

This is the required radius for a disk which is tangent at the outside of point K, but there is another condition of this problem in which the disk touches the required surfaces and also passes through the point K as shown by the larger arc in the diagram. This may be found by laying off NL equal to NC and erecting perpendiculars at both points L and C as shown. Then by passing a 45-degree diagonal from point M through these perpendiculars, the intersection with each will be the center of the required disks. The radius, then, of the large disk may be simply found by multiplying NC by 2 and adding CM. That is,

$$PL = 2 \times 0.707106 + 0.542894 = 1.957106 \text{ inches}$$

MEANING OF TERMS "FLASH POINT" AND "FIRE POINT"

G. H.—What is meant by the terms "flash point" and "fire point," as applied to oil?

A.—The flash point of oil is the lowest temperature at which the vapor will ignite or flash up momentarily without setting fire to the oil. If the temperature of the oil is increased beyond the flash point, the vapor is given off so rapidly that it will maintain a continuous flame, and the fire point is the lowest temperature at which the oil will burn continuously. The temperatures for the flash point and the fire point may be practically the same for some oils and 20 degrees apart in other oils.

CAST STEEL

R. A.—Cutting tools are sometimes marked "cast steel." Do the terms "cast steel" and "tool steel" mean the same?

A.—The term "cast steel" is sometimes used to designate what is known as tool steel or crucible steel, but this usage is becoming more and more obsolete and should be discontinued, as it is confusing. Steel castings made by pouring molten steel into suitable molds are sometimes referred to as cast steel, but the latter term should not be applied to the high-carbon steel which is made by the crucible or electric processes and is suitable for cutting tools.

COMPARATIVE USE OF BESSEMER AND OPEN-HEARTH STEELS

T. O. R.—Is open-hearth steel used much more extensively at the present time than Bessemer steel? If so, when did this change in practice occur?

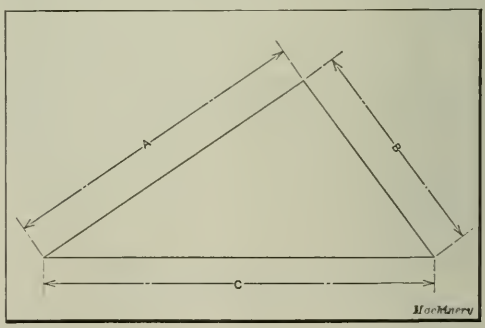
A.—Most of the steel used at the present time is made by the open-hearth process. The tonnages of the Bessemer and open-hearth processes were about equal in the United States in 1907, but in 1912 the open-hearth furnace produced approximately twice as much steel as the Bessemer converter and since then the open-hearth process has been gaining steadily. Better grades of structural steel are made in the open-hearth furnace, and the process produces a more uniform and reliable steel than the Bessemer, as the operations are under better control.

SIMPLE FORMULA FOR FINDING AREA OF TRIANGLE

A. L.—Is there a simple formula which may be used to find the area of a triangle when the only known values are the lengths of the three sides? A formula which involves only simple arithmetic is desired.

ANSWERED BY F. C. MASON, CLEVELAND, OHIO

The formula stated below, which is not commonly found in text-books, may be readily employed by those not familiar with the use of mathematics such as commonly required in



formulas for finding the area of a triangle. Aside from the simple arithmetical operations of multiplication, addition, and subtraction, the only other work required in the solution is the extracting of a square root. The formula is given in the following

$$\text{Area} = \sqrt{S\,(S-A)\,(S-B)\,(S-C)}$$

In this equation $S = \frac{1}{2}$ the sum of the sides A, B, and C (see accompanying diagram). As an example, let $A = 9$ inches, $B = 6$ inches, and $C = 11\frac{1}{2}$ inches. Then one-half the sum of these three is $S = 13\frac{1}{4}$ inches. Substituting in the formula:

$$\text{Area} = \sqrt{13\frac{1}{4} \times 4\frac{1}{4} \times 7\frac{1}{4} \times 1\frac{3}{4}} = 26.73 \text{ sq. in. approx.}$$

The German Machine Tool Industry

From MACHINERY'S Special Correspondent

Berlin, June 7

THE German machine industry has many difficulties to contend with. There has been an immense increase in the prices of all raw materials. Production has decreased due to shorter working hours and lessened efficiency on the part of the workers. As a result, a large amount of capital must be tied up in raw materials and semi-finished parts. The upward tendency of prices for materials, due mainly to increased wages, has not yet come to a standstill. While it is true that the selling prices for machine tools have also increased proportionately, a long time elapses between the time of buying the raw materials at the increased prices and the selling of the completed machine. For this reason, most of the machine building firms have increased their capital and must doubtless make further increases in the future. As examples may be mentioned that the Sächsische Maschinenfabrik, formerly Richard Hartmann, has increased its capital from 15,000,000 to 30,000,000 marks. The firm of Siemens & Halske has increased its capital to 126,000,000 marks, and the Allgemeine Elektrizitäts Gesellschaft has increased its capital from 225,000,000 to 300,000,000 marks. Of this increase it is said that 25,000,000 marks was taken by American financiers, who paid in dollars at the exchange rate at the time this arrangement was made (50 marks to $1). Increases in capitalization and consolidations of firms are the features of the day.

News of the German Machine Tool Industry

The firm of Otto Wolff of Cologne, dealer in iron and steel, has acquired a large interest in the Düsseldorfer Maschinenfabrik, formerly Schiess Aktiengesellschaft. Another iron and steel firm, the Rheinstahl & Phönix, has become the owner of three machine building concerns, Klingelhoeffer, G. m. b. H., of Grevenbroich, de Fries & Co., of Düsseldorf, and the Internationalen Bohrgesellschaft of Erkelenz. These plants will be organized along modern lines with proper standardization and specialization, and will divide between themselves the building of heavy and light machine tools.

There is a tendency to greater specialization in the machine tool industry in Germany. The Union Works of Chemnitz and the firm of Karl Wetzel of Gera, who are both manufacturing horizontal boring machines, have agreed that each firm will build only certain types in the future. The Union shops will build the smaller sizes in two types, and Karl Wetzel will build the larger sizes in two types. The two leading makers of magnetic chucks have made a similar arrangement. Makers of molding machines have also entered into an agreement whereby five of the more important firms will employ a common sales organization under the name of Giessereimaschinen Gesellschaft m. b. H. The individual companies in the combination will merely take care of the manufacture, each specializing on certain types.

A large company for the manufacture of agricultural machinery has been formed, known as the Delma Deutsche Landwirtschaftsmaschinen A. G. Twenty-five machine building firms as well as one hundred landowners are the founders and owners of this company. The capital is 10,000,000 marks, which it is expected will be doubled shortly.

The Exhibition at Leipzig

The success of the exhibition at Leipzig in the early part of the spring was interfered with by the street fighting and rioting which took place in the city. Nevertheless, it is stated that machines were sold to an amount of several hundred million marks. The German machine tool builders' exhibition formed the most important part of the engineering side of the fair. Since the show in 1902 at Düsseldorf, no other machine tool exposition in Germany has been as impressive as that at Leipzig this year. It took four months of intensive work on the part of the German machine tool builders' association to arrange for a successful exhibition. Three hundred and forty firms who build machines for the metal-working trade were represented, and in addition seventy-five woodworking machinery firms had exhibits. There were also over one hundred concerns manufacturing precision tools and small tools. On account of the difficulties in the transportation facilities in Germany, only smaller and medium-sized machines were exhibited. The machines exhibited give an accurate indication of the present tendencies in German machine tool design, and some of the details relating to these tendencies will therefore be given.

Types of Lathes Exhibited

The majority of the lathes exhibited had cone pulley drives. The points emphasized were that in the design care had been taken to place feed-levers, handles, etc., within easy reach. One machine exhibited by Heidenreich & Harbeck of Hamburg had all handles required for operating the entire machine placed in the apron. The same firm also exhibited a lathe of a type similar to the "Lo-swing" lathe built in America.

Turret lathes were exhibited by Pittler and Carl Hasse & Wrede, as well as by the Magdeburger Werkzeugmaschinenfabrik; the latter showed turret lathes provided with from eight to ten roughing tools working simultaneously, special multiple tool-holders being used. These machines proved very efficient and had a high rate of production.

Automatic Screw Machines

The various types of automatic screw machines formerly imported into Germany from the United States are now being built by German firms. The design in general follows the American model closely, although in various details new features may be observed. Hahn & Kolb and Ludwig Loewe exhibited small automatic machines of the Brown & Sharpe type; Alfred H. Schütte had on exhibition a large multiple-spindle automatic, while Gebrüder Böhringer, Carl Hasse & Wrede, and Heidenreich & Harbeck showed automatic machines of the Gridley type. In these machines the drive had been changed, a single-pulley drive with gear-box being employed. It is stated that two other German firms are preparing to manufacture machines of the Gridley type. It is also said that the German automatic machines of this type are built in a heavier design than the American machines, as they are used on castings of tougher composition than those ordinarily employed in the United States. Various new features in design have been introduced, among others an automatic speed selection, whereby the cutting speed best suited for each cut is introduced. The automatic machine shown by Pittler at the exposition is of the Cleveland type, while a machine was shown by Carl Hasse & Wrede which was somewhat different from the well-known types.

Other Classes of Machine Tools Exhibited

Fritz Werner, Ltd., of Berlin-Marienfelde exhibited new grinding machines—among others a grinder spindle made originally for the Fortunawerke at Cannstatt, which runs at

60,000 revolutions per minute. Fontaine exhibited a die-grinder, particularly interesting on account of its size.

In the field of planers and shapers there has been remarkable progress in specialization. The Samsonwerke exhibited a new shaper having many original features. The planers exhibited were well designed and indicated attention to detail. In the boring and drilling machine group more compact designs and increased dimensions of columns were noticeable. The Titaniawerke exhibited a drilling machine with box column, and in general there is a tendency to design columns or frames of very strong construction.

Some heavy punching machines were exhibited by the Berlin-Erfurter Maschinenfabrik, but on the whole only the smaller machine tools have survived from the war industry and passed into the peace-time industries. Some milling machines designed originally by the Titaniawerke for the manufacture of fuses for projectiles have been redesigned to suit the needs of the machine building trade in general.

The Small Tool Industry in Germany

The small tool industry was well represented at the Leipzig Fair. Tools of various descriptions, milling cutters, drills, reamers and chucks were exhibited by first-class makers. Of particular interest was the group of measuring instruments exhibited by Hirth & Zeiss, possessing features of great interest, and opinions were expressed that in regard to measuring tools, the German industry has reached American quality, and in many cases surpasses in original design. Zeiss of Jena, in particular, exhibited many new tools of great interest, including new optical measuring and testing appliances, a new microscope for measuring threads, micrometers, etc. It was evident that the physical laboratory methods of scientific measurements have had a distinct influence on the design of measuring instruments used directly in the machine building industries.

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ILLINOIS MANUFACTURERS ON THE BASIS OF WAGES

The Illinois Manufacturers' Association has submitted to the United States Railroad Labor Board a brief in which the following very important points are made:

The practice of basing wages on the cost of living, without taking into account the work performed for the wages, is at the very bottom of the present disturbed and unsatisfactory labor conditions. It is usual now, in presenting claims for wage advances, to attach an estimated family budget, upon which the percentage of wage increase is predicated. Unfortunately this family budget is presented only to further the claims of a particular body, but a universal application of the budget presented might lead to impossible economic results. If, for instance, the figures submitted by Mr. Lauck that $1700 represents the lowest subsistence level and $2500 the lowest comfort level for an American family were accepted, and the scale of wages in the transportation service were based on the assumption that every man engaged in this service, no matter where he lives, whether married or single, is entitled to a wage based on a scale with those figures as minimum, would it not be fair to assume that every wage earner in every part of the country is entitled to a scale based on that same minimum?

"From our experience as manufacturers," says the Illinois Manufacturers' Association, "we should say that if Mr. Lauck's budget were made the basis of a universal demand, the farms, the mines, and the industries would be wholly unable to meet it on a straight time basis." The Railroad Labor Board, therefore, can render a signal service to the country by indicating to these claimants that while wages should be equalized in those cases that have lagged behind in the wage readjustment, wages cannot be *paid* unless they are *earned*, and that we cannot get more out of the common pot than we put into it.

The divorce of wages from production has been one of the calamities of the war, for it has created in the mind of the wage earner, the delusion that irrespective of output, performance, or character of service rendered, he is entitled to live on a certain scale. Statisticians spend their time in developing elaborated lists of family requirements, instead of determining how wage increases based on these requirements can be paid. And so it happens that during the most critical time in the industrial history of the country, when the consumption of commodities has expanded, and world production of commodities has been greatly impaired, there has been established a shorter working day, piece and premium forms of payment have been abolished in many instances, and the worker has the idea that he is entitled to a good living irrespective of how much he produces.

The time has come when it is necessary to emphasize the necessity that part, at least, of the increased cost of living shall be met by longer hours and increased output, and that piece and premium rates of pay should be re-established.

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THE FEDERATED AMERICAN ENGINEERING SOCIETIES

Delegates representing sixty-one national, regional, state and local engineering and technical societies of the country attended the conference held at Washington, D. C., on June 3 and 4, for the purpose of effecting an affiliation of these bodies. The constitution and by-laws presented to the conference were favorably voted upon by forty-nine societies, the remaining societies either not voting or being absent from the meeting. Representatives of the American Society of Mechanical Engineers and the American Institute of Electrical Engineers, who were empowered to take such action for their respective societies, ratified the constitution and by-laws. A similar action could not be taken by the remaining societies represented at the conference because their delegates were not empowered to act, and a ratification must later be made by each society desiring to become a member of the organization. The constitution provides that the name of this association of societies shall be the "Federated American Engineering Societies." The work of promoting the interests of the organization until it can become active was entrusted to the Engineering Council.

The object of the federation is to further the interests of the public through the use of technical knowledge and engineering experience, and to consider and act upon matters common to the engineering and allied technical professions. The management of the organization will consist of a body known as the "American Engineering Council," which will act through its executive board. Each national, regional, state, and local organization will be entitled to one representative on the council for a membership of from 100 to 1000 inclusive, and one additional representative for every additional 1000 members or major fraction thereof, but no organization can have over twenty members on the council. Meetings of the council will be held annually, although special meetings can be held at any time upon the request of twenty-five of its members. The functions of the council are to coordinate the activities of state councils and local affiliations whenever these activities are of national or general importance or may affect the general interests of engineers. The executive board will consist of the six officers of the council and twenty-four of its members.

Resolutions were adopted advocating the payment of adequate salaries to teachers of engineering in technical institutions, and the adoption of appropriate measures to give effect to the recommendations recently made to Congress for a more adequate salary schedule for engineering and other technical services of the Federal Government, and indorsing the bill now under consideration by Congress, for the creation of a Department of Public Works.

Spring Meeting of the American Society of Mechanical Engineers

At the spring meeting of the American Society of Mechanical Engineers held in St. Louis, Mo., May 24 to 28, a great number of important papers relating to mechanical engineering subjects were read, particular attention being given to engineering problems affecting industries of the Middle Western states. Six specific sessions were held, devoted to appraisal and valuation, aeronautics, foundry practice, power and combustion, and general mechanical engineering science, and a local session with papers presented by St. Louis engineers. The papers most important to the machine-building field are briefly reviewed in the following.

Tight-fitting Threads for Bolts and Nuts

A paper on this subject was presented by Chester B. Lord of St. Louis, Mo., who stated that although in general the thread forms now in use are quite satisfactory, perfection has by no means been reached. There is still considerable search for "a thread that will not loosen," and in the preliminary portion of the paper, the author discussed the fundamental principles involved in the manufacture of threads. The problem to be solved, he stated, is as follows: "Without sacrifice of strength, without increase of rejection, without additional manufacturing costs, find a method whereby a male and female thread of the same lead and pitch diameter may be made after repeated loosenings to fit right without the aid of a locking device." The reasons for departing from accepted practice were presented and discussed, and as a result of experimental work, the author drew the following conclusions: (1) The cause of stripped threads is lack of room into which the metal can flow; (2) the pitch diameter should be the same in both threads; (3) the lead should be the same; (4) the thread angle should differ by not more than 10 degrees; (5) the limits for the inside diameter of nut need not be adhered to closely, as the inner part of the nut thread holds very little, if any; (6) the outside diameter of plug and pitch diameter of both plug and nut are important and should be adhered to fairly closely.

Malleable Castings

In this paper Enrique Touceda of Albany, N. Y., stated that malleable castings are now regularly made weighing as much as 500 pounds, with an ultimate strength of 50,000 pounds per square inch and an elongation of 10 per cent or over. With these properties in mind he compared such castings with gray iron and steel castings, showing that with respect to the former the malleable casting has equal physical properties, costs no more, is lighter in weight and is not liable to breakage. More than 70 per cent of the steel castings produced in this country are not annealed and are in a state of internal strain. Annealed malleable castings are free from such strain, are less expensive to produce, and in the author's opinion will stand more abuse in service. Their use is therefore recommended for any part of such size as can be successfully made where strength combined with ductility and low cost per pound is essential.

Die-castings

A paper on die-castings was presented by Charles Pack, of Brooklyn, N. Y., in which he stated that the die-casting process is best adapted to alloys of comparatively low fusing points, such as those of zinc, tin, lead, and aluminum. While it is stated that no general rules can be laid down governing the design and application of die-castings, the paper nevertheless outlines the general properties of the various alloys used and their fields of application, and gives particulars regarding such limitations as maximum weight of casting, minimum wall thickness, minimum number of threads, and minimum diameter of holes that can be cast, draft for cores and side walls, etc.

Aluminum Castings

A paper on aluminum castings by Zay Jeffries of Cleveland, Ohio, first gave particulars of the various aluminum alloys used for casting purposes. The metallography and physical properties of these alloys were then dealt with, following which information was given on maximum and minimum weights, tolerances on dimensions, and machining data. Later sections dealt, respectively, with heat-treatment, aging, effect of thickness of section and rate of chill on physical properties of aluminum alloys, fatigue resistance, special places where the use of aluminum castings is indicated by reason of their lightness and ease of machining, and with the selection of alloys for special purposes.

Steel Castings

The paper on steel castings was prepared by John H. Hall of High Bridge, N. J. This paper dealt briefly with the physical properties of steel castings and their improvement through annealing and heat-treatment, cost of castings, and the classes of work for which steel castings should be specified. Castings are now made, it is stated, with physical properties nearly twice as good as those of the ordinary commercial product, and where the service demands unusual strength, toughness, and resistance to wear and fatigue, their use is urged even though they machine somewhat less freely.

Gray Iron Castings

In a paper on gray iron castings, Richard Moldenke, of Watchung, N. J., dealt briefly with the chemical composition of gray iron castings, giving in this connection a table of recommended compositions for many varied purposes. He then indicated the extent to which specialization has taken place in iron founding and enumerated the various classes of foundries and the lines of work to which they are best adapted. Dealing with recent tendencies in gray iron foundry practice, he called attention to the very high sulphur content now met with in castings—a result of the use of abnormal proportions of scrap during the war because of the high price of pig iron—and gave brief particulars of an economical duplexing process by means of which the sulphur in molten cupola metal may be brought down in an electric furnace from, say, 0.12 per cent to 0.05 per cent and even lower.

Brass and Bronze Castings

In the paper on brass and bronze castings, Christopher H. Bierbaum, Buffalo, N. Y., after a short discussion regarding the terminology employed in designating alloys of copper tin, zinc, and lead, stated certain precautions that an engineer should take when specifying an alloy for a given service and then dealt briefly with the various deoxidizers and fluxes used in the brass foundry. The latter half of the paper was devoted to an enumeration of the more important bronzes and copper alloys, their compositions, properties, and uses being set forth in considerable detail.

Industrial Housing

A paper on industrial housing was presented by Leslie H. Allen of Springfield, Mass., in which he treated industrial housing as a financial problem. Our housing shortage is said to be due partly to the fear of a financial panic and partly to the fact that rents, high as they are, are not high enough to show an adequate return on present-day construction costs. The relation of rents to capital invested, the calculation of proper rents, and methods of financing house construction were discussed in some detail. The paper closed with a discussion of the scheme of cooperative housing, which the author suggested may be the solution of America's housing problems.

Appraisal and Valuation Methods

This paper, prepared by David H. Ray of Pasadena, Cal., brought out the need of the engineer's entering the appraisal field in the full capacity which his training and experience warrant. The engineer is likely to be more familiar with the cost and value of materials, machines, and structures than the lawyer or accountant, who in the past have been the only ones considered competent to direct this work. The topic of appraisal and valuation is essentially an engineering function, and it is the duty of the engineer to develop, guide, and control the method and procedure. Reports must necessarily depend on the purpose of the valuations and are divided into two main groups, private and public. It is pointed out that the variables affecting values depend on labor, material, and a factor to cover the general risk of the business, with particular reference to marketing. Charts, curves and tabulations were given to show the change in these values during the period of the war, and terms used in appraisal work were defined. The paper further showed the desirability of giving a value to a machine as a unit, of the grouping of similar tools, and of the use of symbols in the form of numbers and letters in tagging the materials to be appraised.

In addition to this paper on appraisal and valuation methods, other papers on kindred subjects were also read as follows: "Price Levels in Relation to Value," by Cecil F. Elmes, Chicago, Ill.; "Data on the Cost of Organizing and Financing a Public Utility Project"; "Rational Valuation," by James Rowland Bibbins, Chicago, Ill.; and "The Construction Period," by H. C. Anderson, Ann Arbor, Mich.

Aeronautical Papers Read before Spring Meeting

Four papers relating to aeronautics were read before the meeting dealing with various phases of mechanical engineering work in aeronautics. These papers were as follows:

"Aeronautic Instruments," by Mayo D. Hersey, Washington, D. C.; "Analytical Theory of Airplanes in Rectilinear Flight, and Calculation of the Maximum Cruising Radius," by A. Rateau, Paris, France; "The Flow of Air through Small Brass Tubes," by T. S. Taylor, Pittsburg, Pa.; and "Physical Basis of Propeller Design," by F. W. Caldwell and E. N. Fales, the latter paper being illustrated by moving pictures.

Power and Combustion Session

At the power and combustion session four papers were presented as follows: "Locomotive Feed-water Heating," by Thomas C. McBride, Philadelphia, Pa.; "Efficiency of Natural Gas Used in Domestic Service," by Robert F. Earhart, Columbus, Ohio; "Pulverized Coal in Metallurgical Furnaces at High Altitudes," by Otis L. McIntyre, New York City; and "A Method for Separation of the Dissolved Gases from Water and Some of Its Uses," by J. R. McDermet, of Greensburg, Pa.

Local Session

At the local session, papers contributed by St. Louis engineers were read. One of these papers was that on "Tight-fitting Threads for Bolts and Nuts," previously reviewed. In addition a paper on "The Housing Problem" was read by Nelson Cunliff, and the following papers were also presented: "Mississippi Valley River Transportation Activities," by E. W. Schadek; "Design of an Ore Fleet for the Upper Mississippi River," by William S. Mitchell; and "Burning Eastern Coals Successfully on a Conveyor-feed Type of Stoker," by Lloyd R. Stowe.

Scientific Session

The scientific session was a joint session of the American Society of Mechanical Engineers, the American Society of Refrigerating Engineers, and the American Society of Heating and Ventilating Engineers, who held their conventions in St. Louis at the same time. M. S. Van Dusen of the American Society of Refrigerating Engineers contributed a paper on "The Thermal Conductivity of Heat Insulators," and in addition the following papers were read: "The Dissipation of Heat by Various Surfaces," by T. S. Taylor, Pittsburg, Pa.; "An Improved Form of Weir for Gaging in Open Channels," by Clemens Herschel, New York City; and "Simplification of Venturi-meter Calculations," by Glenn B. Warren, New York City.

Committee Reports

A number of committee reports were also presented, including a code of safety standards for the construction, operation, and maintenance of elevators and escalators prepared by the American Society of Mechanical Engineers with the assistance of representatives of the U. S. Bureau of Standards, the Elevator Manufacturers Association of the United States, the Elevator Manufacturers Association of New York, the casualty and fire insurance companies, the American Institute of Architects, and various related engineering societies, elevator specialty manufacturers, and independent engineers. A special committee on code of ethics also reported a proposed code.

Machine Shop Practice Section Organized

An important feature of the meeting was the organization of the section on machine shop practice, the purpose of which will be to study the design, construction and operation of metal-working machines, including metal-working tools and appliances. A committee, consisting of Ralph E. Flanders of the Jones & Lamson Machine Co., Springfield, Vt., Forrest E. Cardullo of the G. A. Gray Co., Cincinnati, Ohio, C. V. Lord of the Wagner Electric Mfg. Co., St. Louis, Mo., and Professor H. B. Fairfield of the Worcester Polytechnic Institute, was selected to nominate permanent officers who will be elected by the members of the section.

An inspection trip was arranged to the Commonwealth Steel Co., Granite City, Ill., the plant of which was viewed by the visiting engineers with great interest. The following plants were also visited: Busch-Sulzer Bros. Diesel Engine Co., the Mississippi Valley Iron Co., and the coke plant of the Laclede Gas Light Co.

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MAKING POWER PRESSES SAFE

Safety engineers who have attracted national attention through their effective work in the safeguarding of power presses addressed the conference of the Engineering Section of the National Safety Council at a meeting held in the Auditorium of the Western Society of Engineers in the Monadnock Bldg., Chicago, on June 24. The program of this conference was divided into three sessions, morning, afternoon, and evening. The latter session was based on the subject of safety as it affects production, and was held jointly with the Chicago Safety Council, the Western Society of Engineers, and the Accident Prevention Committee of the Illinois Manufacturers' Association. The information resulting from the meeting will be used in drafting the national safety code on power presses, sponsorship for which has been accepted by the National Safety Council.

Gears from a Purchaser's Standpoint

By D. G. STANBROUGH, General Superintendent, Packard Motor Car Co., Detroit, Mich.

IN a paper read before the American Gear Manufacturers' Association convention at Detroit, which is here reviewed, the author first dealt with questions relating to personnel and organization, labor market, plant buildings and equipment, in so far as these affect the gear manufacturing industry. He next dealt with the fact that satisfactory gears from a purchaser's standpoint can only be produced as a result of conformity to good practice along the following lines: (1) Design; (2) materials; (3) forgings and castings; (4) heat-treatment; (5) machining; (6) hardening; and (7) inspection.

The Importance of Correct Design

There are certain fundamental considerations of design that can be counted upon to produce good gears, although a partially satisfactory product may be turned out if all of these fundamentals are not strictly adhered to. The good features of gears are uniform sections and a tooth form which will meet all the requirements as to strength. The design must also take into consideration the practice of the plant in which the gears are to be manufactured. Take, for instance, the familiar cluster gear used in automobiles. This cluster can be made from the blank with integral gears, or can be made with three integral gears and a fourth gear riveted or fastened to a flange. In the first case, a certain method of cutting has to be employed, and there will be unquestionably a considerable loss from warpage in heat-treatment. In the other case, the loss from warpage is reduced, but on the other hand considerable grinding is introduced and a nice fitting job is necessary. The decision as to the design should naturally rest with the practice of the shop. Good gears can be produced by either method, and the one to be adopted depends more upon which is in vogue than upon any technical consideration as to the results that can be obtained with either method.

Method of Mounting

Another thing which needs careful attention in designing gears, if satisfactory results are to be obtained, is the method of mounting. The best cut gear that can be made will not give satisfaction unless properly mounted. Many a noisy gear would not be noisy if it were run on quiet bearings. The mounting of gears should be such as to take care of the stress incident to the pressure angles. The shafts should be stiff, the mounting rigid, and the bearings as close to the center of the load application as it is possible to make them. In designing a gear-case, strains should receive careful consideration. The manufacturer cannot be expected to turn out a finished product which will conform to the customer's specifications unless the product be given at least fair conditions under which to operate. Much time and energy can be saved by giving more consideration to the design of gear mounting before the manufacturing work is undertaken. Too little attention has been paid to the mounting of gears by designers in the past. The manufacturers can do the purchaser a favor by pointing out the deficiency in design before undertaking contracts.

Materials for Gears

In selecting the materials from which gears should be manufactured, the conditions under which the gears are to be operated should be considered. First, those subjected to practically no stress and very little wear should be made of bronze, cast iron, untreated bar stock, and aluminum. Second, if the service will produce great wear but not severe stresses, the material should be "straight" carbon steel and should be carburized. Third, if the gears are subjected to extreme wear and considerable stresses, they should be made from forgings of alloy steel and should be carburized. Fourth, where severe impact and other stresses are involved with a normal rate of wear, high-grade alloy steel forgings should be used, oil-treated and not carburized. Fifth, where the gears are to be subjected to extreme wear and extreme stresses, they should be made from self-hardening steels which have been forged.

Castings and Forgings

No serious difficulty is encountered when the gear blanks are cast, although it is important to keep the sections uniform in order to guard against shrinkage cracks, especially in the case of gear blanks made from steel castings. With cast iron, it is important, in order to obtain long life, that the combined carbon be high and that the metal be cast so that the blank will be chilled, thereby retaining a sufficient quantity of the carbon in solution. The blanks should not be so hard that they cannot be machined without annealing, the most satisfactory results being obtained with a scleroscope hardness of about 35; the combined carbon content should be between 0.30 and 0.50 per cent. No particular difficulty is experienced with bronze and aluminum castings.

The forging of gear blanks represents a considerable problem. The temperatures at both the beginning and end of the operation should be held within certain well defined limits, according to the forging temperatures of the steels being used. High temperatures produce burnt gears, which sometimes can be used only after an expensive corrective treatment process has been employed. A low finishing temperature results in cold strains which when relieved in heat-treatment reveal cracks, seams, and fissures. Another phase of the forging of gears is in regard to the type of forging machines employed. Generally speaking, the flow lines of the metal in a forging should be at right angles to the forces applied to the gear teeth while in operation. It follows, then, that a gear that is flat can be produced under a drop-hammer, while gears having bosses and those in which length is the predominant feature, can best be produced by a forging machine. The size of the hammer has an important bearing on the subject; a large gear cannot be satisfactorily forged under a light hammer, as the time required to close the dies permits the gear to cool and results in too low a finishing temperature.

Preliminary Heat-treatment

Practically all gears that have been forged should be given a preliminary heat-treatment before machining, particularly those gears that will be subjected to great stress and that must be practically free from distortion after hardening. On mild steel, this initial heat-treatment consists simply of annealing or normalizing. Normalizing the steel eliminates whatever stresses have been set up in the forgings and renders the gears suitable for machining. On the alloy and high-carbon steels, the normalizing treatment is not sufficient. Gear blanks made of these steels are first quenched from a suitable temperature and then drawn sufficiently to enable them to be machined.

Salient Points in the Machining of the Blanks

In manufacturing gear blanks, it is important that the surfaces be held parallel and that they be machined true with the holes in the blanks. In the author's experience, broaching will produce a straighter hole than reaming.

Gears that have splined holes should be machined from the splines, both in the blanking and cutting operations. It is also essential that the pitch line of the gear be concentric with the hole.

Probably the simplest method employed for locating the gears when finish-grinding the bores and faces is the one in which the work is located from the periphery. Another method employed is that in which the gear is located from the root diameter, and still another method and the most difficult of the three, is that by which pins carried in the chuck contact with the gear teeth at the pitch line. Locating a gear from the root diameter is the most practical method. When this practice is followed, it is necessary to finish-cut the root diameter at the same time as the pitch diameter. This method also enables the locating pins in the chuck to be made stationary for each size of gear, which is an advantage. Although the method of locating from the pitch line has given satisfactory results, it is probably just a little less accurate owing to the fact that warpage produced in heat-treatment will have a greater effect at the pitch line than upon the root or at the top of the teeth. Locating the gear from the periphery is open to the objection that greater accuracy is required in the primary operations in order to get satisfactory results. Further difficulties to locating from the periphery arise from the fact that burrs are often thrown up, which if not removed will cause errors.

Final Hardening of Gears

All gears made from carburized stock and, as a rule, all oil-treated gears are finish-machined before final heat-treatment. Although considerable difficulty may be experienced in the final heat-treating process, the "hump" method developed by Leeds & Northrup Co., Philadelphia, Pa., is one of the most satisfactory of the various methods which may be employed. Distortion in gears is dependent to a large degree upon heating. The range of heating, together with the establishment of constant quenching temperatures, can be relied upon to solve problems in gear distortion which formerly were believed to be uncontrollable. To a large measure the solution of these temperature-control problems is due to the development of the electric furnace.

Methods of Testing Gears

After the purchaser has satisfied himself that the various manufacturing conditions required to produce a satisfactory gear have been complied with, attention should be directed to the final inspection process. The hardness test is of much importance, but it should be remembered that tests such as the scleroscope furnishes are comparative only, and that standards of hardness to suit the service to which the gears will be subjected should be established. The limits of these standards should be such that the gear will withstand a reasonable amount of wear, but it should not be so high as to make the gear brittle. The work of inspection, then, so far as hardness is concerned, is to determine whether the gears are within the limits allowed.

After the hardness test, each piece should receive a rigid visual inspection under good lighting conditions, for the purpose of discovering cracks and seams which may develop during the final hardening operation. With reference to inspection of tooth form, a rolling fixture in which the gears are mounted at the correct center distance and rolled with a master gear is recommended. A hand rolling fixture will give better results than a power type. The gears should be tested for backlash and for conformity to the dimensions specified by the established practice of the manufacturer.

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It is reported from Sheffield, England, that production of high-speed steel is unable to keep pace with the demand and that heavy buying, especially from the United States, as well as a great domestic demand will cause an increase in the price. After the armistice, the high-speed steel industry faced a depression, but today the demand exceeds the supply.

NEW BOOK ON GAGE MAKING

GAGE DESIGN AND GAGE MAKING. By Erik Oberg and Franklin D. Jones. 310 pages, 6 by 9 inches; 231 illustrations. Published by The Industrial Press, 140-148 Lafayette St., New York City. Price, $3.

As has often been pointed out, the cost of manufacturing any machine, device, or mechanism may be greatly influenced by the tolerances specified on the parts and by the gages employed in the manufacture and inspection. There is no doubt but that there is still a great deal of misunderstanding with regard to tolerances and their application in the manufacture of machines and mechanisms. The tolerances should be based upon the practical requirements of the mechanism to be made. Unnecessary accuracy which does not improve the working quality of the product merely increases the manufacturing cost. After the tolerances have been established, the gages used for maintaining these tolerances must be so designed that they are not only accurate, but well adapted to shop use. The relation between the gaging system and the design of the jigs and fixtures is also essential.

The book under review deals with such fundamental and vital points as outlined above, and is therefore a valuable addition to the technical literature of today. Briefly, it is a treatise on the development of gaging systems for interchangeable manufacture, covering the design of different types of gages and their production, and dealing in detail with the precision machining operations and lapping processes required in making accurate gages. It also deals with various modern appliances for gage measurements. Much has been published in the past on manufacturing practice, but comparatively little is available in book form on the design and making of gages. This book, in fact, is the first one of its kind dealing with the subject in a comprehensive and systematic manner; and at a time when the mechanical world has fully come to realize that gages should control the different manufacturing processes so that the required degree of interchangeability may be obtained, the book will be received with favor by production engineers, gage designers, and toolmakers.

The scope of the work is best indicated by a general review of its contents. The opening chapter contains a comprehensive review of the various steps required in the development of a gaging system. This is followed by chapters dealing with different types of gages, such as snap and plug gages, contour or profile gages, flush-pin and sliding-bar gages, hole gages, and thread gages. The chapters dealing with these types of gages describe in detail the various points to be considered in designing, and show numerous examples of actual designs.

The next main section of the book contains chapters on the making of different types of gages, especially thread gages, and covers the making of Whitworth thread gages, the grinding and lapping of thread gages, as well as various methods for measuring thread gages, including lead and diameter measurements, microscopic measuring machines for testing the accuracy and contour of thread gages, and an explanation of the projection method of testing gage threads. As a final chapter, a review of general gage-making practice is included dealing with such subjects as steel used for gages, the grinding of snap gages, gage grinding machines, heat-treatment of gages made either from machine or tool steel, restoring worn gages, and other subjects of interest to the gage-maker.

The part of the book dealing with the development of gaging systems and gage design is based largely upon the experience and practice of the Pratt & Whitney Co. in making gaging equipment for small arms and heavy ordnance. This company has done a great pioneer work along these lines, and the principles established during the war have in this manner been made available for the production of tools and machines used in peace-time pursuits.

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW AMERICAN METAL-WORKING MACHINERY

Niles-Bement-Pond Radial Drilling Machines. Niles-Bement-Pond Co., 111 Broadway, New York City....1085
Cincinnati 16-inch Gear Hobber. Cincinnati Gear Cutting Machine Co., Elam St. and Garrard Ave., Cincinnati, Ohio.1088
Index Base for Milling Machine. Industrial Engineering Co., 25 Fort St. E., Detroit, Mich....1088
Lovejoy Turret Toolpost. Lovejoy Tool Co., Springfield, Vt..1089
Knauel Adjustable Taper Caliper. Knauel Tool Works, Rock Island, Ill. 1089
Ingersoll-Rand Pneumatic Drills. Ingersoll-Rand Co., 11 Broadway, New York City....1089
Blush Multiple Micrometer. A. T. Blush Tool Co., Erie, Pa..1090
Wallace Pipe and Angle Benders. Wallace Supplies Mfg. Co., 412-420 Orleans St., Chicago, Ill....1090
Hobart Motor-driven Grinder. Hobart Bros. Co., Troy, Ohio.1091
"Simplex" Direct-reading Micrometer. Consolidated Tool Works, Inc., 261 Broadway, New York City....1091
Precision Grinding Wheel Truing Machine. Precision Truing Machine & Tool Co., Cincinnati, Ohio....1091
Brehm Shell Trimming Die. City Engineering Co., 35 S. St. Clair St., Dayton, Ohio....1092
Storm Boring Mill. Storm Mfg. Co., 6th Ave. and 4th St. S., Minneapolis, Minn. 1092
Cylinder Boring and Grinding Machine. Sunderland Machine Shops, 21st and Pacific Sts., Omaha, Neb....1092
Westinghouse Electric Welding Outfit. Westinghouse Electric & Mfg. Co., East Pittsburg, Pa....1093
Davis Lathe Milling Attachment. Hinckley Machine Works, Hinckley, Ill. 1093
Derringer Combination Tool-holder. Maurice H. Derringer, 3133 N. Eighth St., Philadelphia, Pa....1094
Oliver Planer and Jointer. Oliver Machinery Co., Grand Rapids, Mich. 1094
Guldager & Jantsch Mottling Tool. Guldager & Jantsch Co., 460½ Lenox Ave., Detroit, Mich....1094
Quick-change Chuck and Socket. Titan Tool Co., Erie, Pa...1095
U. S. Tool Co.'s Sub-presses. U. S. Tool Co., 51-53 Lawrence St., Newark, N. J....1095
Set of "Red-E" Lathe Tools. Ready Tool Co., 650 Railroad Ave., Bridgeport, Conn....1095
Allan-Diffenbaugh Pipe and Nut Wrench. Allan-Diffenbaugh Wrench & Tool Co., Baraboo, Wis....1095

Niles-Bement-Pond Radial Drilling Machines

SEVERAL noteworthy departures from established practice in the construction of radial drilling machines have been made in working out the design of the tools which form the subject of this article. They are known as "right line" radial drilling machines and are built in both plain and universal types by the Niles-Bement-Pond Co., 111 Broadway, New York City. Among their more noteworthy features

Radial drilling machines of this type are built in 5- and 6-foot sizes, and in both plain and universal styles. They may be driven by 4 to 1 variable-speed motors, with provision for reversing the direction of rotation for performing tapping operations. Eight chonges of feed are available, covering a range of from 0.006 to 0.060 inch per spindle revolution. With variable-speed motor drive, there are twenty-eight available speeds, ranging from 20 to 400 revolutions per minute. A constant-speed driving motor may also be utilized with a gear-box for obtaining speed changes. With this equipment there are sixteen available speeds, covering a range of from 13 to 452 revolutions per minute. A number of noteworthy departures from standard practice have been made in designing these machines, and the more important of these unusuol features are fully described.

of design there are included an arrangement for passing the arm through the center of a double column, a motor-driven column-clamping mechanism controlled by a switch on the drill head, an improved type of transmission from the motor to the spindle, and other features which will be dealt with in the following description. It will be seen that provision is made for the application of direct-connected electric motor

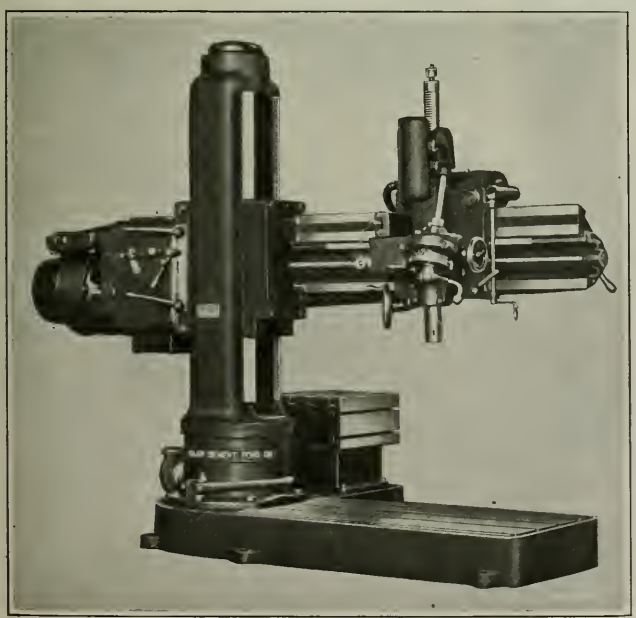


Fig. 1. Plain Type of Radial Drilling Machine built by the Niles-Bement-Pond Co.

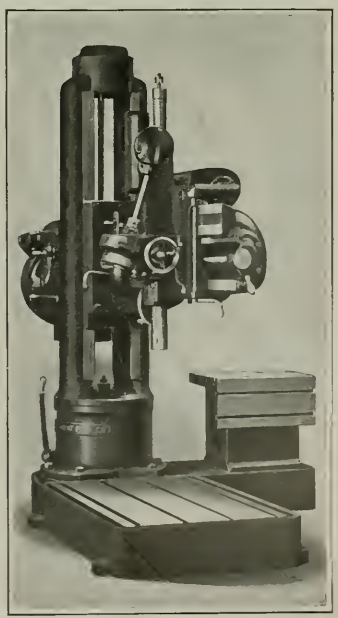


Fig. 2. End View of Machine



Fig. 3. Column-clamping Mechanism operated either electrically from the Head or by a Hand-lever shown in this Illustration

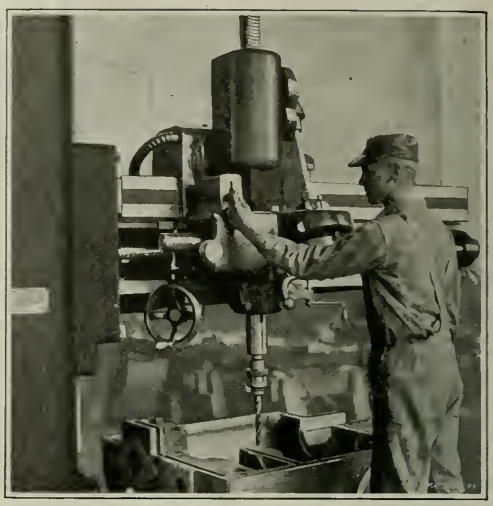


Fig. 4. Close-up View of Drilling Head, illustrating Method of operating a Switch controlling the Column-clamping Mechanism

drive, and other features to which attention is called are the provision of an automatic safety stop for the arm-elevating mechanism, which prevents accidents resulting from overtravel, and interlocking arm-elevating and clamping mechanisms, which prevents damage resulting from simultaneously engaging both of these movements.

The radial arm is of a special cross-section, as shown in Fig. 6, which affords ample resistance to torsional strains, and power is applied to the spindle as close as possible to the drill, the arrangement of this transmission mechanism being illustrated in Fig. 8. Conforming with modern practice in machine tool design, centralized control has been applied on these radial drilling machines, every lever and handwheel being within arm's reach of the operating position. Provision is made for the performance of tapping operations through the application of a reversing motor, which is controlled from the head and provides for reversing the direction of rotation of the spindle when it is required to back out the tap.

Arrangement of the Double Column

Probably the most decided departure from standard practice in constructing a radial drilling machine lies in the design of the column, and Fig. 2 shows this feature quite clearly. This arrangement makes it possible to employ an unusually simple drive from the motor to the spindle. The column is a single casting formed of two box-section members which are cast integral at the top and bottom, with the arm saddle mounted between them. The motor is carried at the rear of the arm saddle, and drives the spindle through a single horizontal shaft running between the column members, the arrangement being shown diagrammatically in Fig. 8. By having the column rotate with the arm it has been found possible to advantageously distribute the metal in the form of a beam section that is said to possess great rigidity for its weight. To provide additional support to the column the trunnion or cylindrical part extends through to the bottom of the base as shown in Fig. 5. V-tracks are employed

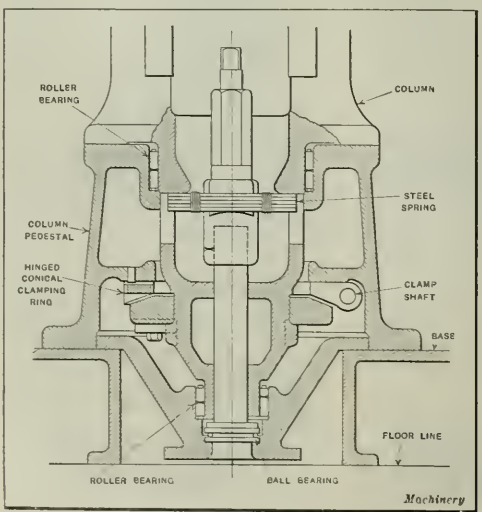


Fig. 5. Cross-section of Column Trunnion, showing how Column extends through Pedestal to Bottom of Base to afford Additional Support

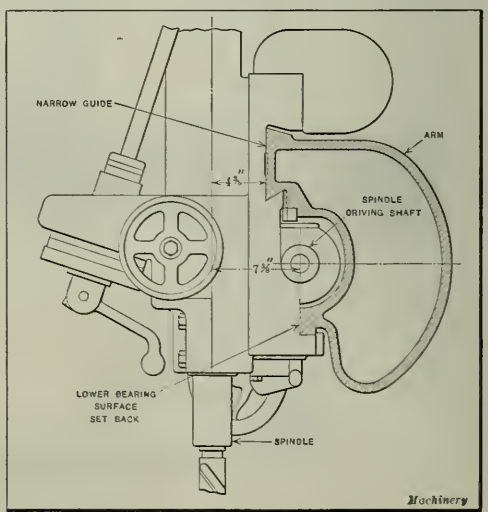


Fig. 6. Cross-section of Radial Arm, showing Lower Bearing set back of Upper Guide to bring Spindle Driving Shaft close to Spindle

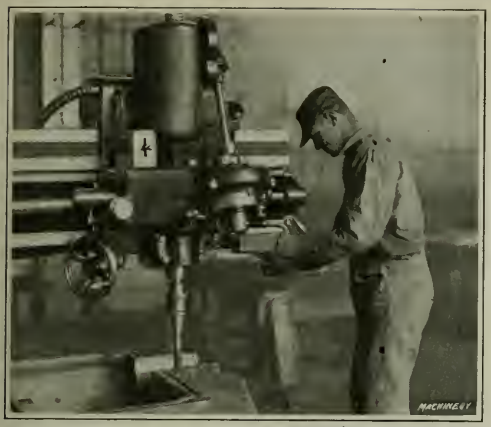


Fig. 7. Close-up View of Drilling Head, showing Method of performing Tapping Operation by reversing Direction of Rotation of the Motor

at the front and rear of the column for guiding the arm saddle, and when clamped by means of a wedge action on these tracks, the arm and column form a single unit.

Electrically Operated Column Clamp

Fig. 3 illustrates an electrically operated column clamp that is provided on these radial drilling machines, and in Fig. 4 the operator is shown manipulating an electric switch on the head which provides for the tightening or releasing of the clamp. This mechanism is instantaneous in action and positively secures the column. In addition to the motor-operated device, a hand-lever is provided for manipulating the clamp, as shown in Fig. 3. Fig. 5 illustrates the clamping mechanism in some detail, from which it will be seen that the mechanism consists of a hinged conical ring acting on the column trunnion. When this ring is contracted by either the power-driven or hand-operated device, it pulls the column flange firmly down on the base. This column flange is of large diameter with a wide bearing on the base, so that when it is clamped there is a broad metal-to-metal contact. When the column is clamped, the roller bearings are entirely relieved of all drilling strains. The electric clamp is operated by a small individual motor which transmits power through a worm-wheel and nut, this mechanism being self-adjusting so that wear can be taken up automatically.

Method of Supporting the Arm and Column

By supporting the entire weight of the arm and column on a ball bearing at the bottom of the column and providing for taking side thrusts on two roller bearings, assurance is obtained that the arm will swing easily. This result is further assured by having the moving parts well balanced, the ball bearing being located almost directly under the center of gravity of the structure. When the clamping mechanism is relieved, the steel springs shown in Fig. 5 lift the column a few thousandths of an inch, so that its flange clears the base. In this way friction at the joint is eliminated and the column and arm turn freely on the ball and roller bearings that are furnished for their support.

As shown in Fig. 6, the arm is of an improved cross-section, which is said to give exceptional rigidity to withstand stresses that are set up while performing heavy drilling operations. There is a narrow upper guide for the saddle, and the lower bearing is set in a plane back of the front surface. This construction brings the driving shaft close to the spindle, and gives plenty of depth from the front to the back of the arm, so that for a given amount of metal an unusual degree of rigidity is said to be obtained. Provision is made for raising and lowering the arm by power taken from the driving motor, which is transmitted through a stationary elevating screw and a revolving nut in the arm saddle. The mechanism is engaged by throwing a clutch lever on the driving-gear box, and it is started and stopped by the controller handle on the drill head.

As previously stated, the elevating and column-clamping mechanisms are interlocking to safeguard them from damage. At this point, attention is again called to the provision of an automatic stop which prevents accidents or damage to the machine, in case the operator should carelessly run the arm to the limit of its travel at either the top or bottom. This device also stops the movement of the arm in case either the arm or spindle strikes an obstruction while lowering it. The elevating screw is hung on a friction ring at the top of the column, and when the arm reaches the top or bottom of its travel, this revolving nut comes into contact with a pin on the screw, causing the screw to turn and thus bringing the arm to a stop. When the spindle or arm encounters an obstruction in lowering, the elevating screw is lifted and turns freely, thus stopping the arm.

Arrangement of the Spindle Drive

Reference to Fig. 1 will show that the driving motor is mounted at the back of the arm saddle, and Fig. 8 illustrates the way in which power is transmitted from this driving motor to the drilling spindle. This unusually simple drive is made possible by the double-column construction. Power is transmitted to the spindle by a horizontal shaft running through the column, and the drive is applied at the lower end of the spindle as close as possible to the drill. This arrangement is the means of conserving the power of the motor. It will be seen that the gears for direct drive consist of two spur gears at the motor end, and two bevel gears and an intermediate double-faced pinion in the drill head. The back-gears are located in a gear-case next to the motor, and they run in oil.

Motor Control on the Head

A motor controller is located on the drilling head, and the spindle may be started, stopped, reversed, or have its speed varied by manipulating a convenient lever. A spindle counterweight is geared directly to the spindle, and it is supported at the center of gravity to eliminate frictional resistance and binding on the guides.

Range of Feeds

There are eight positive geared feeds covering a range of from 0.006 to 0.060 inch per revolution of the spindle. These changes are effected by means of a disk that is graduated to show the rate of feed that is obtained for each position. The feed change-gears are entirely enclosed and run in oil, and they are so constructed that the gears can be removed from the head as a single unit. A sufficient range of feeds

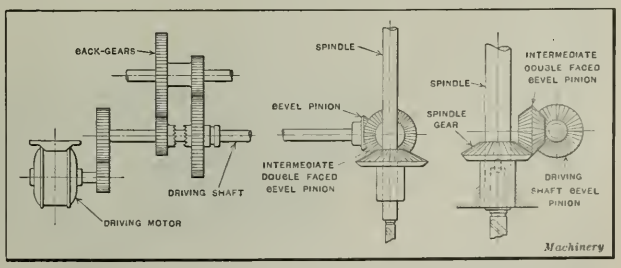


Fig. 8. Improved Type of Direct Drive from Motor to Drilling Spindle through Single Horizontal Shaft and Four Gears, in Addition to which there is One Double-faced Bevel Pinion

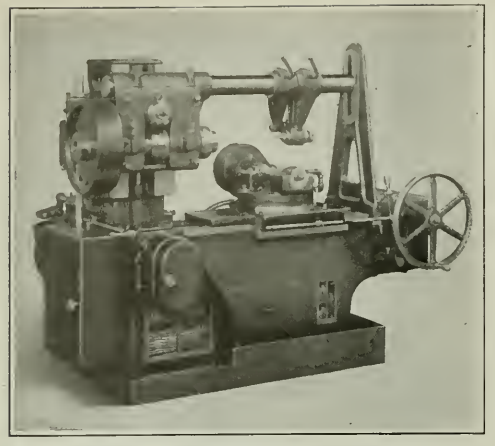


Fig. 1. Sixteen-inch Gear-hobber built by the Cincinnati Gear Cutting Machine Co.

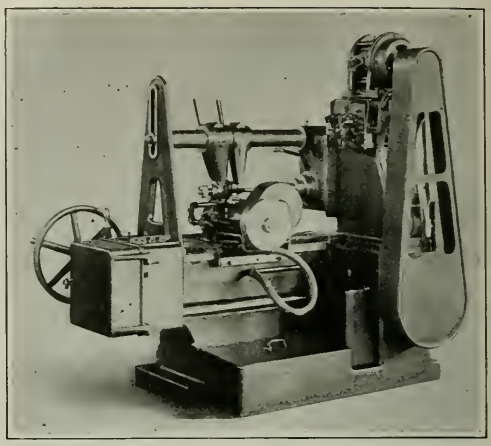


Fig. 2. Opposite Side of the Cincinnati Gear-hobbing Machine shown in Fig. 1

and speeds is available to provide for the performance of any ordinary boring operation that has to be performed on a radial drilling machine; and in addition, the range is ample for all drilling and tapping operations.

Provision is made for quickly and accurately reversing the spindle by reversing the driving motor through the controller that is located within easy reach of the operator. Fig. 7 shows the way in which this result is accomplished. A bottoming tap can be accurately driven to a specified depth, as the motor can be slowed down before the tap bottoms, thus enabling the exact depth to be reached without difficulty.

Depth Gage with Automatic Feed Trip

A depth gage with an automatic feed trip is provided for drilling holes to a given depth, and there are two graduated disks on the head, one of which is adjustable and the other fixed to the feed-shaft. The adjustable disk is set to a pointer at the desired depth of hole, and it is then clamped to the fixed disk by means of a knob, which also acts as a stop to trip the feed-clutch automatically. This disk also carries a safety stop for automatically throwing out the feed at the end of the spindle traverse. The fixed disk is graduated to show the position of the spindle in its traverse. Rapid hand traverse of the spindle is accomplished by means of a knob lever, and a convenient operating feature is that this lever may be pulled down to engage the power feed. Fine hand feed is also provided for the spindle.

Traversing the Head

The drill head is traversed along the arm by means of a handwheel conveniently located at the front of the head, where it is within easy reach of the operator. On universal machines, this handwheel can be swung back out of the way when the spindle is to be swiveled. From Fig. 1, it will be seen that the base has T-slots provided in its finished face. This base is of box-section, and ribbed both transversely and longitudinally. It has an extension at the back of the column and at right angles to the main part of the base, and the table is usually mounted on this extension. There is a reservoir cast in the base and a trough around its edge to collect the coolant. The table is of box design and has T-slots machined in the top and front surfaces. Power for driving the machine is furnished by a 10-horsepower, 4 to 1, variable-speed motor.

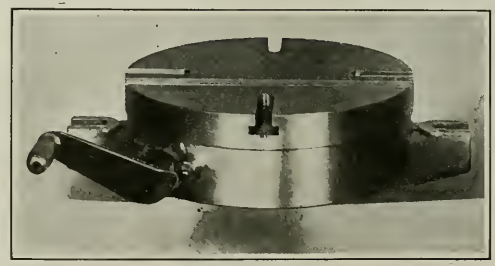


Fig. 1. Milling Machine Index Base built by the Industrial Engineering Co.

CINCINNATI 16-INCH GEAR HOBBER

The Cincinnati Gear Cutting Machine Co., Elam St. and Garrard Ave., Cincinnati, Ohio, has recently placed a new gear-hobbing machine on the market. It is designed especially for the purpose of producing accurate gears at high cutting speeds, and the parts have been very liberally proportioned for the capacity rating of the machine. A front view is shown in Fig. 1, while Fig. 2 shows a rear view. It will be noticed that a large handwheel is located on the operating side of the machine in a position which permits the operator to obtain an uninterrupted view of the work while manipulating the handwheel. The bore inside the work-spindle is ordinarily 2 9/32 inches in diameter, although this can be increased to 2 9/16 inches, which is often an advantage when employing the machine for splining shafts.

INDEX BASE FOR MILLING MACHINE

The index base shown in Fig. 1 is made by the Industrial Engineering Co., 25 Fort St. E., Detroit, Mich. It is designed to reduce the idle time incident to loading and unloading fixtures which are used for ordinary milling machine work. The index base consists essentially of a round table having suitable slots for attaching special milling fixtures, and provision for indexing the table. This arrangement permits the use of a fixture having two work-holding sides, so that the cutters can be operating on the work held on one side while the finished pieces can be removed from the other side and replaced by new work. When the cut has been completed, it is only necessary to index the table 180 degrees and repeat the operation. The large bearings of this base insure rigidity and eliminate vibration, thus permitting heavy cuts to be taken. The base is carefully machined to insure accuracy, and a special clamping device of great power is employed to lock the table. A single movement of the hand-lever with-

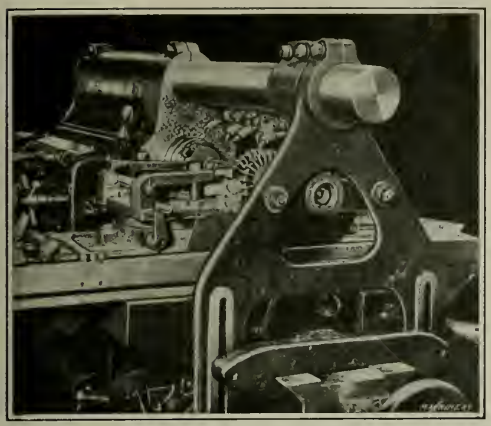


Fig. 2. Use of Industrial Engineering Co.'s Index Base shown in Fig. 1

out the application of a hammer or mallet is sufficient to clamp the rotating table to its base firmly. When used on a drilling machine, this attachment will be found a great time-saver, as two drill jigs can be mounted on the table, thus permitting one to be loaded while the other is employed for the drilling operation.

In Fig. 2 the index base is shown mounted on a milling machine for milling two steering arms for an automobile. With this arrangement one arm is milled while the operator is replacing the finished piece with a new forging.

LOVEJOY TURRET TOOLPOST

The Lovejoy Tool Co., Inc., Springfield, Vt., has recently brought out a turret toolpost shown in the accompanying illustration. The original Lovejoy positively locked cutter principle is used on all tool-holders which are held in this turret toolpost, and the turning and facing cutters are adjustable for height as they become worn, which permits their cutting edges to be kept in line with the lathe center without sacrificing strength and rigidity.

By one movement of the binding lever, the operator can release and accurately index the turret to the next tool position, where it will be securely clamped in place by the completion of the single movement. The turret rings are approximately 4⅜ inches square, made of hardened steel, and are interchangeable on any base. This interchangeable feature permits the use of additional rings carrying a variety of tool combinations for various jobs, without disturbing the individual cutter adjustment, as well as a quick method of changing tools from outside to inside work.

The boring-bars are 1 inch in diameter and are free from projections, and they will cut to the bottom of a hole which is only slightly larger than the bar itself. However, special boring-bars ¾ inch in diameter with bushings can be supplied if desired. The turning tools have a shank diameter of 1 inch, and are furnished with 19/32-inch high-speed steel cutters. The round shank permits of rotating the holder to produce any desired side clearance, and also provides for a small amount of end adjustment without disturbing the height of the cutting edge, which is a convenience when used on lathes equipped with diameter stops or feed-screws having direct-reading dials. This toolpost will interchange with any regular engine lathe toolpost without requiring any special fitting of the lathe.



Turret Toolpost made by the Lovejoy Tool Co., Inc., for Use on Engine Lathes



Adjustable Taper Caliper made by the Knauel Tool Works

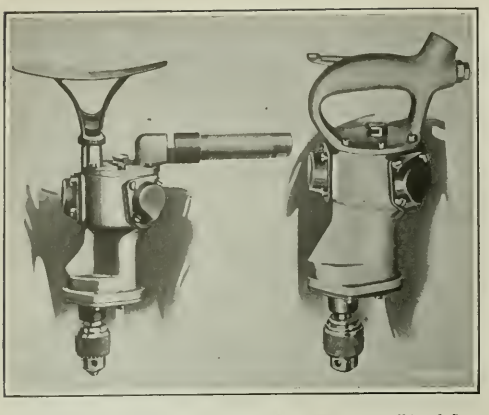
KNAUEL ADJUSTABLE TAPER CALIPER

The taper caliper shown in the accompanying illustration is made by the Knauel Tool Works, Rock Island, Ill. It consists essentially of a V-shaped member, and a straight-edge that can be instantly adjusted and locked in position opposite the V-shaped member as shown in the illustration. This taper caliper provides a substantial and convenient tool for use in the duplication of tapered work. It is made in different sizes to accommodate Brown & Sharpe taper shanks of all sizes from Nos. 1 to 10.

INGERSOLL-RAND PNEUMATIC DRILLS

The Ingersoll-Rand Co., 11 Broadway, New York City, has recently brought out several new sizes of small portable pneumatic tools. These new tools include a small sized pneumatic drill for close-quarter work, known as No. 8, and a small high-speed pneumatic grinder made in two types—Nos. 601 and 602—also a light-weight drill furnished in two styles known as Nos. 6 and 600. These tools have been developed to satisfy the demand for light-weight high-speed tools that are adapted for operating on certain classes of work for which the heavier types of tools are not so well suited.

The No. 600 and No. 6 drills, shown at the left and right, respectively, in the accompanying illustration, are especially designed for drilling small holes with a minimum amount of drill breakage. They will handle twist drills from the smallest size up to ⅜ inch in diameter. The free speed at 90 pounds air pressure is about 2000 revolutions per minute.



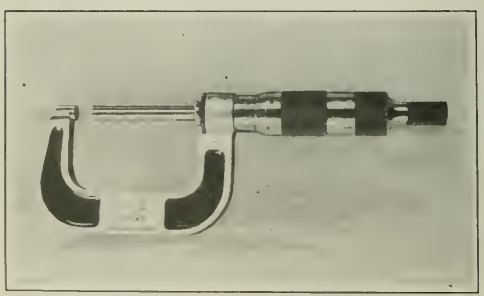
No. 600 and No. 6 Pneumatic Drills made by the Ingersoll-Rand Co.

The two tools differ essentially in the handle construction, the motor being the same in both types. The No. 6 drill has the pistol grip type of handle, while the No. 600 is furnished with breast-plate and rolling throttle handle. Aluminum reinforced with steel bushings, is used where practicable, and this results in a very light machine, the No. 6 weighing only 9 pounds. The motor is of a three-cylinder type and similar to those used in the Nos. 601 and 602 pneumatic grinders. The cylinders are separate iron castings, easily accessible, renewable, and interchangeable. All rotating members have either ball or roller bearings.

The No. 8 close-quarter drill, referred to previously, is especially designed for drilling close to a wall or corner. This machine runs at 250 revolutions per minute without load, and will handle drilling, reaming, or tapping work up to 1¼ inches. The Nos. 601 and 602 grinders are lightweight, high-speed tools running with a free speed of 4200 revolutions per minute and are suitable for grinding, buffing, or polishing work of a varied nature. These two machines are similar in design, the principal difference being the method of control; the No. 601 has the closed type of inside trigger handle while the No. 602 is fitted with the rolling type of throttle handle.

BLUSH MULTIPLE MICROMETER

A new type of micrometer, the purpose of which is to eliminate the necessity of using two instruments when taking measurements ranging from 0 up to 2 inches, has been recently developed by the A. T. Blush Tool Co., 1145 W. 11th St., Erie, Pa. This is accomplished by the use of two screws or threads having different pitches, namely, a 20-pitch thread on the measuring screw and a 40-pitch thread for the thimble carrier. Although the mechanism embodies two screws, the arrangement is such that the accuracy depends entirely upon the 20-pitch thread, as the function of the 40-pitch thread is simply that of keeping the thimble in proper alignment with the graduations on the hub. The difference in the pitch and travel of these threads makes it possible to obtain a 2-inch movement of the spindle with only a 1-inch movement of the thimble.

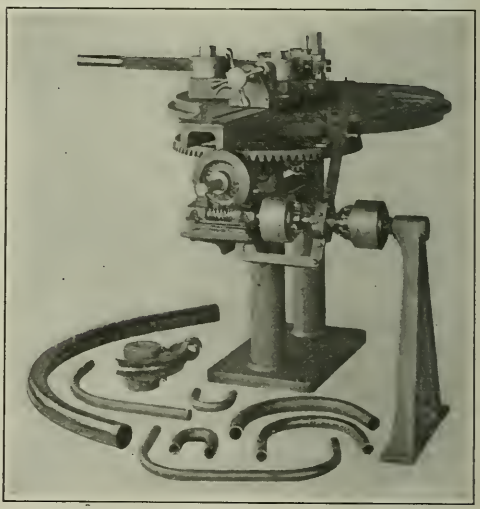


Multiple Micrometer made by the A. T. Blush Tool Co.

The adjustment for wear on the anvil and spindle is made without changing the position of either the anvil or the measuring nut, which is a very desirable feature, as there is absolutely no chance for the anvil and the spindle to be turned out of parallel when making adjustments. Arrangements are being made to manufacture this micrometer in several combinations such as, 1½ to 3, 2 to 4, 3 to 5, 4 to 6, and 5 to 7 inches.

WALLACE PIPE AND ANGLE BENDERS

The pipe bender shown in the accompanying illustration is made by the Wallace Supplies Mfg. Co., 412-420 Orleans St., Chicago, Ill. This machine is designed for bending pipe while cold and, to some extent, without the use of an inside follower or floating mandrel. For special forms, however, inside follower bars or floating mandrels are employed. In the lower left-hand corner of the illustration is shown a forming head used when bending pipe or tubing. The standard equipment furnished with the machine consists of four forming heads similar to the one here shown, which may be employed for bending different sizes of pipe as follows: 1-inch pipe to an angle of 90 degrees with a 6-inch radius; 1¼-inch iron pipe to an angle of 90 degrees or less with a 9-inch radius; 1½-inch iron pipe to an angle of 90 degrees or less with a 12-inch radius; and 2-inch iron pipe to an angle of 90 degrees or less with a 14-inch radius. When making a bend, the pipe is secured to the form by means of a strap. Both the outside follower and the form are grooved, and the clearance between the pipe and the follower and form is such that satisfactory results are obtained. The outside follower bar operates between the tube and the roller so that the tube is well supported. This method of supporting the tube prevents the forming of depressions in the pipe.



No. 5-A Pipe Bending Machine built by the Wallace Supplies Mfg. Co.

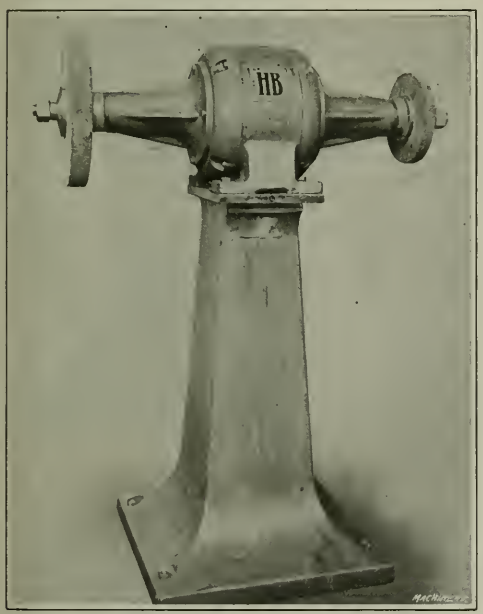
The roller bracket is adjustable and will take forms up to 50 inches in diameter. The machine is controlled by a lever operating two friction clutches which permits the table to be rotated in either direction at the will of the operator. Adjustable stops are provided which can be set to automatic-

ally throw the clutch out of engagement so that the bending operation can be stopped at any desired point. For bending light-gage tubing to a sharp radius, without flattening or crimping, special forms with inside follower bars or floating mandrels can be supplied, which will permit tubing with 1/32-inch walls and from 1 to 2 inches in diameter to be bent to small radii. The approximate weight of this machine is 1200 pounds.

A machine of this type is also made with suitable equipment for bending angles, channels, tees, rounds, squares, twisted squares, or special steel sections, and flat bars on edge.

HOBART MOTOR-DRIVEN GRINDER

A machine known as the H. B. ball bearing motor-driven grinder is a recent product of the Hobart Bros. Co., Troy, Ohio. It is equipped with a two-horsepower ball bearing electric motor, and is adapted for use in grinding castings, sharpening tools, buffing rubber tires, and for the performance of many other operations that have to be handled in garage or machine shops. A buffing wheel or a wire brush wheel can be substituted for one of the grinding wheels.

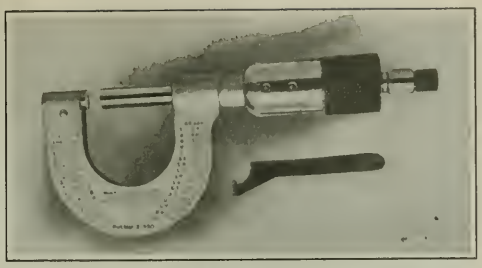


Ball Bearing Motor-driven Grinder built by the Hobart Bros. Co.

This machine is designed for severe service, and it is stated that very little power is consumed in its operation. The bearings may be packed with lubricant so that they only require attention every three or four months. The weight of this grinder is 275 pounds. Either an alternating- or direct-current motor may be furnished on the machine, that is suitable for connection to a regular lighting or power circuit. This grinder occupies a floor space of 20 by 36 inches.

CONSOLIDATED TOOL WORKS DIRECT-READING MICROMETER

The Consolidated Tool Works, Inc., 261 Broadway, New York City, have recently brought out a new line of direct-reading micrometers. The design of these tools is essentially the same as that of standard types, but they have the

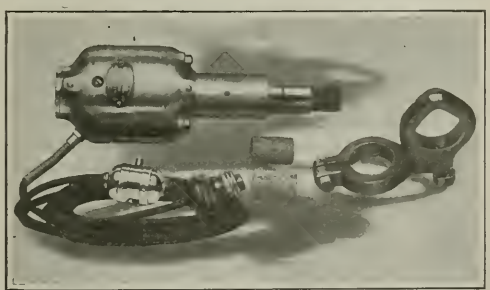


"Simplex" Direct-reading Micrometer made by the Consolidated Tool Works

advantage of direct-reading numerals, which give the exact reading at all times through small apertures in the barrel. This feature not only prevents mistakes being made by unskilled operatives in reading lines, but also avoids errors in computing measurements. There are only two working parts in the direct-reading unit of these micrometers, and both of these units are composed of hardened steel members which are of substantial design. Nine sizes of micrometers are made for the English system of measurement, with a range for taking measurements from 1 inch to 6 inches. The 1-, 2-, and 3-inch sizes can be obtained with graduations reading either to 0.001 or 0.0001 inch, while the 4-, 5-, and 6-inch sizes read to 0.001 inch. These micrometers are also made in six sizes for taking measurements by the metric system. They have a range for measuring to 0.01 millimeter, from 25 up to 150 millimeters. Both the English and the metric system micrometers can be furnished with ratchet stop, lock-nut, or with both ratchet stop and lock-nut.

PRECISION GRINDING WHEEL TRUING MACHINE

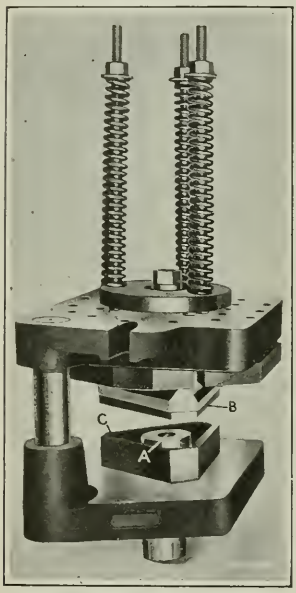
The Precision Truing Machine & Tool Co., Cincinnati, Ohio, has recently developed and placed on the market the grinding wheel truing machine shown in the accompanying illustration. It is claimed that the results obtained by the use of this truing machine are equal, and in some cases superior, to those obtained with a diamond. This machine can be applied to any make and style of grinder, and is operated by either alternating or direct current of 110 or 220 volts. The attaching bracket shown at the right is furnished with each machine, but additional brackets for special or unusual applications can be supplied. Three general-purpose abradant nibs are also furnished with each machine, and nibs for special purposes can be supplied to meet requirements. The general-purpose nibs are 1 inch in diameter by 1½ inches long, and it is claimed that one of these nibs will keep an average grinding wheel in proper condition for 100 hours' continuous operation. The machine has ball bearings throughout, with provision for taking up wear.



Grinding Wheel Truing Machine built by the Precision Truing Machine & Tool Co.

BREHM SHELL TRIMMING DIE

In drawing deep shells under a power press, a ragged or at best an irregular edge is left at the top of the work, which must be trimmed off by a subsequent operation. Such work is frequently done by chucking the shell in a lathe and removing the excess metal with a parting tool, but to facilitate the speed with which this operation can be performed the City Engineering Co., 35 S. St. Clair St., Dayton, Ohio, has developed the Brehm trimming die here illustrated, which has been protected by patents. With such an equipment, it will be evident that the time required to handle work of this kind is far less than that consumed in setting up shells in a lathe to provide for cutting off the excess metal. On the upper die member there is a pilot that enters the opening at the top of the shell, and when the press carries down the upper die member, the shell that is to be trimmed is pushed down into the opening *A* in the lower die.



Brehm Shell Trimming Die made by the City Engineering Co.

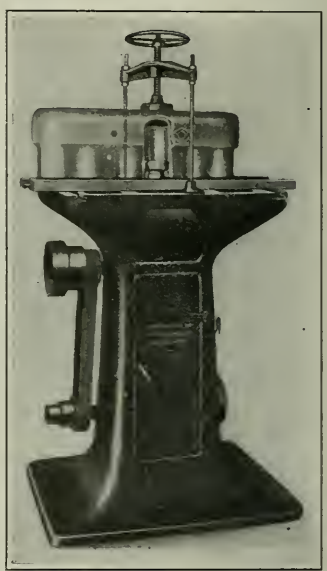
On the upper die there is a floating member *B* on which the previously mentioned pilot is carried, and the die descends until the bottom of the pilot has come almost level with the top surface of die member *A*. When this position has been reached, three cam surfaces on member *B* come successively into engagement with the inner sides of a triangular cam *C* to provide for imparting transverse movements in three directions to the floating member *B*. As the shell has descended into hole *A* to the position at which its upper end is to be trimmed off, it will be evident that these transverse movements of the pilot inside the shell, acting in conjunction with the upper edge of hole *A*, constitute an ideal shearing action to provide for trimming the surplus metal from the top of the shell. The accompanying illustration shows one form in which the Brehm die is made, but there are other designs, and dies will be made in sizes to suit different classes of work.

STORM BORING MILL

The boring mill shown in the accompanying illustration has been recently placed on the market by the Storm Mfg. Co., 6th Ave. and 4th St. S., Minneapolis, Minn. This machine is especially adapted for the boring or reboring of motor cylinders and other parts such as large gears, heavy bushings, tractor wheels, and large holes in castings which are of unusual shape, size, or outside dimensions. Referring to the illustration, it will be seen that the machine consists essentially of the following parts: A main frame or casting of the heavy pedestal type which is provided with a flat table on which the cylinders or other work can be mounted; a boring head which is mounted on a vertical boring-bar supported within the base casting; a device for clamping work to the table, consisting of two upright adjustable bars 40 inches long, a heavy arch, and a handwheel and clamping screw.

The boring-bar is hollow, and it is 48 inches long by 2 9/16 inches in diameter. The heat-treatment to which this bar is subjected gives it great strength and stiffness, and it is claimed that it will withstand a thirty-ton load applied at the center of a twenty-inch length of the bar without springing. Four cutter-heads of the regular Storm multiple-cutter adjustable type are furnished as regular equipment, giving a range for boring holes from 2⅝ to 7⅞ inches in diameter by 20 inches deep. However, special equipment can be furnished for reboring cylinders up to 12 inches in diameter. The cutter-heads are so designed that they can be quickly adjusted by simply turning the adjuster until the desired diameter as measured with a micrometer caliper is obtained.

A centering cone is furnished for each head, so that the work can be quickly centered. When centering a cylinder, it is placed on a table directly above the boring-bar with the head and centering cone in position. The bar is then raised by means of a handwheel, until the cone fits into the bore of the cylinder and raises it slightly from the table or bars. This action draws the bar directly over the cutter-head. The work is then clamped in place, and the boring-bar lowered to remove the cone.



Boring Mill built by the Storm Mfg. Co.

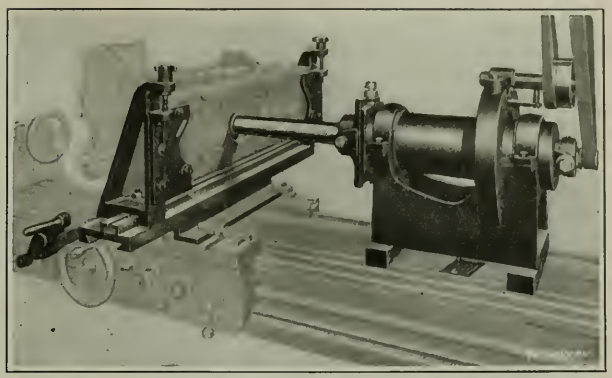
A variable boring-bar speed is obtained through a countershaft and three-step cone pulleys, and positive feed is obtained through cut gears and heavy central steel screws. An automatic return and stop is a feature incorporated in the design of this machine, which is a means of saving considerable time, as the operator can leave the machine after the operation has been started without danger of spoiling the work. This machine, which occupies a floor space of 30 by 36 inches, is 44 inches high, has a table or upper face of 24 by 30 inches, and a shipping weight of approximately 10,000 pounds.

CYLINDER BORING AND GRINDING MACHINE

The cylinder boring and grinding machine shown in the accompanying illustration is made by the Sunderland Machine Shops, 21st and Pacific Sts., Omaha, Neb. This machine is designed for use on any lathe having a swing of from 14 to 24 inches, and it is claimed to be capable of performing either boring or grinding operations with equal facility and accuracy. The machine consists essentially of a cross-slide carrying an adjustable fixture for holding the cylinders, which is designed to be mounted on the lathe carriage, and a head carrying the boring and grinding spindle, as shown in the accompanying illustration. When boring a

cylinder, the work is mounted in the fixture and so adjusted by the fixture screws and the cross-slide screw that the center of the bore is in line with the center of the boring head.

The boring head is equipped with an outer spindle to which the boring tool can he attached. This spindle revolves at a slow rate of speed and is driven through a large heavy-duty enclosed gear bolted to its outer surface. An overhead belt transmits power to the pinion shaft which is equipped with tight and loose pulleys. The inner or grinding spindle rotates inside the outer boring spindle and is supported by three sets of S K F double-row self-aligning ball bearings which give it the required bearing support, thus assuring a true and free-running shaft that will not throw out, whip, or vibrate. It is claimed that a degree of exactness of 0.00025 inch can be readily obtained with this machine if desired.

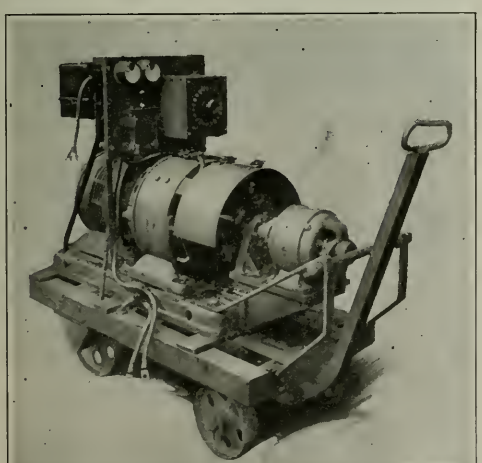


Cylinder Boring and Grinding Machine built by the Sunderland Machine Shops

Among some of the advantages claimed for it are its low cost, the fact that it can be used for boring or grinding with equally good results, that it can be used on either closed- or open-head cylinder blocks, that it can be mounted or removed from the lathe in ten minutes, that changing the work from one cylinder bore to another requires only a few seconds, and that its use does not interfere with chucking work in the lathe. The capacities are: Swing of spindle, 22 inches; boring and grinding capacities, 2½ inches and larger; and length of spindle, 15½ inches. The equipment includes one main spindle and operating standard, one countershaft, one cross-slide table, two adjustable work-holding brackets, one cutter-head, two grinding wheels, one diamond wheel tracer, one truing-up indicator, and two wrenches. The machine equipment, boxed for shipment, weighs approximately 500 pounds.

WESTINGHOUSE ELECTRIC WELDING OUTFIT

The electric arc welding equipment shown in the accompanying illustration is a recently developed product of the Westinghouse Electric & Mfg. Co., East Pittsburg, Pa. This equipment is claimed to be exceptionally efficient, due to the fact that the generator operates at the arc voltage and therefore does not require the interposition of a resistance controller between the generator and the arc. The generator is designed to inherently stabilize the arc, thereby eliminating the use of automatic devices such as relays, solenoid control resistors, etc., which not only increase the initial investment and maintenance cost but which are usually not quick enough in action to follow the instantaneous changes in the voltage of the arc circuit.



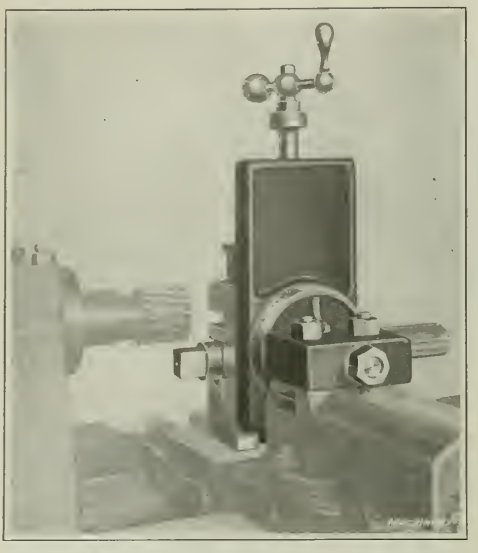
Electric Welding Outfit made by the Westinghouse Electric & Mfg. Co.

The design of the control is such that very close adjustment of current may be easily and quickly made and maintained at the desired point. There are twenty-one voltage rates available ranging from 50 to 225 amperes. This gives a current regulation of less than 9 amperes per step, which is an advantage, especially for overhead work such as that which is encountered in railroad shops or ship construction. Although the generator is strictly a short-arc machine, it is claimed that the arc produced is very tenacious and causes the deposited metal to penetrate deeply into the work. The generator and motor are mounted on the same shaft and bedplate. The motors can be supplied for either direct- or alternating-current circuits. This equipment can be adapted for use on circuits of different voltage by simply changing the connections.

The generator sets are supplied in four sizes having capacities of 300, 500, 750 and 1000 amperes, respectively. The generator is compound-wound, and delivers 60 volts at no-load and also when carrying full load. The commutator is designed so that any momentary overload can be carried without special protection, even at the striking of the arc. The sets of 300-ampere capacity are made in both portable and stationary types, but those of greater capacity are usually employed as stationary sets. Multiple operator equipments are provided with separate control or outlet panels, so that it is possible for several operators to take current from the same generator without interfering with each other's work.

DAVIS LATHE MILLING ATTACHMENT

One of the latest products of the Hinckley Machine Works, Hinckley, Ill., is the Davis lathe milling attachment which is here illustrated and described. This attachment is useful for handling a variety of jobs such as milling plain and Woodruff keyseats, squaring the ends of shafts, splining shafts, splitting bushings, and for the performance of sawing, drilling, boring, and various other operations. The attachment fits any type of lathe with a swing of from 12 to 24 inches. It will be evident from the illustration that this attachment may be swung with a compound rest to bring the work in the right position relative to the cutter. When handling cylindrical work, a steel V-block lines up the piece to be milled, while a filler block is placed above the work so that the two binding screws may securely clamp it in place



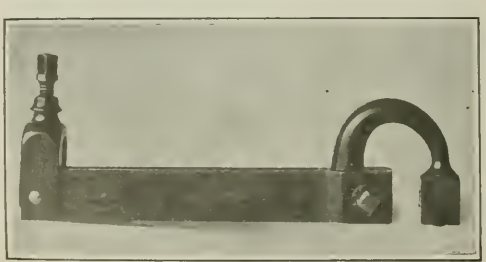
Davis Lathe Milling Attachment built by the Hinckley Machine Works

without marring the surface. The milling cutter is mounted in the lathe spindle. This attachment has a vertical hand feed of 7 inches, while the transverse and longitudinal feeds are provided by the lathe. The vertical feed is accomplished by turning a ballcrank by hand, and the screw has a graduated collar reading to 0.001 inch. Provision is made for swiveling in a vertical plane through an angle of 180 degrees. The vise jaws are 1¾ inches deep by 5⅛ inches wide, and the vise has a maximum opening of 4 inches. The attachment weighs 50 pounds.

DERRINGER COMBINATION TOOL-HOLDER

A combination tool-holder recently perfected by Maurice H. Derringer, 3133 N. Eighth St., Philadelphia, Pa., is shown in the accompanying illustration. This holder is intended for medium sized work, and will hold cutters made from either square or round stock. It is made of steel, and all parts are hardened and drawn. Cutters made from square stock up to 5/16 inch, and which can be used for turning, boring, and internal threading, can be held in one side of the tool-holder. By turning the yoke to the opposite side of the holder, a 45-degree slot is presented which will take round stock from ⅛ to 9/16 inch in diameter. This side of the holder is useful for holding cutters employed in boring or internal threading of small and large holes. This holder is also well adapted for many other kinds of work such as holding an indicator or scriber when setting up work for various machining operations. The yoke, which is attached to the body of the tool-holder, is fastened with a taper pin, and can be removed in a few seconds. This yoke has a 5/16-inch screw and when the holder is placed in the toolpost of a lathe, a double grip is obtained on the tool, the screws in the yoke and the toolpost both gripping the tool so that it is positively prevented from springing.

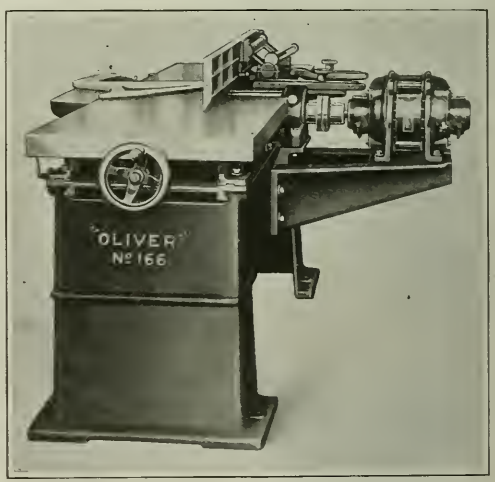
Another feature of the Derringer combination tool-holder is a spring tool-holder in the form of a gooseneck, which is brought into use by taking out the taper pin that holds the yoke in place and removing the yoke. The gooseneck is then attached with a taper bolt and nut which, when tightened, positively prevents the gooseneck from moving. The spring tool is broached to receive a 5/16-inch tool bit and will be found especially useful for cutting threads. This tool will also be found useful for planer and shaper work as well as for performing turning operations in the lathe.



Combination Tool-holder made by Maurice H. Derringer

OLIVER PLANER AND JOINTER

In the August, 1919, number of MACHINERY, reference was made to a No. 166 ball bearing jointer and planer built by the Oliver Machinery Co., Grand Rapids, Mich. This machine had the motor built right into the frame and was limited to the use of three-phase, 60-cycle, 220-volt current. Recently a direct-coupled motor-driven ball bearing planer and jointer of similar design has been added to the line of woodworking machinery built by this company, to permit of the use of any desired motor having a speed of approximately 3600 revolutions per minute. That is, the machine can be

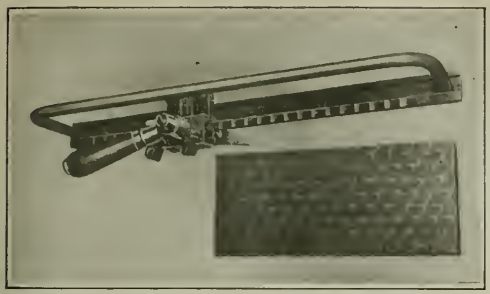


No. 166 Hand Planer and Jointer built by the Oliver Machinery Co.

furnished for use with either direct current or with alternating current of one, two, or three phase in various voltages. It has all of the advantages of the previous type and eliminates belts and the necessity of using guards; also, there is a saving of floor space. The machine is regularly furnished with three high-speed knives in the head, which is of the round or safety type previously used on this company's machines. This planer and jointer is adapted for use in pattern shops, furniture plants, and other places where a smooth and accurate-cutting jointer is required.

GULDAGER & JANTSCH MOTTLING TOOL

The mottling tool shown in the accompanying illustration is now being manufactured by the Guldager & Jantsch Co., 460½ Lenox Ave., Detroit, Mich. It is used for fancy scrap-

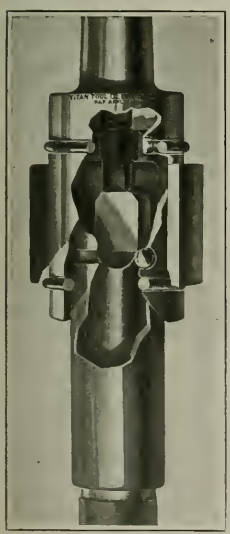


Mottling Tool made by the Guldager & Jantsch Co.

ing or mottling on machine faces, and is intended for work which heretofore has been done largely if not entirely by the hand manipulation of a scraper. The operation of this tool is practically automatic, it being only necessary to move the slide across the work while the operation and guiding of the scraper is accomplished by parts of the machine itself. Different kinds of mottling are obtained by changing the form of the cutting edge of the scraper.

TITAN QUICK-CHANGE CHUCK AND SOCKET

A quick-change chuck having unusually simple features has been brought out by the Titan Tool Co., Erie, Pa. The main feature of this chuck is that the collet is provided with what has been termed a "self-contained drift," so that drills may be removed from the collet without using a taper drift. For this purpose a plunger is fitted at the upper end of the collet, acting against the end of the tang. When the drill is put in place the plunger slips upward; but when the drill is to be removed, a slight blow on the end of the plunger will release the drill. The plunger has a movement great enough to permit it to move out of the way in the drift spline, so that a regular taper drift may be used if desired. A recess is provided in the chuck proper for the end of the plunger.



Quick-change Drill Chuck and Socket made by the Titan Tool Co.

The collet is driven from the chuck by means of a pin which bears against a flat milled on the collet. A half circular groove is provided in the collet into which a ball fitted in the side of the chuck enters and thereby retains the collet in the chuck when the chuck ring is down in position to hold the ball in place in the groove. As soon as the chuck ring is moved upward, a counterbore or recess at its lower end permits the ball to move outward, due to centrifugal force, and then the collet can be removed from the chuck very quickly.

This type of chuck will be made to take any size of drill, and can be used in conjunction with the Titan quick-change positive drive chuck for straight drills, so that both straight- and taper-shank drills may be used as required. The chuck body may also be provided with collets for taking broken tang drills, providing for a positive drive on the broken tang.

U. S. TOOL CO.'S SUB-PRESSES

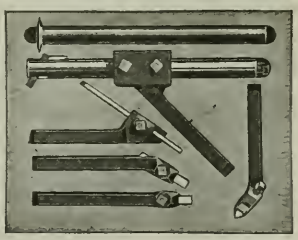
The U. S. Tool Co., Inc., 51-53 Lawrence St., Newark, N. J., is now manufacturing a line of sub-presses of standard design, which are made in various sizes to meet the requirements of different users. These sub-presses are built with two, three, and four pilots; and one of their principal features is said to be the accurate alignment of the pilots. To any experienced mechanic the features of these tools will be apparent from the accompanying illustration, without the need of a more complete description.



Standard Type of Sub-press made by the U. S. Tool Co., Inc.

SET OF "RED-E" LATHE TOOLS

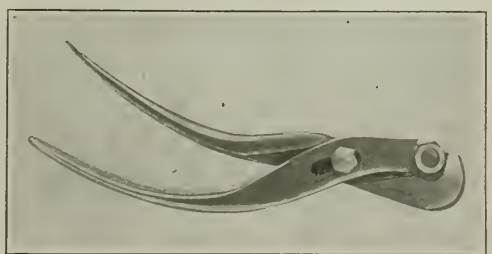
The Ready Tool Co., 650 Railroad Ave., Bridgeport, Conn., has recently brought out a line of lathe tools especially adapted for garages, repair shops, and small machine shops. As shown in the illustration, this set consists of an offset cutting-off tool, an offset threading tool, an inside boring-bar with a holder, an inside threading bar provided with an extra cutter, and a board on which the tools are mounted. All the cutters are made of high-speed steel, except the threading cutters, which are made of tool steel, properly hardened and drawn. The holders are designed to hold tools ½ by 1 inch.



Set of Lathe Tools, made by the Ready Tool Co. for Use in Garages and Jobbing Shops

ALLAN-DIFFENBAUGH PIPE AND NUT WRENCH

The tool shown in the accompanying illustration has been recently put on the market by the Allan-Diffenbaugh Wrench & Tool Co., Baraboo, Wis. It can be instantly adjusted to fit any size of pipe or nut within its capacity, and a powerful grip is obtained with this wrench, as the arrangement of



Pipe and Nut Wrench made by the Allan-Diffenbaugh Wrench & Tool Co.

its two sliding bearings and the fulcrum give a compound leverage. The jaws are always parallel, a feature which makes this wrench especially well adapted for tightening or removing nuts. The length of the tool is 8 inches, the maximum jaw opening ¾ inch, and it is only ⅜ inch thick and 1⅛ inches wide when closed.

NEW MACHINERY AND TOOLS NOTES

Motor-driven Hammer: C. C. Bradley & Son, Inc., Syracuse, N. Y. Helve hammers of the regular type manufactured by this company, which are equipped with motors included as part of the hammer equipment.

Drilling and Centering Machine: Cadillac Tool Co., 268 Jefferson Ave., Detroit, Mich. A single-end drilling and centering machine capable of drilling 17/32-inch holes in steel, which can be furnished with either belt or motor drive.

Four-post Screw Press: Manhattan Machine & Tool Works, Grand Rapids, Mich. The Type BB four-post screw press intended for testing punches and dies, etc. This press has a capacity of 80 tons, a bed 20 by 36 inches, maximum distance from bed to ram 22 inches, and a weight of about 2270 pounds.

Diamond Truing Tools: Tungsten Tool Co., Inc., 110-114 W. 42nd St., New York City. A line of diamond-pointed tools intended for use in truing abrasive wheels. The diamonds are mounted in drill-rod nibs by a patented process which does not require the diamonds to be subjected to the injurious effect of heat.

Double-end Tapping Machine: Cadillac Tool Co., 268 Jefferson Ave., Detroit, Mich. A double-end tapping machine designed for simultaneously tapping both ends of turnbuckles or similar work. It is made in five sizes ranging from 12 to 60 inches between the ends of the spindles and for tapping holes up to ⅝ inch.

Electric Starting Switch: Harvey Machine Co., Los Angeles, Cal. A starting switch for use with alternating-current motors of from 1 to 7½ horsepower and 110, 220, 440, and 500 volts. Among other improvements are included push-button control, separate starting and running contacts, improved type of contact point, and simplicity of construction.

Oil-filtering Cabinet: Wayne Oil Tank & Pump Co., Fort Wayne, Ind. Type C oil-filtering cabinet designed to be placed below the machine from which the oil is to be filtered so that surplus oil from the bearings will flow to it by gravity. This type of filter is built in four sizes which are claimed to have capacities for filtering from 100 to 600 gallons of oil per hour.

Slotting Attachment for Milling Machine: Cleveland Milling Machine Co., Cleveland, Ohio. A slotting machine attachment that can be clamped directly to the column and located in place by two pins at the top of the base. It is graduated for close settings and can be rotated through 180 degrees. Any length of stroke can be obtained from 0 to 4¾ inches.

Piston Blasting Machine: Gray Machine Tool Co., Inc., Buffalo, N. Y. A machine designed for cleaning the inside of pistons with steel grit or shot, which is said to be capable of cleaning from 140 to 150 pistons per hour. The machine occupies a floor space of 36 by 42 inches, weighs 800 pounds, and consumes about 40 cubic feet of air per minute at 70 to 90 pounds pressure.

Oil-fired Furnace: Tate-Jones & Co., Inc., Pittsburg, Pa. A new design of rotary hearth-type oil-fired furnace having a revolving carriage or hearth, 16 feet 6 inches outside diameter, 6 feet 6 inches inside diameter, and 5 feet wide. The motor-driven hearth makes one revolution in the time required for a single carburizing operation, and is so designed that it can be operated continuously.

Indicator Holder: Guldager & Jantsch Co., 460½ Lenox Ave., Detroit, Mich. An indicator holder made to fit the blades of try-squares which is adjustable for different widths of blades from 2 to 3 inches. Steel balls are used for sliding contacts so that the holder can be easily moved up or down the try-square blade. A conveniently located thumb-screw provides for locking the holder in any desired position.

Rustproofing Process: Andrews Rustproofing Laboratories, 821 Book Bldg., Detroit, Mich. A process of rustproofing ferrous metals by which the minute cavities in the metal are first penetrated by an oxide generated in a furnace in which the pieces are enclosed. Following this treatment the pieces are placed in an oil bath which causes the pores to be filled with a rustproofing paste. The final operation of quenching causes the pores to contract and thus effectively seal up the deposits.

Pneumatic-motor Hoist: Independent Pneumatic Tool Co., 600 W. Jackson Blvd., Chicago, Ill. A pneumatic hoist equipped with a two-cylinder double-acting pneumatic motor provided with an automatic stop which shuts off the air before the cable is fully wound and which can also be adjusted to stop the motor for any length of lift within the capacity of the hoist. These hoists are made in six sizes, ranging in capacity from ½ ton to 2 tons with a lift range of from 10 to 40 feet at a speed of from 8 to 32 feet per minute.

Aerial Grinder: Van Dorn Electric Tool Co., Cleveland, Ohio. A suspension type grinder weighing from 26½ to 31 pounds, which has a 12-inch extension carrying the abrasive wheel well out from the frame. The device is made either with a direct-current motor, of ½ horsepower and 110-220 volts, running at 4000 revolutions per minute; or with an alternating-current polyphase motor of 1/3 horsepower, 110-220 volts, running at 3600 revolutions per minute; or with an alternating-current single-phase motor of ½ horsepower, 110-220 volts, running at 3600 revolutions per minute.

Transferring Device for Screw Machine: Brown & Sharpe Mfg. Co., Providence, R. I. An automatic machine developed in this company's screw machine department for use in machining a small brass key bearing. With this machine, the pieces are automatically cut from bar stock and completely machined at the rate of 1080 per hour, including a slotting operation. The special feature of this device is the transfer arm which automatically carries the piece from the first operating position, where it is formed, drilled, and cut off, to the second position, where it is faced off and subsequently dropped down a chute on a traveling belt, which carries it under a slotting saw.

Vacuum Chucks and Pumps: Crescent Sales & Engineering Co., Detroit, Mich. A vacuum chuck and pump manufactured by the Crescent Pump Co. The chuck is intended for holding non-magnetic work and is made of a non-magnetic material. It consists of a vacuum chamber, in the top surface of which there is a series of very fine holes. When in use the work is placed on the perforated surface with a gasket of thin paper between the chuck and work to prevent leakage. The rotary pump developed for use with the vacuum chuck is claimed to be capable of producing a vacuum of 28½ inches. It can also be employed as a blower, in which capacity it will produce a pressure of 15 pounds.

Track Scales: E. & T. Fairbanks & Co., St. Johnsbury, Vt. Light- and heavy-duty scales designed to meet the specifications recently adopted jointly by the American Railroad Association, the Bureau of Standards, and other associations. The scales are built in four sections with a series of primary or main levers transmitting the load to longitudinal extension levers, which, in turn, transmit the load to a transverse extension lever connected through a shelf lever to the beam. It is built in two capacities for light-duty service where only a relatively small number of cars are to be weighed. The capacity of the two light-duty scales is 60 to 75 tons per section, respectively. For heavy service or where a large number of cars are to be weighed, the scale is built in capacities of 75 and 100 tons.

* * *

Some idea of the rapid development of the hydro-electric resources of France within the past few years may be gained from the following statements which appeared in a recent Department of Commerce report. Between 1916 and 1918 it is estimated that 450,000 horsepower was developed, bringing the total development up to the time of the armistice to 1,250,000 horsepower. Projects started in 1919 totaling 175,000 horsepower and construction planned for 1920 and 1921 which will develop 225,000 horsepower will, when completed, bring the total up to 1,650,000 horsepower by the end of 1921.

* * *

United States Civil Service Commission announces an open competitive examination for research engineer on July 20. A vacancy at the Watertown Arsenal, Watertown, Mass., at $3000 to $3600 a year and vacancies in positions requiring similar qualifications at these or higher or lower salaries will be filled from this examination. Applicants should apply for Form 2118, stating the title of the examination desired, to the Civil Service Commission, Washington, D. C., prior to the hour of closing business on July 20.

ROUTING AND ESTIMATING COST OF GEARS AND MACHINE PARTS

The methods used by the Brown & Sharpe Mfg. Co., Providence, R. I., in routing gears and machine parts through the shop, and the manner of estimating the number of labor and machine hours required in the production of a part were described in a paper recently read before the Detroit meeting of the American Gear Manufacturers' Association by J. A. Urquhart. Routing, as the term is used by the concern mentioned, includes ordering the material and tools required in the manufacture of a product, planning the procedure of the various operations and the departments or machines in which they are to be performed, scheduling the date that the work should arrive at each department or machine and the date on which the operation should be completed, and dispatching the work from department to department during the manufacturing process. The purpose of routing is to enable a part to be started at the proper time over the shortest and best route; not to have it in progress for a longer period than is necessary; to have control of the part at all times; and to be able to give positive dates on future deliveries. The practice is to have the part finished or in storage for a short time before it is required.

This routing system was described in an article, "Stock Parts and Their Routing," by Luther D. Burlingame, in MACHINERY for August, 1919. Hence a further description of the routing methods is considered unnecessary; however, the method of estimating the time required to produce a part will be dealt with. In making estimates on gears or machine parts, and especially on new work, it is the practice to obtain the time required for each operation from each department, and the delivery dates. In making this estimate a printed form of the type illustrated in Fig. 1 is sent to each foreman of the departments which have operations to perform. On this form is given the number of pieces to be estimated on. The foreman is also furnished with a drawing of the piece, which gives adequate information to enable him to make an estimate readily. The form and drawing are returned to the estimating department with an estimate of the number of hours required to do the work and a list of the special tools needed. The estimates are then filed for future reference.

When an order is received for a job on which an estimate has been made, a production record card is sent to each of the foremen. A card made out for 1900 gears is shown in Fig. 2. This record card reminds the foremen of what they have promised to do, and has space to permit them to mark the time spent on the job each day so that they can check up and determine whether they are ahead of or behind their estimate. Fig. 3 shows a summary card that is used to record the labor and machine time estimated for each operation. A drawing or photostat of the work is pasted on the back. Cards on which estimates of gears have been made are filed in a cabinet according to the pitch diameter of the gear.

ESTIMATE Nov. 29, 191

CUSTOMER'S NAME

MR. THOMPSON

PLEASE ESTIMATE ON THE FOLLOWING:	HOURS MACH.	HOURS MAN
ROUGHING		
400 DIFF. GEARS	120	120
28 T. 4-5 P.		
MILLING OIL GROOVE	47	47
PER BLUE PRINT C-54118		

TOOLS WANTED: M.H. GARVEY
SULLIVAN

4 CUTTERS 3 O.D. 1⅛ HOLE H.S.
2 SPECIAL MILL. ARBORS
1 INDEX PLATE

Nov. 29, 191 MR. A. MICHAND

NOTICE:

THIS ESTIMATE MUST HAVE YOUR CAREFUL ATTENTION

BROWN & SHARPE MFG. CO.

5668 10M 10-17

Fig. 1. Form sent to Department Foremen for making Estimate on Work to be performed

PRODUCTION RECORD

Mr. POTHEN Date 11-13-19

Name Firm

Time No. 7214 Time Estimated Mch. 150 Man 75

Operation THREADING No. of Pieces 1900

Remarks

DRIVING GEARS 17 T. 6-8 P.

Hours Estimated should be on this card before starting work. If you cannot do as well or better than Time Estimated Notify Foreman of Hour. If he cannot produce better results, he will notify the man responsible for this Record.

DATE	HOURS MACH.	PIECES	DATE	HOURS	PIECES	DATE	HOURS	PIECES
NOV. 15	13	257						
" 16	7	143						
" 17	6	128						
" 18	19	381						
" 19	8	128						
" 20	12	256						
" 22	18.5	363						
" 23	6.5	130						
" 24	10	120						
	100	1906						

MACH. MAN

GAIN 50 − 25 HRS.

Fig. 2. Card given to Foremen for keeping Record of Production of Estimated Work

257-S 1M 9-15 COMPENSATING GEARS

Kind For Time No. | Work No. T 28 P 7-9 | Quantity 10000 Face Hole

	MACH.	MAN		MACH.	MAN
Drawings		20	8 Ft. G. Cut Machine 5 BRUSH WHEELS		
Patterns CHUCKING	1248	624	O. S Machines, and P. 23		
Forging BRUSH		225	28 in. Spiral G. Cut Machine		
Cleaning Castings			Double Tool Gleason Planer		
Machinist's Work		890	12, 24 & 36 in. Gleason Planer		
Screw Machines			Bilgram Planer DRILLING		800
Milling Machines			Auto. Rack Cut Machine		
Milling Machines, P. & W.			~~Index Drilling Machine~~ A.V.G.P.	1400	1400
Reed Lathes, Special			72 in. Index Hobbing Machine		
~~Bullard~~ Lathes	3000	1500	Emery Wheel Grinding	1400	1400
Potter & Johnson Lathes			Filing		550
Small Vertical Boring Mill			Hardening $ ——		
Large Vertical Boring Mill			Hobs		
O. S. G. Cut Machines			Tools $ ——		
Hob Machines			Cutters $ ——		
P3, P4, P11 and P13 H.S.	1600	1600	Inspection		624
P5, P6, P14 and Duples			Boxing		150

Material 10-15 CAR. ST. Date of Estimate Date of Order Remarks

FORGINGS $ ——

Fig. 3. Summary Card showing Labor and Machine Time estimated for Each Operation on a Part

EXHIBITORS IN MACHINE TOOL AND SMALL TOOL FIELD AT AMERICAN RAILROAD ASSOCIATION'S CONVENTION

Air Reduction Co., Inc., New York City.
Ajax Mfg. Co., Cleveland, Ohio.
Ajax Metal Co., Philadelphia, Pa.
American Car & Foundry Co., New York City.
American Tool Works Co., Cincinnati, Ohio.

Baird Pneumatic Tool Co., Kansas City, Mo.
Beaudry & Co., Inc., Boston, Mass.
Besly, Charles H. & Co., Chicago, Ill.
Betts Machine Co., Rochester, N. Y.
Black & Decker Mfg. Co., Towson Heights, Md.
Bullard Machine Tool Co., Bridgeport, Conn.

Cambria Steel Co., Philadelphia, Pa.
Carbo-Hydrogen Co. of America, Pittsburg, Pa.
Carborundum Co., Niagara Falls, N. Y.
Cashman Tool Co., Waynesboro, Pa.
Chicago Pneumatic Tool Co., Chicago, Ill.
Chrobaltic Tool Co., Chicago, Ill.
Cisco Machine Tool Co., Cincinnati, Ohio.
Cleveland Pneumatic Tool Co., Cleveland, Ohio.
Cleveland Punch & Shear Works Co., Cleveland, Ohio.
Cleveland Twist Drill Co., Cleveland, Ohio.
Clipper Belt Lacer Co., Grand Rapids, Mich.
Cutler-Hammer Mfg. Co., Milwaukee, Wis.

Dale-Brewster Machinery Co., Inc., New York City.
Davis Boring Tool Co., St. Louis, Mo.
Davis-Bournonville Co., Jersey City, N.J.
Davis Machine Tool Co., Rochester, N.Y.
Dayton Pneumatic Tool Co., Dayton, Ohio
Detroit Lubricator Co., Detroit, Mich.
Disston, Henry & Sons, Inc., Philadelphia, Pa.
Dixon, Joseph, Crucible Co., Jersey City, N. J.
Duff Mfg. Co., Pittsburg, Pa.
Duntley Pneumatic Tool Co., Chicago, Ill.

Electric Arc Cutting & Welding Co., Newark, N. J.
Elwell-Parker Electric Co., New York City.
Emmert Mfg. Co., Waynesboro, Pa.

Fairbanks Co., New York City.
Fairbanks, Morse & Co., Chicago, Ill.
Foster, Walter H. Co., New York City.
Frontier Chuck & Tool Co., Buffalo, N.Y.

General Electric Co., Schenectady, N. Y.
Gibb Instrument Co., Detroit, Mich.
Goddard & Goddard Co., Detroit, Mich.
Gould & Eberhardt, Newark, N. J.
Grand Rapids Grinding Machine Co., Grand Rapids, Mich.
Greenfield Tap & Die Corporation, Greenfield, Mass.
Grip Nut Co., Chicago, Ill.

Harrington, Edwin, Son & Co., Inc., Philadelphia, Pa.
Hauck Mfg. Co., Brooklyn, N. Y.
Heald Machine Co., Worcester, Mass.
Herbert, Alfred, Ltd., New York City.
Hyatt Roller Bearing Co., New York City.

Independent Pneumatic Tool Co., Chicago, Ill.
Ingersoll-Rand Co., New York City.
International Machine Tool Co., Indianapolis, Ind.

Jacobs Mfg. Co., Hartford, Conn.
Johnson Bronze Co., New Castle, Pa.
Jones & Laughlin Steel Co., Pittsburg, Pa.

K-G Welding & Cutting Co., New York City.
Karry-Lode Industrial Truck Co., Long Island City, N. Y.
Keller Pneumatic Tool Co., Grand Haven, Mich.
King, Julius Optical Co., New York City.

Landis Machine Co., Waynesboro, Pa.
Latrobe Tool Co., Latrobe, Pa.
Luster Machinery Co., Philadelphia, Pa.

Manning, Maxwell & Moore, Inc., New York City.
Metal & Thermit Corporation, New York City.
Midvale Steel & Ordnance Co., Philadelphia, Pa.
Morton Machinery Co., 139 N. Third St., Philadelphia, Pa.

National Lock Washer Co., Newark, N. J.
National Tube Co., Pittsburg, Pa.
Newton Machine Tool Works, Inc., Philadelphia, Pa.
Niles-Bement-Pond Co., New York City.
Nuttall, R. D. Co., Pittsburg, Pa.

Onondaga Steel Co., Inc., Syracuse, N. Y.

Page Steel & Wire Co., New York City.
Production Machine Co., Greenfield, Mass.

Quickwork Co., St. Marys, Ohio.

Racine Tool & Machine Co., Racine, Wis.
Rhodes Mfg. Co., Hartford, Conn.
Rich Tool Co., Chicago, Ill.
Ryerson, Joseph T. & Son, Chicago, Ill.

Sellers, William & Co., Inc., Philadelphia, Pa.
Simonds Mfg. Co., Fitchburg, Mass.
Southwark Foundry & Machnie Co., Philadelphia, Pa.
Swind Machinery Co., Philadelphia, Pa.

Torchweld Equipment Co., Fulton and Carpenter Sts., Chicago, Ill.
Trumbull Waste Mfg. Co., Philadelphia, Pa.

Underwood, H. B. Corporation, Philadelphia, Pa.
United States Graphite Co., Saginaw, Mich.
United States Rubber Co., New York City.

Vanadium-Alloys Steel Co., Pittsburg, Pa.
Victor Tool Co., Inc., Wayneshoro, Pa.

Walworth Mfg. Co., Boston, Mass.
Wards, Edgar T. Sons Co., Boston, Mass.
Warner & Swasey Co., Cleveland, Ohio.
Westinghouse Electric & Mfg. Co., East Pittsburg, Pa.
Whitman & Barnes Mfg. Co., Akron, Ohio.
Wilmarth & Morman Co., Grand Rapids, Mich.
Wilson Welder & Metals Co., Inc., New York City.

Yale & Towne Mfg. Co., Stamford, Conn.

CONVENTION OF AMERICAN RAILROAD ASSOCIATION

The second annual convention of the American Railroad Association (Section III—Mechanical, including the former American Railway Master Mechanics' and Master Car Builders' Associations) was held at Atlantic City, N. J., from June 9 to 16, inclusive. The opening session was held in the Greek Temple on Young's Pier on June 9, and W. J. Tollerton, general mechanical superintendent of the Chicago Rock Island & Pacific Railroad, who is chairman of the Mechanical Section of the American Railroad Association, called the meeting to order at 9:40. Mr. Tollerton introduced Edward L. Bader, mayor of Atlantic City, who delivered a brief address of welcome.

All of the enclosed space on the pier, including the balconies, was occupied by exhibits of a large variety of different types of railroad equipment. The exhibits of greatest interest to readers of MACHINERY were the machine tools, machinists' small tools, and various auxiliary equipments for use in railroad machine shops. These exhibits occupied the entire south side of the pier and many of the machines were shown in operation so that visiting railroad men were able to obtain a definite idea of the productive capacity and operating characteristics of a number of the latest types of machine tools.

The attendance was comparatively light during the four days of the first week, but this was more than offset in the second week, when a large and representative gathering of delegates was constantly looking over the exhibits on the pier or attending meetings held in the boardwalk hotels. The activities of Section III of the American Railroad Association were partially suspended during the war period; but the activity of this section at the present time appears to be as great as ever and doubtless will result in many improvements in the traffic conditions of our railroads.

OBITUARIES

CHARLES ETHAN BILLINGS

CHARLES ETHAN BILLINGS, founder of the Billings & Spencer Co., Hartford, Conn., died June 5 in his eighty-fifth year. He was born December 5, 1835 in Windsor, Vt. When he was seventeen years old he was apprenticed for three years to the Robbins & Lawrence Co., machinists and gun-makers at Windsor. In 1856 he entered the employ of the Colts Patent Fire Arms Mfg. Co. of Hartford as a toolmaker and die-sinker. In 1862 he was awarded a contract from E. Remington & Sons, Utica, N. Y., to manufacture, by the drop-forging process, certain pistol parts which previous to that time had been made by old-fashioned hand methods. Upon completing the contract in 1865 he returned to Hartford and became superintendent of the Weed Sewing Machine Co.



Four years later he became associated with Christopher M. Spencer, the two men subsequently organizing the concern which is now the Billings & Spencer Co. He was president of the company from its organization

until about five years ago, when he retired from active management. For many years Mr. Billings gave personal supervision to the manufacture of the products of the company, and he invented many articles now being manufactured.

WHITFIELD P. PRESSINGER

WHITFIELD P. PRESSINGER, vice-president of the Chicago Pneumatic Tool Co., 6 E. 44th St., New York City, died June 10 as a result of complications following an operation. He was born in New York City in 1871. Mr. Pressinger was actively engaged in the pneumatic tool and allied machinery industry for many years. He was general manager of the Clayton Air Compressor Co. for seven years, and became widely known through numerous activities in the American Society of Mechanical Engineers and the Compressed Air Society. In addition to the foregoing societies he was a member of the Engineers' Club, New York Railroad Club, and Machinery Club.



PERSONALS

O. C. PARKER, formerly general manager of the Bullock Tractor Co., is now general manager of sales of the Franklin Tractor Co., Greenville, Ohio.

W. A. DIBBLEE has become field manager for the Western Appraisal Co. and the National Industrial Engineering Co., Atlas Bank Bldg., Cincinnati, Ohio.

ALFRED SPANGENBERG, formerly superintendent of the Reading Valve & Fittings Co., Reading, Pa., has been made works manager to succeed J. T. MacMurray.

R. K. MORSE has been appointed western manager of the Milwaukee Electric Crane & Mfg. Co., Milwaukee, Wis., with offices in the Pittock Block, Portland, Ore.

STANLEY P. ROCKWELL, formerly vice-president of the Weekes-Hoffman Co., Syracuse, N. Y., has become metallurgist of the Whitney Mfg. Co., Hartford, Conn.

GEORGE H. EARL, who was formerly superintendent of the Otis Elevator Co. at Quincy, Ill., has become associated with the Hollister-Whitney Elevator Co. of Quincy.

GEORGE BATZER, who was connected with the Foote-Burt Co., Cleveland, Ohio, for seven years, is now general factory manager with the F. B. Stearns Co. of Cleveland.

CHARLES T. CASKEY, formerly of the Gardner Bryan Co., Cleveland, Ohio, has left this company and is now special factory representative of the Badger Tool Co., Beloit, Wis.

H. A. BAXTER, metallurgical engineer of the Tacony Steel Co., Philadelphia, Pa., has been appointed metallurgical engineer of the Penn Seaboard Steel Corporation of Philadelphia, Pa.

JOHN E. MOORE, formerly of the Ludlum Steel Co., Watervliet, N. Y., has become associated with the American Machine Products Co., Detroit, Mich., in the capacity of secretary and general manager.

VAN H. MANNING, director of the Bureau of Mines, Department of the Interior, Washington, D. C., resigned June 1 to take the position of director of research with the recently organized American Petroleum Institute.

GEORGE A. SHOEMAKER has been appointed works manager of the Bound Brook Oil-less Bearing Co., Bound Brook, N. J. Mr. Shoemaker was formerly connected in a similar capacity with David Lupton Sons Co., Philadelphia, Pa.

ROBERT N. BIRD has been made manager of the Perfection Machine Works, Inc., Buffalo, N. Y., manufacturer of gages, fine tools and special machinery. B. J. Phillips, the former president, is no longer connected with the company.

W. H. PATTERSON, manager of the resale section of the Westinghouse Electric & Mfg. Co., East Pittsburg, Pa., has been appointed assistant to the manager of the industrial department in charge of the metal-working and woodworking industries.

WILLIAM R. MARSHALL has been appointed manager of the Industrial Division, New York office, of the Westinghouse Electric & Mfg. Co., East Pittsburg, Pa., to succeed Harlan A. Pratt, who is now sales manager of the Atlantic Elevator Co. of New York.

ALOIS HAUSER has been appointed assistant to the works manager in charge of engineering, of the Timken Roller Bearing Co., Canton, Ohio. For several years past, Mr. Hauser has been efficiency engineer at the Saucon plant of the Bethlehem Steel Co.

A. G. NORRIS has been appointed district manager for western New England with headquarters at New Haven, Conn., for the SKF Industries, Inc., 165 Broadway, New York City, sales distributors of the SKF and Hess-Bright ball bearings and Atlas steel balls.

B. G. PRYTZ has resigned as president of the SKF Industries Inc., New York City, to take the position of managing director of the parent company, with headquarters at Gothenburg, Sweden. F. B. Kirkbride, vice-president of the company, was elected president to succeed Mr. Prytz.

T. W. MCMANUS, master mechanic for the Kellogg Switchboard & Supply Co., Chicago, Ill., for several years past, has acquired an interest in the Security Tool Works, Chicago, Ill. Mr. McManus has been elected vice-president of the company and has assumed the duties of general manager.

WILLARD S. SISSON, formerly secretary and treasurer of the D. & W. Fuse Co., Providence, R. I., announces that he is no longer connected with that company, as the plant is now operated by the General Electric Co. under a long-term lease. Mr. Sisson will continue in the electrical business.

CLYDE E. DICKEY, president of the Dickey Steel Co., Inc., New York City, has been elected first vice-president and general manager of the Hammond Steel Co., Inc., Syracuse, N. Y., manufacturer of alloy and carbon tool steels. Mr. Dickey has been engaged in the steel business for the past twenty years.

EDWARD E. BRITIGAN, for a number of years connected with the American Die & Tool Co., Reading, Pa., manufacturer of automobile transmissions, axles, gears, tools, machinery, etc., in the capacity of engineer, has left this company and expects to devote his time to machinery or automotive sales or service work.

JACOB AUER, formerly superintendent of the De La Vergne Machine Co., New York City, has gone into business for himself under the name of Enterprise Machine & Tool Co., at 903 E. 135th St., New York. Mr. Auer's shop is equipped to do contract work on machine parts, tools, and dies, and general repair work.

VICTOR J. SMITH, for four years connected with the engineering and sales departments of the Cleveland Milling Machine Co., Cleveland, Ohio, is now associated with the Shields Cutter Co., of Cleveland, in the capacity of engineer in charge of general sales correspondence. Mr. Smith will also handle sales in the Cleveland district.

C. E. MCARTHUR, secretary and sales manager of the Modern Tool Co., Erie, Pa., sails from New York July 3 on the *Mauretania* for a two months' visit to England, France, and Belgium, with the purpose of studying the business situation in these countries and the opportunities for the sale of machine tools in the European market.

ROBERT A. BOLE, a director of Manning, Maxwell & Moore, Inc., New York City, and general sales manager of the Pittsburg branch of the business, was elected vice-president of the company at a recent board meeting of the directors. Mr. Bole has been with this company for a great many years, and is well known in the railroad and metal industries.

L. M. BAKER, formerly supervisor of sales of the Motor Equipment Division of the Hyatt Roller Bearing Co., New York City, has been appointed exclusive representative in the state of Michigan for the Dittmer Gear & Mfg. Corporation of Lockport, N. Y., manufacturer of automobile, truck, and tractor gears. His headquarters will be in the Book Building, Detroit, Mich.

JOHN M. PRICE has recently been placed in charge of the Chicago office (1160 Monadnock Block) of the Industrial Controller Co., Milwaukee, Wis. Mr. Price was formerly affiliated with the Mechanical Appliance Co. of Milwaukee, manufacturer of Watson motors, as general sales manager. The Industrial Controller Co. manufactures automatic compensators, starting switches, and a complete line of controlling devices for electric motors.

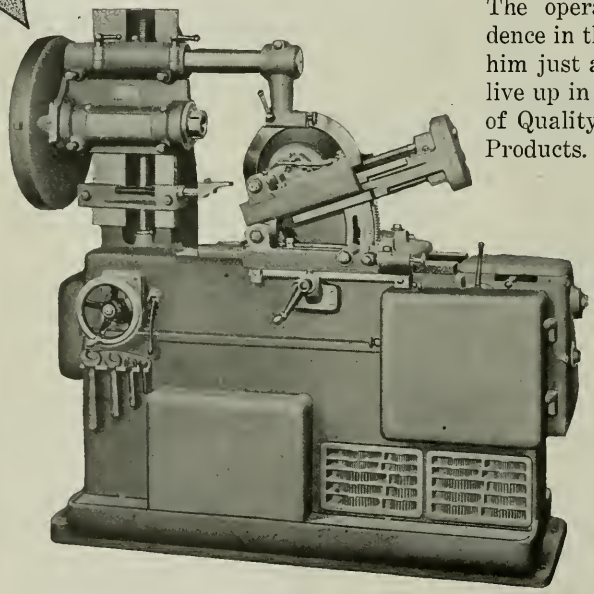
BROWN & SHARPE

THEY SATISFY

Executive and Operator—

The manufacturer knows that they are producers—that they assure him high uninterrupted production and that the accuracy of finished work meets requirements.

The operator knows he can place confidence in them—that they turn out work for him just as he would have it and that they live up in every way to the High Standards of Quality maintained by Brown & Sharpe Products.



No. 13. A convenient size for all-round use. Cuts both spur and bevel gears. One of the seven in the line.

Brown & Sharpe Gear Cutting Machines have been cutting gears for over 40 years and daily are producing results which satisfy. Being automatic in their operation, one workman can easily run several machines.

Whether it be the largest machine with a capacity for spur gears to 72 in. in diameter with 13 in. face, or the smallest—or perhaps one of the bevel gear cutting machines, the work produced is typical of that by which Brown & Sharpe maintain their High Standards of Quality.

BROWN & SHARPE MFG. CO.

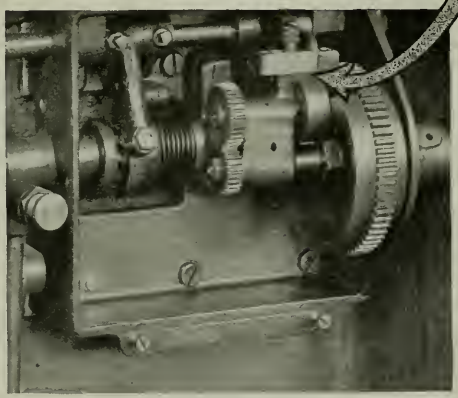
GEAR CUTTING MACHINES

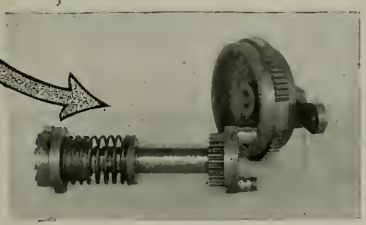
The Indexing Mechanism

The indexing mechanism determines how accurate a gear cutting machine may be.

The design of the indexing mechanism of Brown & Sharpe Gear Cutting Machines meets every demand for accuracy. It starts and locks positively for each tooth space. In addition, the index wheel, keyed to the work spindle, is made very large. This still further reduces the possibility of a tooth on the gear receiving an incorrect circular pitch.

When work is being indexed, cutter feed is automatically thrown out, obviating any chance of cutter meeting the rotating blank.





There are no teeth in mesh at the starting and stopping of indexing for when the index dog starts or locks the movement, the pinion, shown in insert opposite, is over the blank surface of the gear. The gear is brought into mesh with pinion by the two pins turning the gear cam.

These movements are thus both positive and accurate.

PROVIDENCE, R. I., U. S. A.

L. H. KEIM has been appointed general sales manager of the R. D. Nuttall Co., Pittsburg, Pa., gear manufacturer. Mr. Keim has been connected with the company since 1911, having had charge of erection work and the installation of equipment, as well as the designing and developing of heavy-duty railway and steel mill gearing as assistant chief engineer. Mr. Keim will be located in the main office in Pittsburg.

A. H. MITCHEL and E. R. ABBOTT, formerly with H. W. Cotton, Inc., are now associated with the Coe Stapley Mfg. Corporation in charge of the contract sales department, with headquarters at the New York office, 136 Liberty St. The Coe Stapley Mfg. Corporation specializes in the manufacture of sheet-metal parts for automobiles, motorcycles, electrical devices, automobile accessories, phonograph motors and parts, clocks, etc.

C. W. SCHUCHARDT, formerly representing the High Speed Hammer Co., Inc., of Rochester, N. Y., in St. Louis, Mo., has been transferred to Chicago, Ill. A branch has recently been established in Chicago at 568 W. Washington Blvd., where a full line of riveting machine samples is carried in order to demonstrate to customers which size of high-speed hammer will be best adapted to handle their riveting, upsetting, or flush countersinking problems.

W. H. DIEFENDORF, formerly chief engineer of the New Process Gear Corporation, Syracuse, N. Y., and recently general manager of the Weekes-Hoffman Co., of Syracuse, has entered into the gear business at 118 Dickerson St., Syracuse, N. Y., under the name of Diefendorf Gear Corporation. The new company will manufacture spur, bevel, worm, and spiral gears in metal, rawhide, or composition. Special attention will be given to gears for the machinery trade.

FRED THORNLEY, director and works manager of W. Thornley & Sons, Ltd., engineers and iron founders, Sydney, Australia, has come to the United States with a view to purchasing machinery for the company's plant in Sydney, including a fully equipped tool-room. Among the machines required are turret lathes, automatic screw machines, grinding and milling machines, and a complete hardening plant. Mr. Thornley's address is Highland Court Hotel, Hartford, Conn.

CARL WIGTEL, vice-president and chief engineer of the Watson-Stillman Co., 50 Church St., New York City, sailed June 14 on the Swedish-American Line for a ten weeks' trip to the Scandinavian countries. Mr. Wigtel also expects to visit England, France, Belgium and Holland. While he is going mainly for a vacation (this being the first time he has returned to his old home in Norway since his connection with the company thirty-three years ago), he will also investigate new developments in the line of hydraulic machinery in the countries mentioned.

E. M. HERR, president of the Westinghouse Electric & Mfg. Co., East Pittsburg, Pa., and L. A. OSBORNE, president of the Westinghouse Electric International Co., New York City, were decorated with the Order of the Rising Sun by the Emperor of Japan. Mr. Herr and Mr. Osborne have been in Japan for several months studying Oriental industrial conditions. The Westinghouse companies, which they represent, have had close relations with Japan and have supplied that country with a great deal of power machinery. A number of Japanese students have also been trained at their works.

E. J. BOGGAN, formerly factory manager of the U. S. Metal Goods Co., Cleveland, Ohio, has entered the executive organization of the Dittmer Gear & Mfg. Corporation, Lockport, N. Y., in the capacity of sales engineer. He will devote his entire time to looking after sales matters, including the supervision of sales representatives. Mr. Boggan was formerly associated with the Frontier Chuck & Tool Co. as sales engineer and with the King Sewing Machine Co. of Buffalo as time-study and efficiency engineer. He also served the Covert Gear Co. of Lockport as production manager and the Harrison Radiator Corporation in the same capacity.

COMMANDER R. D. GATEWOOD of the Construction Corps, United States Navy, has been selected as director of construction and repair of the Emergency Fleet Corporation, relieving R. L. Hague. Commander Gatewood graduated from the Naval Academy in 1903 and from the post-graduate course of naval architecture and marine engineering at the Massachusetts Institute of Technology in 1906. He has been in charge of repairs and new construction on both the Atlantic and Pacific coasts, and for two and one-half years was fleet constructor of the North Atlantic Fleet. During the war he was superintendent of motive power for the Panama Railroad, in charge of the large shops and drydocks at both ends of the Isthmus.

ALLAN E. GOODHUE has been elected vice-president in charge of sales of the Chicago Pneumatic Tool Co., 6 E. 44th St., New York City, the position of vice-president having been made vacant by the death of Whitfield P. Pressinger. Mr. Goodhue has been, since May, 1919, managing director of the company's English subsidiary, the Consolidated Pneumatic Tool Co., London, England, as well as director of European sales for the Chicago Pneumatic Tool Co. He was connected for a number of years with the sales department of the Midvale Steel Co. and Midvale Steel & Ordnance Co., leaving that company in March, 1918, to enter the service of the government. From that time until January 1, 1919, when he became connected with the Chicago Pneumatic Tool Co., he was assistant manager of the steel and raw material section, production division, of the Emergency Fleet Corporation.

G. A. UNGAR has been appointed general sales agent and consulting engineer of the "Flexite" division of Slocum, Avram & Slocum Laboratories, Inc., 120 Pacific St., Newark, N. J. Mr. Ungar has been prominently identified with the automotive industry for the last ten years, and was the originator of the "Flexite" designs manufactured by this company. He has also been closely connected with the marketing of these products since their inception. In order to devote himself entirely to the commercial development of "Flexite" universal joints and propeller shafts, he resigned his position as technical manager and chief engineer of the S K F Industries. Slocum, Avram & Slocum Laboratories, Inc., has found it necessary, in order to utilize its full facilities for the manufacture of "Flexite" products, to concentrate the manufacturing and selling functions and has inaugurated separate sales headquarters for the "Flexite" products in the Woolworth Bldg., New York City, where Mr. Ungar will be located.

COMING EVENTS

September 14-18—Second annual convention and exhibit of the American Steel Treaters' Society of Chicago, Ill., and the Steel Treating Research Society of Detroit, Mich., in the Commercial Museum, Philadelphia, Pa. Department of Exhibits, 208 N. Wabash Ave., Chicago, Ill.

September 20-October 9—Sixteenth annual convention of the International Association of Machinists, at Rochester, N. Y.

October 4-9—Annual convention and exhibit of the American Foundrymen's Association at Columbus, Ohio.

SOCIETIES, SCHOOLS AND COLLEGES

Purdue University, Lafayette, Ind. Circular illustrating and describing the engineering experiment station of the university.

Michigan College of Mines, Houghton, Mich. Year book for 1919-1920, containing calendar and announcement of courses for 1920-1921.

University of Vermont, Burlington, Vt. Catalogue for 1919-1920 with calendar and announcements for 1920-1921, courses of instruction, and other relative matter.

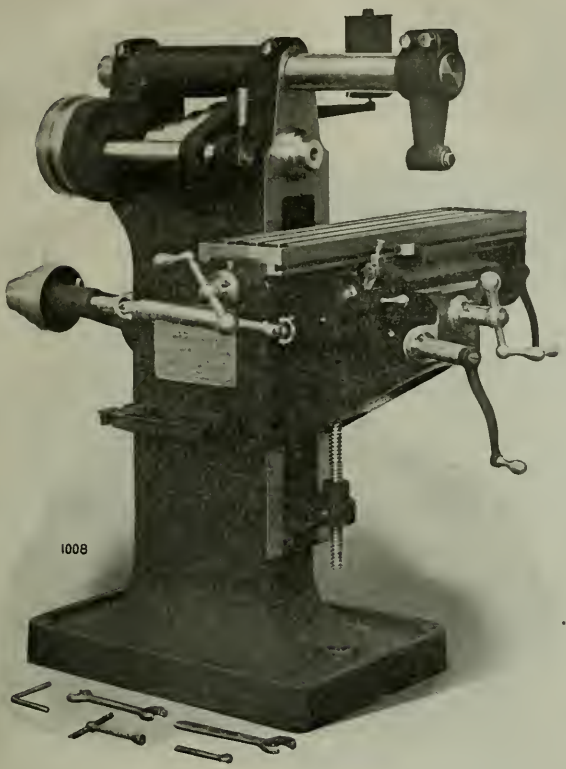
BOOKS AND PAMPHLETS

Electro-deposition of Metals. By George Langbein. Translated with additions by William F. Brannt. 875 pages, 6¼ by 9¼ inches; 185 illustrations. Published by Henry Carey Baird & Co., Inc., 2 W. 45th St., New York City. Price, $7.50.

This is the eighth edition of the present work, which has been revised, enlarged, and entirely reset. The book illustrates and describes processes and apparatus used in plating and finishing metals. It is written in simple language with special reference to the needs of the practical plater and metal finisher, and gives hundreds of tested formulas for solutions, many of which have heretofore been considered trade secrets. It discusses electro-plating, galvanizing, metal coloring, lacquering, and electrotyping, and covers the history and theory of electro-metallurgy. The translator has added considerable matter to the original work, particularly in the chapter on "Apparatus and Instruments" and in the section of "Useful Tables." The present volume describes new developments in machinery and apparatus for this work, such as the latest types of plating machines, ball bearing grinding and polishing lathes, sand-blast apparatus for cleaning, and lacquer spraying by compressed air. It also treats of the use of electrically heated japanning and lacquer baking ovens.

The Engineering Index (1919 Edition). 528 pages, 6½ by 9½ inches. Published by the American Society of Mechanical Engineers, 29 W. 39th St., New York City. Price, $4.

This book comprises a comprehensive guide to the engineering literature of 1919, and should be of considerable value to mechanical engineers and others interested in articles relating to this field. It contains over 12,000 references to nearly 700 engineering and allied technical publications. This volume is the first to be compiled by the staff of the society, the publication having been acquired at the close of 1918. The articles are classified according to subject, arranged in alphabetical order; this arrangement is new, the material in previous editions being grouped under divisions of engineering such as civil, electrical, mining, mechanical, etc. The method of indexing is exceedingly simple; each item contains the exact title of the article indexed, the author's name (if given), the name of the periodical in which the article appeared, the volume, number, and date of publication, as well as page numbers and number of figures. A brief note summarizing each article is included; this feature together with the numerous cross-references throughout the volume, will enable the user to confine his search to those particular articles which bear directly upon his problem. At the back of the book is given a list of the periodicals indexed, place of publication, and frequency of issue; this list covers publications printed in about ten different languages, containing scientific and engineering material.



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Wide Speed Range—21 to 500 r. p. m.
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THE CINCINNATI MILLING MACHINE CO.
CINCINNATI **OHIO, U. S. A.**

The Gasoline Automobile. By P. M. Heldt. 633 pages, 5½ by 8½ inches. Published by the author, at Nyack, N. Y. Price, $6.

This is the fourth edition of the second volume of a comprehensive work on the gasoline automobile, this volume dealing with the transmission, running gear, and control. The author is engineering editor of "Automotive Industries," and the treatment is such as to appeal to the designer, rather than the automobile owner or layman. The book gives formulas for designing the gears and other parts of the transmission. It discusses stresses and bearing loads and gives rules for their calculation. The various types of drives are fully described. Attention is given to critical speeds in shafts, the theory of critical speeds being explained and rules for their calculation given. In the present edition, about thirty pages of tabular and other matter have been added to the appendix, which it is believed will materially enhance the value of the book as a work of reference. In the regular text important changes and additions have been made relating to truck axles, control mechanism, and disk wheels, while minor revisions taking account of recent changes in practice have been made in many chapters. The material presented in the book is divided into nineteen chapters, headed as follows: General Lay-out of Cars; Friction Clutches; Sliding Change Speed Gears; Planetary Change Speed Gears; Friction Disk Drive; Universal Joints; Differential Gears; Unit Power Plants; Transmission Axles; Bevel Gear Drive and Rear Axle; the Worm-gear Drive; the Chain Drive; Bevel-spur Gear, Internal Gear, and Four-wheel Drives; Brakes; Front Axles; Steering Gears; Control; Frames; Springs; and Road Wheels.

Automobile Starting, Lighting, and Ignition Systems. By Victor W. Page. 815 pages, 5 by 7½ inches; 425 illustrations. Published by the Norman W. Henley Publishing Co., 2 W. 45th St., New York City. Price, $3.

This is a revised and enlarged edition of a book on automobile starting, lighting, and ignition system practice, written with special reference to the requirements of the reader desiring easily understood explanatory matter relating to all types of automobile electrical systems. Elementary electrical principles are considered before an attempt is made to discuss the features of the various systems. The basic principles are clearly stated and illustrated with simple diagrams. Over 200 wiring diagrams are presented. All the leading systems of starting, lighting, and ignition have been described and illustrated with the cooperation of the experts employed by the manufacturers. Complete data are given for locating troubles in all systems, and full directions are given for making repairs. Various accessories operated by electric current, such as electrical gear shifts, brake actuation, signaling devices, vulcanizers, etc., are also described. An idea of the material presented in the book will be obtained from the chapter heads, which are as follows: Elementary Electricity; Battery and Coil Ignition Methods; Magneto Ignition Systems; Elementary Electric Starter Principles; Typical Starting and Lighting Systems; Starting System Faults and their Systematic Location; Miscellaneous Electrical Devices; Late Ford and Maxwell Electrical Systems; the Hudson-Delco and Two-unit Delco Systems; the Dodge Brothers' Ignition-Starting-Lighting System; the Stutz-Remy and Mitchell-Remy Systems; Bijur-Roamer Electrical Systems; Design of Electrical Measuring Instruments and Use in Testing; 1917-1918 Wiring Diagrams of Popular Cars; 1919-1920 Wiring Diagrams of Popular Cars, Electrical System Details —1920 Cars.

NEW CATALOGUES AND CIRCULARS

Henry G. Thompson & Son Co., 277 Chapel St., New Haven, Conn. Circular advertising Milford hacksaw blades.

Smalley-General Co., Inc., Bay City, Mich. Circular illustrating different sizes of Smalley-General thread milling machines and flange thread millers.

Mattison Machine Works, Rockford, Ill. Circular illustrating and describing the Mattison heavy-duty shaper, which is made in 16-, 20-, and 24-inch sizes.

Ajax Metal Co., Philadelphia, Pa. Leaflet treating of Ajax bull bearing alloy, which is a general-purpose lining metal. Copies will be sent to those interested, upon request.

William L. Procunier, 18 S. Clinton St., Chicago, Ill. Circular containing price lists for "Double-Gripp" safety tapping chucks, tapping attachments, and tap- and die-holders.

Griscom-Russell Co., 90 West St., New York City. Bulletin 1010 containing tables of dimensions, weights, and other data for the Griscom-Russell low-pressure expansion joint for steam lines.

Morrison Machine Products, Inc., 15 Commercial St., Rochester, N. Y. Circular descriptive of the "Inanout" double-acting collet, which combines the principles of the draw-in lathe collet with those of the expanding arbor.

Shepard Electric Crane & Hoist Co., Montour Falls, N. Y. Circular entitled "A Hoist Below the Hook," illustrating the company's line of electric hoists and their application for transporting materials in a wide range of industries.

Westinghouse Electric & Mfg. Co., East Pittsburg, Pa. Circular entitled "Recent Notable Achievements," illustrating electrical equipment produced by the company for transportation on land and sea, as well as large power generating units.

Sunderland Machine Shops, Omaha, Neb. Circular illustrating and describing the "Fox" cylinder boring and grinding machine, which is adapted for grinding either closed- or open-head cylinder blocks, and is made to fit any lathe of from 14 to 24 inches swing.

Henry Disston & Sons, Inc., Philadelphia, Pa. General catalogue giving dimensions, prices, and other data relating to Disston saws, files, sharpening machines, band saw setting machines, cutter grinders, swages, machine knives, saw clamps, screwdrivers, and other tools.

Norton Co., Worcester, Mass. Circular treating of commercial diamonds for truing grinding wheels, including classification of stones—kinds, color, quality, shapes, sizes, etc.—which should be of value in selecting the proper diamond to use for truing purposes; methods of setting; and suggestions on the correct use of diamonds.

Deming Indicator Co., Dayton, Ohio. Circular giving specifications and prices for the Deming precision test indicator, an instrument for accurately determining minute errors in fine mechanical work. These indicators are furnished in several different sets, comprising the indicator, holder and pointers, in leather covered cases.

Economy Tool Mfg. Co., Green Bay, Wis. Circular illustrating and describing this company's line of tool steel universal tool-holders designed to hold stellite or high-speed steel cutters, for lathes, planers, and shapers. Prices are given for the ten sizes of regular right-hand, left-hand, and straight styles and special straight styles.

Butterfield & Co., Derby Line, Vt. Catalogue 18, covering the company's line of thread-cutting tools, including taps, dies, reamers and screw plates. Sizes and prices are given for the tools listed. In addition, the catalogue contains an appendix of tables and general information relating to standard thread sizes, tap drill sizes, etc.

J. G. White Engineering Corporation, 43 Exchange Place, New York City. Folder entitled "Industrial Buildings at Matagorda," illustrating and giving information concerning the power plant, warehouse, machine shop, and model homes erected for the housing of workmen at the sulphur plant of the Texas Gulf Sulphur Co., Matagorda, Texas.

Smith & Serrell, Central Ave. at Halsey St., Newark, N. J. Bulletin 201, containing data on the "Pulmore" pulley tread—a chemically treated fiber compressed into sheet form for application to iron, steel, wood, paper, or other pulleys in order to produce a frictional tread equivalent to leather. The pamphlet gives list prices and directions for installing.

Portland Cement Association, 111 W. Washington St., Chicago, Ill. Circular outlining the advantages derived through the use of concrete in the construction of mercantile and industrial buildings. The pamphlet is illustrated with views showing a large number of concrete buildings of different types that have been constructed for various classes of manufacture.

Howard Iron Works, Buffalo, N. Y. Catalogue illustrating and giving specifications for the line of bolt, nut, and special machinery made by this concern, which includes nut burring machines, hot-pressed nut machines, nut tappers, bolt and rivet headers, forging machines, bar heating furnaces, forges, facing and boring machines, pickling and washing machines, and gears and transmission equipment.

Vanadium-Alloys Steel Co., Pittsburg, Pa. Booklet descriptive of "Vasco Vanadium," an alloy steel developed to meet the requirements of great strength, hardness, and toughness. The booklet gives a list of the types of "Vasco Vanadium" and the heat-treatments for the different types, as well as the tools or parts for which each kind is especially suitable. Copies will be sent upon request.

Hyatt Roller Bearing Co., 6th Ave. and 41st St., New York City. Circular entitled "Hyatt Responsibility Follows the Bearing," advertising the engineering service rendered by the company to the buyer of Hyatt roller bearings. Circular entitled "I Wonder what a Drop of Oil Thinks about?" showing a series of humorous pictures analyzing graphically the action of a drop of oil on a Hyatt roller bearing.

Davis-Bournonville Co., Jersey City, N. J. Booklet descriptive of Davis-Bournonville welding and cutting equipment, which is applicable for a wide range of work, from that done in the small repair shop to that of the large metal-working plants. The large systems comprise the production, compression, and distribution of acetylene, oxygen, and hydrogen, with full equipment for operators of welding and cutting torches.

Golden Co., 405 Lexington Ave., New York City. Catalogue 234, describing the universal measuring machines made by the Societe Genevoise d'Instruments de Physique of Geneva, Switzerland, for whom the Golden Co. is the exclusive agent in the United States. These measuring machines employ a single standard scale of permanent precision, and are used for the checking and control of standards and scales of every form.

Famous Mfg. Co., East Chicago, Ind. Pamphlet entitled "Like Finding Money," containing suggestions for saving waste paper and other material, and describing the complete line of "Famous" and "Champion" baling presses for use in baling scrap of all kinds, waste paper, rags, leather findings, shaving and sawdust, sheet metal wire, etc. Copies of the catalogue will be sent to anyone interested in turning their waste material into profit.

Hess Steel Corporation, Baltimore, Md. Booklet entitled "Electric Steel Making," containing a reprint of a paper on "Electric Furnaces as Applied to Steel Making," by Henry Lawrence Hess, delivered before the Baltimore section of the American Society of Mechanical Engineers. Booklet entitled "Steel for Airplane Motors," containing an article reprinted from the "Iron Trade Review," on the production of airplane parts of electric steel by the Hess Steel Corporation.

Fairbanks Co., Broome and Lafayette Sts., New York City. Catalogue 935, containing 256 pages illustrating and describing the complete line of power transmission appliances and elevator and conveying machinery produced by this company. The catalogue contains tables of dimensions, capacities, etc., which should be of value to those who design or install mechanical equipment of this nature. Copies will be sent upon request to executives, engineers, master mechanics, millwrights, and those concerned in procuring the material described.

South Bend Lathe Works, South Bend, Ind. Booklet entitled "First Year Lathe Work," intended as an instruction book for students in technical, vocational, and industrial schools, and for the apprentice in the shop. This book deals specifically with the subject of how to build an S-inch grinder, giving complete working drawings, with the names of the parts and dimensions, and complete instructions for performing the work. Each detailed part is shown in a drawing by itself, and on the opposite page of the book the instructions for its machining are given.

Sprague Electric Works of General Electric Co., 527 W. 34th St., New York City. Bulletin 44553.1 descriptive of Sprague flexible steel armored hose for railroad service, and giving specifications and list prices for air-brake hose, locomotive tank or tender hose, electro-pneumatic switch hose, etc. Circular B-3567 treating of flexible steel armored hose for industrial work, and showing applications in mines, quarries, machine shops, and industrial plants. The pamphlet includes specifications for air hose, water hose, and steam hose, as well as for the couplings recommended for use with Sprague armored steel hose.

Wellman-Seaver-Morgan Co., Cleveland, Ohio, has issued a series of bulletins Nos. 41 to 48 inclusive, showing some of the company's installations of coal and ore handling machinery; special cranes; hydraulic turbines; hoisting and mining machinery; steel works equipment; coke oven machinery; port and terminal equipment; and rubber machinery. These bulletins show on opposing pages a picture of the particular installation and a working blueprint of each machine. Copies of the bulletins will be sent to anyone interested. The company is also distributing Bulletin 51, treating of the Wellman mechanical gas producer.

Briggs & Turivas, Inc., Westminster Bldg., Chicago, Ill. Booklet entitled "Classified Scrap Iron," containing a classification of scrap iron and steel of various grades, compiled from average practice to enable the manufacturer to segregate his scrap accumulations and quickly identify his scrap in terms of its market value. A table is included giving weights and quantities of rails and accessories in various combinations of tonnage and length of track. Other tabular matter gives the net and gross ton equivalents, equivalent pounds for tons from 1 to 1000, weights of plate, standard gages for sheet and plate iron and steel, and specific gravities and weights.

Moltrup Steel Products Co., Beaver Falls, Pa. Catalogue 1 of Moltrup steel products, which include cold-drawn steel in rounds, squares, hexagons, flats, and special shapes; shafting, screw stock and special polished rod; turned and polished shafting; machine keys, Woodruff keys, and machine rack; and flattened steel plates. The catalogue also contains tables of general data, including weights of round and square steel bars, weights of hexagon steel bars, weights of flat-rolled steel, weights of flat steel bars, circumferences and areas of circles, weights of circular steel plates, weights of sheet and bar aluminum and brass, standard wire gages, and weights of iron and steel sheets and plates in standard gages.

Goddard & Goddard Co., Detroit, Mich. Catalogue B, covering the "Go & Go" line of high-speed steel milling cutters, which includes plain milling cutters, side milling cutters, end-mills, shell end-mills, form cutters, shell drills, reamers, and special tools. The book contains illustrations of the different types of cutters, descriptions of their design, and suggestions concerning the work for which each type is especially adapted, as well

LUCAS "PRECISION"
Boring, Milling and Drilling Machines



Building
Large
Special
Machinery

The photograph shows a Lucas "Precision" Boring, Milling and Drilling Machine set up for milling the lugs on cast-iron rings for a circular loom—one of the many and varied operations brought to this versatile precision machine in the Hartford (Conn.) Special Machinery Co.'s shop. There are two of these machines here. Both five years old and with equally satisfactory service records to their credit—"just the thing" to handle castings of all sizes and shapes such as are used in machine building of this nature.

Let us tell you more about them

LUCAS MACHINE TOOL CO. NOW AND ALWAYS OF **CLEVELAND, OHIO, U.S.A.**

FOREIGN AGENTS: Alfred Herbert, Ltd., Coventry. Societe Anonyme Belge, Alfred Herbert, Brussels. Allied Machinery Co., Turin, Barcelona, Zurich. Benson Bros., Sydney, Melbourne. V. Lowener, Copenhagen, Christiania, Stockholm. R. S. Stokvis & Zonen, Rotterdam. Andrews & George Co., Tokyo.

as complete tables of dimensions and prices. In addition to the catalogue material presented, considerable useful information is given on milling practice, including speeds and feeds for high-speed milling cutters, milling heat-treated steels, tables of weights of round carbon and high-speed steels, dimensions of standard keyways for cutters, dimensions of Brown & Sharpe tapers, and suggestions concerning the proper use of milling machines and milling cutters.

Warner & Swasey Co., Cleveland, Ohio, has published a book in celebration of the fortieth anniversary of the founding of the company in 1880, by Worcester R. Warner and Ambrose Swasey. In 1900 the partnership became a corporation, so that on this occasion is also celebrated the completion of the twentieth year of the corporation. The book contains a brief outline of the lives of the founders, as well as a historical sketch of the founding and development of the company and its products. The results of nearly a half a century of mechanical engineering and scientific progress are portrayed in its pages. An idea of the remarkable strides that have been made in the machine tool field in this time may be obtained by a comparison of the illustrations of the 12-inch hand lathe and the 16-inch monitor lathe, developed in 1880 and 1881, with that of the 3 A universal hollow hexagon turret lathe, produced in the present year. The book is intended for distribution to the members and employes of the company as well as to its many friends, who will undoubtedly read it with a great deal of interest.

Davis-Bournonville Co., Jersey City, N. J. Catalogue of Davis-Bournonville oxy-acetylene apparatus, including acetylene generators, welding and cutting torches, pressure regulators, and portable outfits and supplies. The booklet shows a portable cabinet truck which provides permanent mountings for the pressure regulators inside a steel locker, and safe storage for torches, tools, etc., as well as a new non-flashback welding torch, and new-series press-forged-bronze pressure regulators. Circular containing reprints of articles entitled, "Recent Developments in Oxygen Cutting," by Stuart Plumley and F. J. Napolitan, and "Metallography of Iron and Steel with Reference to Oxygen Cutting," by F. J. Napolitan, read before the American Welding Society. The circular also contains an article on "Heavy Cast Iron Cutting," reprinted from "Autogenous Welding." These articles contain information on what has been accomplished in the cutting of cast iron with the oxy-acetylene torch.

TRADE NOTES

Cinch Fastener Corporation announces that it is now occupying its new factory at 2335 W. Van Buren St., Chicago, Ill.

Gale-Sawyer Co., 36 Oliver St., Boston, Mass., has moved its Detroit office to 289 E. Jefferson Ave. This office remains in charge of E. H. Anthony.

Wagner Electric Mfg. Co., St. Louis, Mo., has opened a sales office and service station at 2007 S. Ervay St., Dallas, Texas, under the charge of Charles O. Rauschkolb.

Dayton-Reliance Tool & Mfg. Co., Dayton, Ohio, manufacturer of the "Quick Change" line of lathe chucks, has been absorbed by the Quickchange Chuck & Mfg. Co., of Dayton, Ohio.

Penn Seaboard Steel Corporation, Philadelphia, Pa., announces that its new blooming mill at New Castle, Del., is now in operation. The mill has a capacity for 20,000 tons of billets, blooms, and slabs per month.

Morrison Machine Products, Inc., 15 Commercial St., Rochester, N. Y., manufacturer of collets for all types of lathes and screw machines, would be glad to receive catalogues from lathe and screw machine manufacturers.

Westinghouse Electric & Mfg. Co., East Pittsburg, Pa., at the annual meeting of stockholders, re-elected the following directors for three years: Guy E. Tripp, Joseph Marsh, H. H. Westinghouse, Albert H. Wiggin, and George W. Davison.

Detroit Tool Co., St. Antoine St., Detroit, Mich., manufacturer of drilling machines, is erecting a two-story concrete addition to its plant, of 120 by 150 feet. The second floor will be used as a general office and engineering department.

J. Lambercier & Co., Geneva, Switzerland, announce that they are planning to place some of the machines included in their line of machine tools on the market in the United States, and would like to get in touch with American dealers interested in handling this trade.

Lehmann Machine Co., 514 S. Broadway, St. Louis, Mo., is erecting a new plant which will cover an area of 45,000 square feet. This plant is of brick, steel, and concrete construction, with a two-story office building adjoining. The plant will be ready to be moved into in August and will give the company four times its present capacity.

Service Casting Co. has recently been organized at Blanchester, Ohio, and will specialize in making small gray iron castings for the trade. The foundry has been in operation since February 1, 1920, doing contract work. The personnel consists of R. B. Huyett and Charles N. Secrist, both of whom are experienced in foundry and machine practice.

Standard Equipment & Tool Works have recently opened showrooms and offices at 307 St. James St., Montreal, Canada, and are desirous of receiving catalogues from manufacturers of machine tools and kindred lines. They would also like to enter into correspondence with manufacturers of a few good lines who wish to enter the Canadian market. Joseph Presner is manager of the company.

Edward R. Ladew Co., Inc., manufacturer of Ladew leather belting, announces that it is now located in its new offices at 428-430 Broadway, New York City, which will be the headquarters of the general sales department of the company as well as of the New York branch. A new and enlarged stock-room and belt shop, with increased facilities for better service, will also be maintained at this address.

Toledo Milling Machine Co., Toledo, Ohio, expects to move into its new factory building about August 1. The new building, which is of two-story steel and concrete construction is nearing completion, and the machine equipment is being installed daily. The entire building will be given over to the manufacture of the Toledo vertical milling machine, and jigs and fixtures are now completed ready for the production of the first lot of machines.

Millersburg Reamer & Tool Co., Millersburg, Pa., has practically completed its new building, and a full line of modern machine tool equipment is being installed for the manufacture of reamers, taps, and small tools. Production is just starting. The building is of cement and steel construction with metal sash, and will cover an area of 2400 square feet. The officers of the company are M. Edward Wilt, president; William Bower, secretary; and W. A. Shatto, treasurer.

Gillespie Eden Corporation, 50 Church St., New York City, has been organized through the consolidation of the Gillespie Mfg. Co., Gillespie Motor Co., Gillespie Foundry Co., and the Brokaw-Eden Co. The new company will manufacture the Eden washing machine, and castings, motors, and wringers used in its production. The officers are T. H. Gillespie, president; E. L. Bergland, H. G. Seaber, P. J. Holdsworth, and George DeLaval, vice-presidents; H. S. Hart, treasurer; and F. J. Nash, secretary.

Nazel Engineering & Machine Works, Philadelphia, Pa., a corporation chartered under the laws of the state of Pennsylvania, has taken over the business of the estate of the late John Nazel. The officers are as follows: Ralph W. Nazel, president and general manager; C. H. Wackernagel, vice-president and assistant manager; J. Milton Nazel, secretary and treasurer. The change will not affect the business policy of the founder, the managing personnel being practically the same as it has been for the past fifteen years.

Meissolbach-Catucci Mfg. Co., 51 Stanton St., Newark, N. J., manufacturer of automatic gear-hobbing machines, hob and gear-cutter grinders, and automatic machine tools for special work has purchased the shop of the Union Wheel Works which is located at 51 Stanton St. in the Freihnghuysen Ave. factory development. The company is converting the building to meet its requirements, and with the added facilities afforded expects to be in a better position to meet the demand for M-C gears and gear-hobbing machines.

Pennsylvania Pump & Compressor Co., Easton, Pa., announces the opening of sales offices at 50 Church St., New York City, H. C. Browne, manager; 2222 Chestnut St., Philadelphia, Pa., W. J. Devlin, manager; 631 Fulton Bldg., Pittsburg, Pa., C. W. Gellinger, manager; Mutual Bldg., Richmond, Va., W. F. Delaney, manager; 2027 Jefferson Bank Bldg., Birmingham, Ala., H. I. Wahn, manager; Newhouse Bldg., Salt Lake City, Utah, C. H. Jones, manager; and 604 First National Bank Bldg., Milwaukee, Wis., Coates & Zarling, representatives.

Cutler-Hammer Mfg. Co., Milwaukee, Wis., has moved its Chicago offices from the Peoples Gas building, where they have been located for the past eight years, to the company's own building at 323 N. Michigan Ave., on the new Michigan Blvd. link. Because of the rapidly growing business in the Chicago territory, it was necessary to provide larger office space. The new building also offers considerable extra storage space, and will make possible to carry a larger stock of standard apparatus and parts for ready delivery. H. L. Dawson is manager of the Chicago office.

Reed-Prentice Co., Worcester, Mass., Backer Milling Machine Co., Hyde Park, Boston, Mass., and Whitcomb-Blaisdell Machine Tool Co., Worcester, Mass., have opened a direct sales office for handling their sales in the New York territory, on the fifth floor of the Grand Central Palace in the International Machinery Exhibition. The office will be in charge of P. K. Dayton, who has been connected with the Niles-Bement-Pond Co., and Manning, Maxwell & Moore. Mr. Dayton will be assisted by P. A. Dyer, formerly of the General Electric Co. These three companies, which are controlled by the same financial interests, have adopted the policy of selling direct to the trade, for the purpose of insuring to their customers prompt and efficient service.

Watson-Stillman Co., 192 Fulton St., New York City, announces the following changes in personnel made at a recent meeting of the board of directors: A. F. Stillman has retired from active interest in the management; E. A. Stillman continues to hold the office of president of the company and also has full supervision of sales; Carl Wigtel, chief engineer, was elected vice-president; J. D. Brocks, was elected treasurer, and A. Parker Nevin, secretary; LeRoy T. Brown was appointed works manager, J. W. Delano, assistant works manager, and W. H. Martin, purchasing agent. Under this arrangement the offices of general manager and superintendent are discontinued, G. D. Kershaw and J. F. Lary, who formerly held these positions, no longer being connected with the company.

Yale & Towne Mfg. Co., Stamford, Conn., announces that it has purchased the Industrial Electric Truck Division of the C. W. Hunt Co. of Staten Island. The business will be combined with the Yale & Towne hoist department, and the company will thus be in a position to furnish complete equipment for moving medium or light loads either vertically or horizontally. Arrangements have been completed for increasing the manufacturing facilities at Stamford, and it is the intention to so organize the business as to give maximum service to users of the trucks. The following changes have been made in the organization: John B. Milliken, treasurer of the company, has resigned to enter other fields, and Willard L. Case will fill the position made vacant by Mr. Milliken's resignation. Edward C. Waldvogel, who has been in the employ of the company for fifteen years, and who has held the position of general manager for four years, having charge of all sales and advertising, has been elected a director.

Wayne Machinery Co., Fort Wayne, Ind., has opened a store at 121 S. 3rd St., Louisville, Ky. L. Kenner, who has been connected with the Fort Wayne plant for the last eleven years, is in charge of the new store. In addition to the Fort Wayne plant's line of woodworking and iron-working machinery, the Louisville branch will handle many well-known production lines of wood- and metal-working equipment, among which will be included the machines manufactured by the Rockford Milling Machine Co., Sidney Machine Tool Co., Thompson Grinder Co., Oakley Machine Tool Co., Colburn Machine Tool Co., Rockford Machine Tool Co., B. C. Ames Co., Mueller Machine Tool Co., Queen City Machine Tool Co., Peerless Machine Co., Whipp Machine Tool Co., Adams Co., Hurlbut, Rogers Machinery Co., and Ingersoll-Rand Co. The company also maintains a branch at 18 W. 2nd St., Dayton, Ohio, in charge of H. F. Himes. Representative lines of machine tools are carried at this branch as well as some woodworking machinery.

J. H. Williams & Co., Brooklyn and Buffalo, N. Y., manufacturer of drop-forgings and drop-forged tools, announces the consolidation of the wrench and drop-forging plants and business of the Whitman & Barnes Mfg. Co., Chicago, Ill., Akron, Ohio, and St. Catharines, Canada, manufacturer of twist drills, reamers, wrenches, and drop-forgings, with J. H. Williams & Co. The Whitman & Barnes Mfg. Co. will retain its twist drill and reamer business, and will continue to manufacture these tools on an extended scale as a separate organization at Akron, Ohio. The consolidated business will continue to be operated by those who have been identified heretofore with J. H. Williams & Co., and with the Chicago and St. Catharine's plants of the Whitman & Barnes Mfg. Co., the organization being as follows: President and managing director, Harvey Williams; vice-president, A. D. Armitage; secretary and treasurer, W. A. Watson; general sales manager, F. W. Trabold; general works manager, captain W. N. McMunn; general purchasing agent, J. O. Scanlon; and Canadian manager, W. J. Elliott.

Technical Advisory Corporation, 132 Nassau St., New York City, has been organized to act as consulting engineers and industrial economists. The men connected with the new corporation formerly served on the technical advisory committee of the War Claims Board, and will continue to serve the Government in an advisory capacity. The officers are as follows: President, Camphell Scott; vice-president and treasurer, Ernest P. Goodrich; and vice-president and secretary, William D. Ennis. The principal associates are Frank B. Maltby, Walter Rautenstrauch, George B. Frankforter, Arthur W. Hixsen, Fred E. Rogers, and Rumsey W. Scott. Two main classes of service will be offered, namely, industrial and engineering. In connection with the industrial section the corporation will undertake work as economists, cost reducers, and business advisers, furnishing studies of and recommendations on problems of production, transportation and distribution. It will prepare authoritative appraisals of real property, equipment, and merchandise, will analyze organization conditions, methods, and personnel, and will undertake problems involved in the harmonization of labor and management. In connection with the engineering section, it will furnish complete factory and institutional lay-outs and specifications based on an approved plan of production and distribution, including all the productive and auxiliary facilities and equipment. Its work covers civil, chemical, electrical, mechanical, and metallurgical engineering in nearly all branches.

VOLUME 26 **MACHINERY** NUMBER 12

AUGUST, 1920

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The Editor's Talk With MACHINERY'S Readers

SOME years ago one of the well known pioneers in the ball bearing business made an estimate of the number of steel balls used in bearings. His figures added up close to a billion steel balls a year. Since that time the industries employing ball bearings have developed to an extent undreamed of ten years ago. The automobiles and motor trucks of today alone use more steel balls for their bearings than the total number used in all the industries of a decade ago.

THE ball bearing is one of the fundamental parts in modern mechanisms, which owe much of their immensely improved efficiency to these bearings. With great capacity, practically no friction, and almost unlimited wearing qualities a properly mounted and properly cared-for ball bearing represents a really great advance in mechanical practice.

GREAT industries have been developed to produce ball bearings alone, and the methods and machinery employed have been developed along specialized lines to which some of the best mechanical genius of the country has been applied. Some of these methods are described in the article on Manufacturing Three-area Contact Ball Bearings in this number of MACHINERY. In addition to the interest readers will have in the processes and machines described, the bearing itself, capable of taking a large percentage of thrust, will prove of interest to mechanical men.

IN April 1917 the United States found itself with scores of enemy-owned ocean liners on its hands, the machinery of which had been damaged in an effort to render the vessels useless for an estimated period of at least eighteen months. Without these vessels, it would have been practically impossible for the United States to transport troops to France at a sufficiently rapid rate to turn the great stalemate into an overwhelming victory. Nevertheless, five months later most of these vessels were ready for service on the high seas, their engines humming and their propellers functioning as well as ever —some of them, it is said, even better than ever. A mechanical miracle had been performed. It is of the greatest interest to note that this engineering achievement would have been impossible fifteen years earlier. But for the development of the very recent arts of electric and oxy-acetylene welding, the broken cylinders of the former German liners could not have been repaired. The engines would have had to be entirely rebuilt, and as for their service during the war, it would have been better if these vessels had not existed. The electric arc and the oxy-acetylene flame manipulated by skilled workers restored the power of the mighty engines of these badly needed ships, and made it possible to place more than two million Americans on French soil within a year.

ELECTRIC arc welding requires skill, and to acquire this skill, training is necessary. This was recognized in the early part of the war by the General Electric Co., and a training school for electric welders was established at the Schenectady plant. When peace came, this school was reorganized for peaceful purposes, and having demonstrated its value, was enlarged and amplified. In this number of MACHINERY an account is given of the methods employed in teaching young men to become proficient arc welders. This is a new, skilled trade, unknown, as a trade at least, ten years ago. It is another step forward in the application of engineering science, and shows how the laboratory methods of the scientific investigator of a decade or two ago become the practical servants of mankind a generation later.

IT is a universal trait of mankind to endeavor to explain and label everything. One label, and a good one, is: "The Horseless Age." At first the horse was driven from city streets and country highways, as far as passenger traffic was concerned, and became altogether a "truck horse," as the saying is. Later, he began to disappear from trucking service, so that today, more loads are doubtless moved by motors than by horses. But on the farms the horse appeared to be indispensable. Even here, however, a great change is taking place. The farm tractor is supplanting the team of horses, and is doing their work quicker, better and cheaper. It is estimated that 200,000 tractors are being built in the United States this year. As these machines become more and more reliable and farmers learn how to handle them, their number will increase.

THE article "Special Machines in a Tractor Shop," in this number of MACHINERY gives a definite idea of this highly specialized new industry, and indicates how it is destined to develop along lines paralleling the amazing progress of the automobile industry.

The Machine Tool Industry

THE greatest difficulties in the industrial field at the present time are caused by the scarcity of coal and coke and the troubles experienced with the railroad freight service. As the scarcity of fuel is directly due to the transportation difficulty, the inability of the railroads to cope with the demands of the industries is really at the bottom of the most serious problems now facing the country in the manufacturing fields.

IN the machine tool industry there has been a marked falling off of orders, although all the machine tool builders are still busy. Present orders are not for as large numbers of machines as during the past nine months, but there are a great many small orders for one or a few machines each. The railroads are continuing to buy machine tools, and have placed fair-sized orders during the past month. It is expected that there will be an increase in orders just as soon as machine tool builders are able to quote on earlier deliveries, but buyers seem to be reluctant to place orders for tools so many months ahead as was necessary during the first half of the year.

THE foreign trade in machine tools and other metal-working machinery fell off considerably during the first months of the year, due almost entirely to the adverse influence of the foreign exchange. During the past month there has been a fair amount of foreign business, and the complete statistics of the Department of Commerce for the month of May, which have just been published, indicate that there was a slight improvement in that month in the export trade of machine tools as compared with the month of April. During the month of May, machine tools to a value of about $2,425,000 were exported, as compared with $2,100,000 during the month of April. There was also a decided improvement in the exports of metal-working machinery other than machine tools. The exports in this class of machinery were represented by less than $1,500,000 in April, as compared with over $1,900,000 in May. The total metal-working machinery exports for the month of May amounted to nearly $4,350,000, which is considerably above the exports during any of the preceding months of the year.

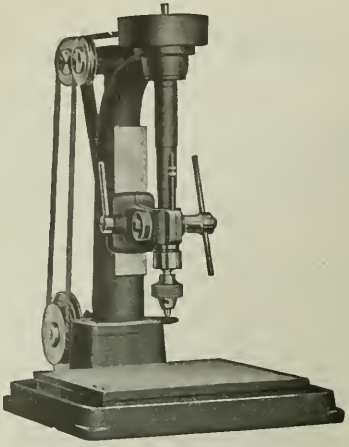
ENGLAND still represents our largest customer for machine tools, the exports of machine tools to that country in May being valued at over $750,000, while the exports of other metal-working machinery to England were valued at nearly $575,000. France imported nearly $375,000 worth of machine tools and $234,000 worth of other metal-working machinery. China imported $27,000 worth of lathes, and nearly $9000 worth of other machine tools, which is significant.

THE Department of Commerce has officially announced the resumption of trade with Russia; but it is not likely that there will be any trade in machine tools of any importance with Russia until that country has settled down to more normal conditions.

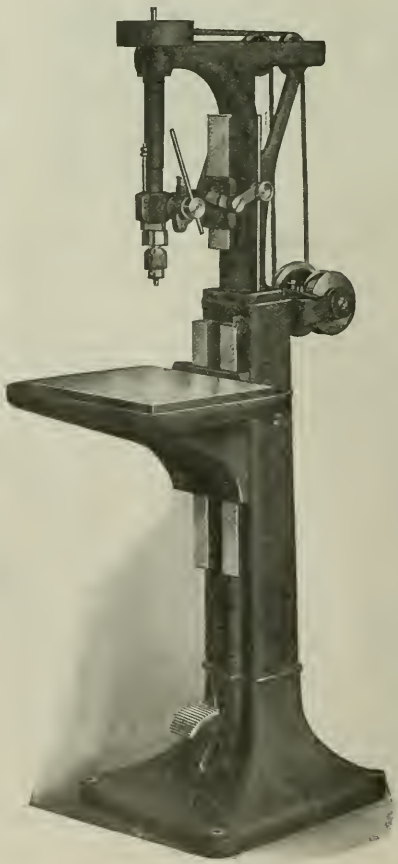
THE labor situation has improved somewhat recently. In many of the leading industries manufacturers have found it advisable to reduce their force on account of the smaller volume of business. This condition has indicated to the workers that the industries cannot indefinitely maintain high wages, often coupled with curtailed output on the part of the worker, and it has been reported in several instances that the more intelligent among the men in the shops have come to understand the necessity for maintaining output in order to prevent prices from mounting still higher and the industrial prosperity of the last few years from coming to an end.

EXPORTS OF METAL-WORKING MACHINERY FROM THE UNITED STATES, MAY, 1920

Countries	Lathes, Dollars	Sharpening and Grinding Machines, Dollars	Other Machine Tools, Dollars	All Other Metal-Working Machinery, Dollars
Belgium	29,148	14,732	67,689	96,452
Czechoslovakia	.....	1,678	.....	.....
Denmark	5,147	9,317	7,914	.....
Finland	.....	.....	1,998	.....
France	75,499	68,917	230,167	234,423
Germany	.....	790	6,890	6,542
Greece	725	.....	3,942	1,412
Iceland and Faroe Islands	.....	52	.....	.....
Italy	24,685	8,604	107,397	168,470
Netherlands	5,702	1,230	1,875	2,243
Norway	.....	860	2,466	9,823
Poland and Danzig	.....	1,500	.....	.....
Portugal	3,403	37	3,190	.....
Roumania	4,733	825	2,348	8,015
Spain	59,940	4,158	18,807	30,279
Sweden	13,941	10,682	15,028	3,647
Switzerland	198	.....	13,456	11,002
Turkey in Europe	.....	.....	651	.....
England	240,812	67,202	445,605	574,513
Scotland	.....	444	10,613	3,640
Ireland	.....	733	2,803	13,976
Bermuda	.....	250	314	.....
Canada	90,665	26,943	140,893	207,941
Costa Rica	.....	444	3,251	.....
Guatemala	.....	.....	116	.....
Honduras	.....	.....	638	.....
Nicaragua	.....	.....	484	.....
Panama	300	15	174	6,175
Salvador	.....	22	.....	.....
Mexico	18,179	3,339	7,665	15,863
Miquelon, Langley, etc	1,050	.....	.....	.....
Newfoundland and Labrador	2,550	.....	.....	170
Barbados	.....	.....	7	.....
Jamaica	56	105	.....	.....
Trinidad and Tobago	112	.....	378	.....
Other British West Indies	106	.....	45	.....
Cuba	24,656	3,519	24,068	24,497
Dutch West Indies	.....	.....	.....	100	.....
French West Indies	.....	.....	.....	85	.....
Haiti	.....	.....	307	.....	.....
Dominican Republic	2,250	360	281	1,454
Argentina	13,140	706	8,848	15,161
Bolivia	650	500	171	1,440
Brazil	12,763	1,944	20,473	3,115
Chile	519	172	3,377	1,171
Colombia	4,631	228	7,590	2,213
Ecuador	935	.....	51	.....
British Guiana	.....	.....	312	.....
Paraguay	.....	.....	358	.....
Peru	6,027	2,592	7,019	5,838
Uruguay	1,700	26	1,098	.....
Venezuela	2,324	330	606	466
China	27,052	2,700	6,202	35,722
Kwantung	.....	1,255	.....	4,000
British India	46,106	1,237	23,386	104,788
Straits Settlements	.....	103	490	2,104
Other British East Indies	.....	22	.....	.....
Dutch East Indies	2,241	4,657	1,159	4,279
Hongkong	.....	595	572	.....
Japan	61,518	15,690	66,182	271,640
Turkey in Asia	3,300	.....	150	.....
Australia	5,517	10,658	30,217	10,896
New Zealand	6,212	1,036	3,924	1,093
French Oceania	.....	.....	.....	965
Philippine Islands	9,522	1,565	2,955	21,104
Belgian Kongo	4,944	.....	.....	.....
British West Africa	30	.....	.....	.....
British South Africa	5,159	1,818	11,088	9,451
British East Africa	.....	.....	566	.....
French Africa	787	.....	.....	.....
Portuguese Africa	3,650	108	348	1,867
Egypt	850	1,050	.....	1,571
Total	829,434	276,057	1,318,478	1,919,421



Bulletin No. 502 gives details



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BECAUSE they have the speed, sensitiveness and rigidity necessary for the fast drilling and handling of small parts, and

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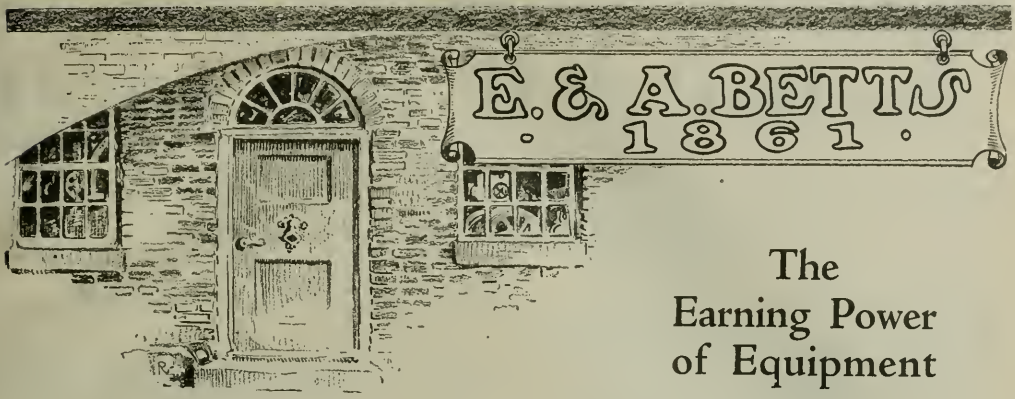
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Heavy Duty Geared Head Engine Lathe

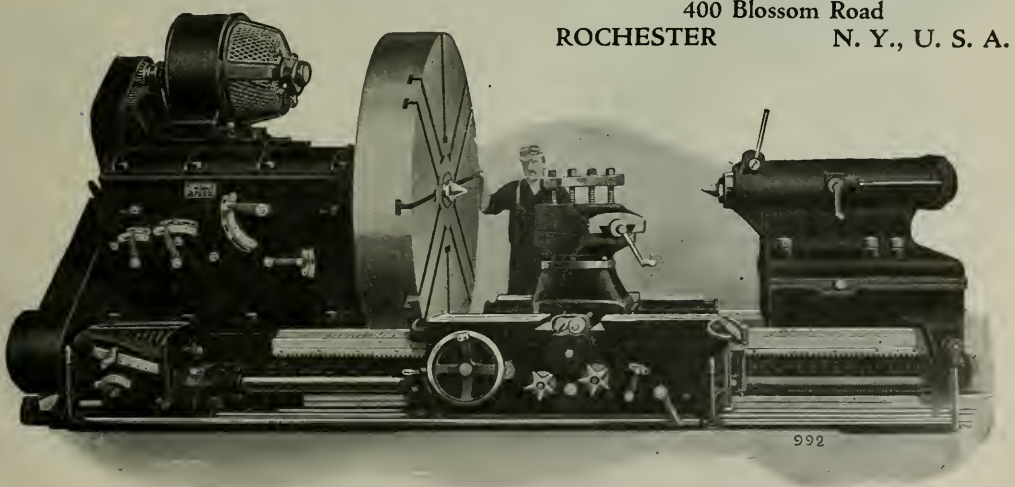
The value of the work done on machine tools is infinitely greater than that of the tools themselves.

The cost of such tools is negligible, therefore, compared to their ability to accomplish.

The record of satisfactory accomplishment for Betts-Bridgeford Heavy Duty Machine Tools covers a period of some sixty years. Since the year 1861 they have demonstrated their remarkable earning power in many widely varying industries in all parts of the world.

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N-B-P RIGHT LINE

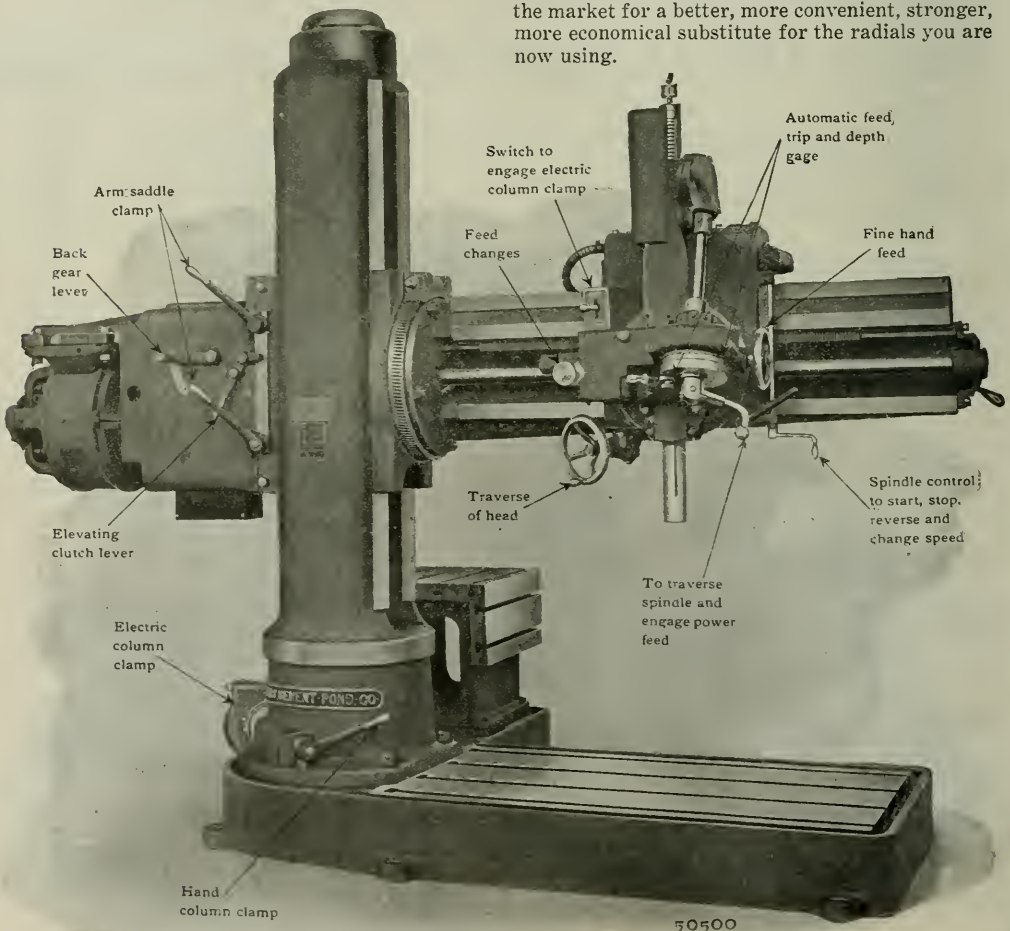
A Radical Advance in Drill Design

SOMEONE recently asked us why we called this new drill of ours the *RIGHT LINE* Radial. There are two very good reasons for this name, and a slight examination of the drill will suffice to make them clear.

The machine, first of all, is correct, that is *right*, in design—its proportions please the eye, they bespeak strength and stamina in every part; it is *right* in construction; it is *right* in the simplicity, ease, convenience and safety of its operation controls.

Again, a *right line* being the shortest distance between two points, this word most clearly describes the distinguishing feature of this drill, the direct drive from motor to spindle made possible by the double column construction.

Hence *RIGHT LINE* Radial Drill—remember the name and its meaning the next time you are in the market for a better, more convenient, stronger, more economical substitute for the radials you are now using.



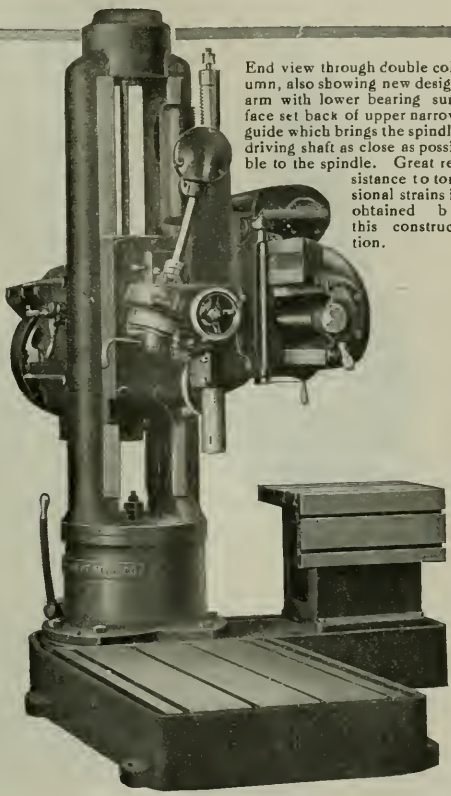
MOTOR DRIVEN RADIAL DRILLS

With Direct Drive Through the Column From Motor to Spindle

BY using a double column, by mounting the motor at the end of saddle arm and driving through column, the simplest, most direct drive from motor to spindle is obtained. Two-thirds of the usual driving gears and countershafting are eliminated, and a saving of 25 percent of the power ordinarily lost in friction is accomplished. *The drive diagrams below tell the story.*

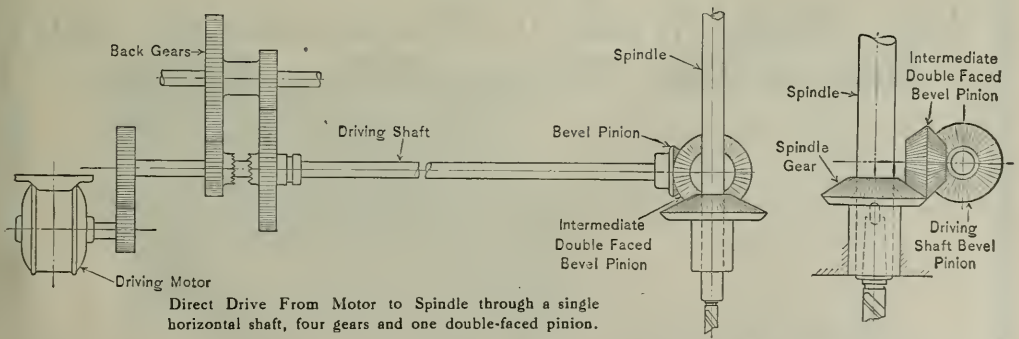
The entire column rotates on ball bearings and swings with the arm, an unusual idea that is the secret of the remarkable rigidity of this drill. Bending stresses in the column are *always* in the direction of its greatest strength.

Simplicity is the keynote of the control equipment. Note the detailed photograph opposite. From his position at the drillhead, the operator can control all movements. One convenient lever starts, stops and reverses or varies the speed of spindle, another traverses spindle and engages power feed. Fine hand feed, traverse of head, the feed change dial, the automatic feed trip and depth gauge are all within arm's reach, as is also the switch operating the electric column clamps.



End view through double column, also showing new design arm with lower bearing surface set back of upper narrow guide which brings the spindle driving shaft as close as possible to the spindle. Great resistance to torsional strains is obtained by this construction.

The new N-B-P RIGHT LINE Radial Drill is described in detail in our catalogue just off the press. Your copy is waiting.

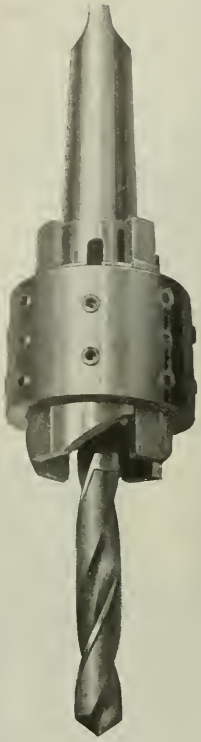


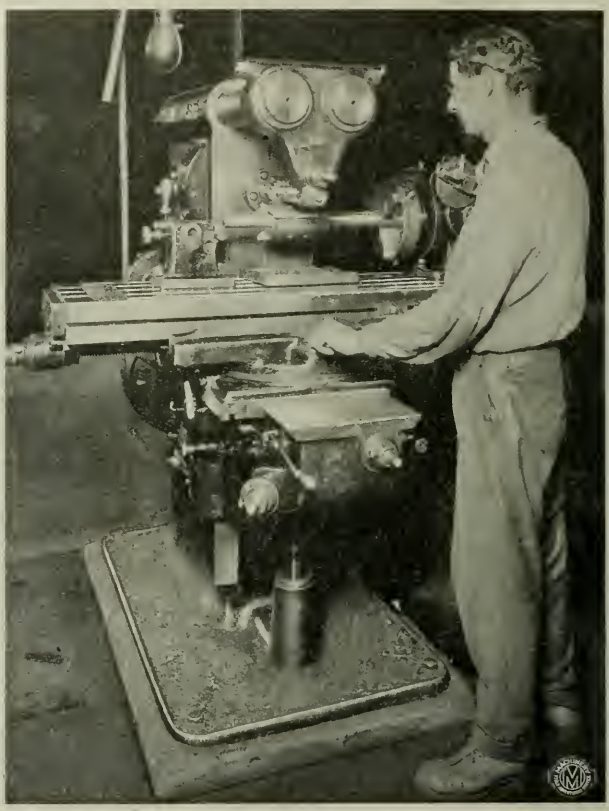
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LOS ANGELES
LONDON

Milwaukee Milling Machines





Tool Room Work or Manufacturing—All One to This Efficient Milling Machine

This Milwaukee Milling Machine was chosen for general use—and *that* in this shop includes everything from fine tool work to roughing cuts on the heaviest castings within the capacity of the machine.

The illustration shows a highly accurate tool-making operation—the manufacture of a special cutter on which all milling work is done on this machine, which is seen taking a cut 1″ wide and 7′ 16″ deep at one stroke.

The double overarm, flanged spindle, solid top, box section knee and generally rigid and accurate construction of these machines insure long and satisfactory service with minimum repairs. For instance, the Milwaukee Milling Machine shown here has been in constant use for over three years with *no repairs*.

Our Catalog describes these machines in detail. Send for it.

KEARNEY & TRECKER CO. MILWAUKEE., WIS., U.S.A.

NEW YORK OFFICE: 1801 Singer Bldg.
CLEVELAND OFFICE: 738 Superior Ave., N. W.
CHICAGO OFFICE: 631 Washington Blvd.

THE OTHER DAY—

an apron from a lathe built by us over 21 years ago was sent in to be overhauled.

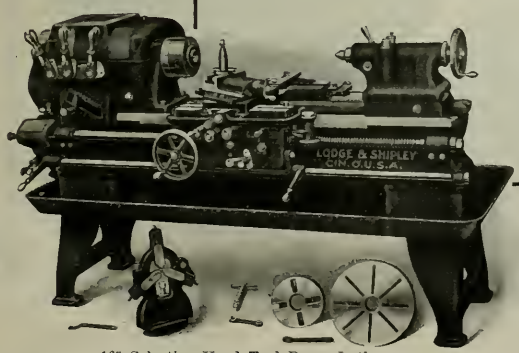
Not that this is really anything out of the ordinary but this particular order serves exactly as an example of the durability and stamina which is built into every LODGE & SHIPLEY Lathe.

The owner states he is more than satisfied with the lathe and the only wear shown is in the apron, which is to be expected.

How many lathes are in good condition after having been run twenty years? The life of a majority is only half that time, yet here is one which the owner is confident will render years of additional service with only the apron being overhauled. *What recommendation could be more convincing?*

If you are considering the purchase of a good lathe, one that is a real investment and which you can rest assured will give satisfaction for many years to come, we invite your further investigation of

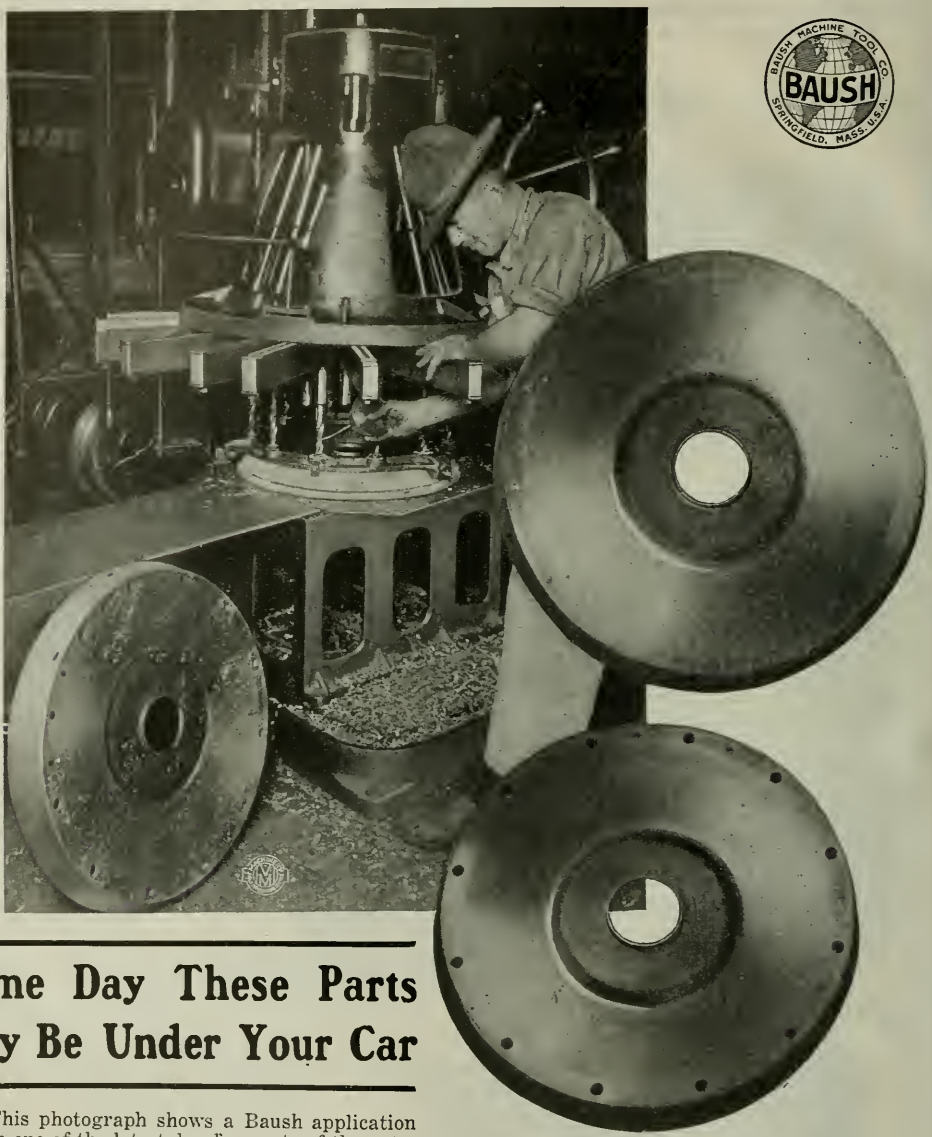
LODGE & SHIPLEY



16" Selective Head Tool Room Lathe.
EQUIPMENT INCLUDES
Draw-in Chuck Without Collets.
Pan. Taper Attachment.
Manufactured in sizes 14" to 20".

Engine Lathes
Manufacturing Lathes
Tool Room Lathes

THE LODGE & SHIPLEY MACHINE TOOL CO.
CINCINNATI OHIO



Some Day These Parts May Be Under Your Car

This photograph shows a Baush application in one of the latest developments of the automobile field—the Disteel wheel. Twelve $\frac{3}{4}$" holes are drilled through $\frac{3}{16}$" steel in this particular wheel; twenty wheels being turned out per hour.

Baush Multiple Spindle Drills are used for other operations in the construction of Disteel wheels, such as drilling for rivets, etc. The growing popularity of these wheels has taxed the factory to the utmost, and the wonderful production possibilities of the Baush Drill are greatly appreciated.

BAUSH

Multiple Spindle Drills

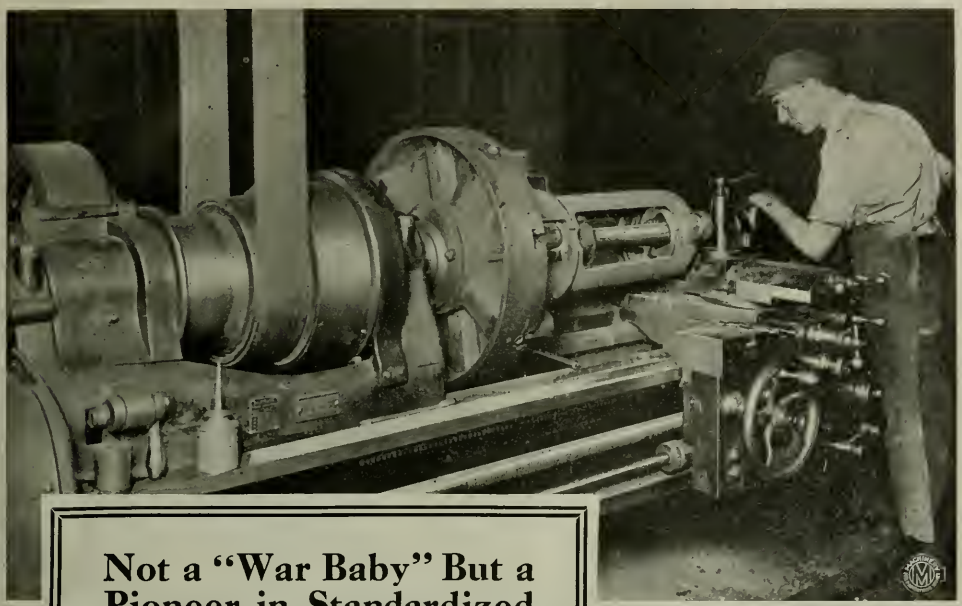
Let us send you full particulars

BAUSH MACHINE TOOL CO. *Detroit Office 1825 Dime Savings Bank Bldg.* **SPRINGFIELD, MASS., U. S. A.**

Manufacturers of Multiple Spindle, Horizontal and Radial Drills

Domestic Representatives:
Manning, Maxwell & Moore, Inc. Motch & Merryweather Mch'y. Co.

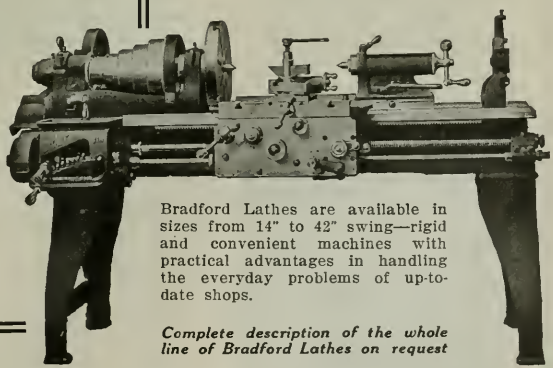
Foreign Representatives:
Alfred Herbert, Ltd., Coventry, England. Fenwick Freres & Co., Paris, France



Not a "War Baby" But a Pioneer in Standardized Lathes

Bradford, the super-production lathe, is not a by-product of the World War, not a "War Baby," but a tried and true pioneer in standardized lathe manufacture. There are no half-baked theories in Bradford's sturdy construction, no untried ideas—just a practical and proven design that has stood up year in and year out and rendered the best of service to users in all parts of the country.

The accompanying photograph shows one of the two 24″ Bradford Lathes installed at the Dayton Pump & Manufacturing Company. The operation is boring, turning and facing the end of a cast-iron gasoline pump body. It is interesting to note that the casting is chucked by its base, and the outer end is 28″ from the chuck and entirely unsupported.

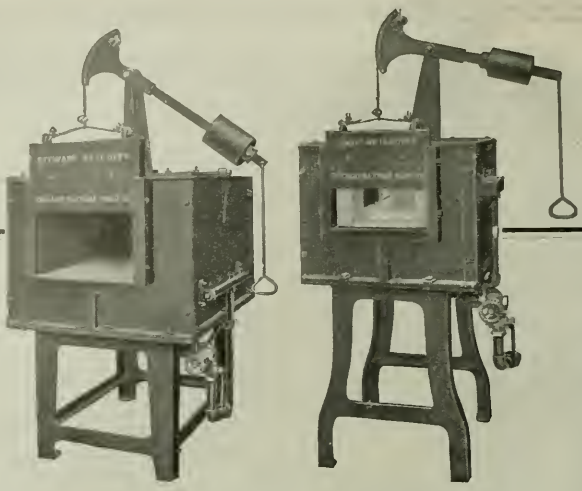


Bradford Lathes are available in sizes from 14" to 42" swing—rigid and convenient machines with practical advantages in handling the everyday problems of up-to-date shops.

Complete description of the whole line of Bradford Lathes on request

BRADFORD MACHINE TOOL CO., CINCINNATI OHIO, U.S.A.

AGENTS: Swind Machinery Co., Philadelphia. Taylor Machinery Co., Boston, Mass. Stocker-Rumely-Wachs Co., Chicago, Ill. Somers, Fitler & Todd Co., Pittsburgh, Pa. The E. A. Kinsey Co., Cincinnati, O., and Indianapolis, Ind. The Mine & Smelter Supply Co., Denver, Colorado. Pacific Tool & Supply Co., San Francisco, Cal. Ogden R. Adams, Rochester, New York. Ralph B. Bowman, St. Louis, Mo. W. J. Baird Mchy. Co., Detroit, Mich. McMullen Mchy. Co., Grand Rapids, Mich. Patterson, Gottfried & Huoter, Inc., New York City. The Biggs-Watterson Co., Cleveland, O. Northern Machinery Co., Minneapolis and Duluth, Minn.



STEWART No. 11 OVEN FURNACE

For Annealing, Carbonizing, Hardening Carbon Steel, Heat-treating, Pre-heating or Re-heating.

Specifications

Opening, 12" x 20".
Depth, 36".
Floor space, 42" x 54".
Gas and air connections, 1½".
Shipping weight, 3,500 lbs.
For gas or oil fuel.

STEWART No. 14-H OVEN FURNACE
For High Speed Steel

Burners on left side enter underneath bottom slab same as in regular oven, but opposite burners enter in heating space, making equipment under and over fed.

Specifications

Opening, 6" x 10"; depth, 13".
Floor space, 36" x 36".
Gas and air connections, 1¼".
Shipping weight, 1450 lbs.
For gas fuel only.
Four other stock sizes.

"Sure! Heat to 1400 and Quench It"

John, the foreman, told Harry that just yesterday, and that gear still comes out soft and warped. Says John: "Bum lot of steel, I guess. Better get a new brand—send to Marks and get some of Blank's steel, and we'll try it. It's more expensive, but we've got to get those machines off the floor this week."

Ever hear this before? It happens daily in many a shop, and is an expensive process for some one—experimenting usually is. And with it go all the profits.

Have Catalog No. 75 for Ready Reference

80 large pages, attractively illustrated, thoroughly describing Stewart Furnaces. Forges and Heat-treating Equipment. Valuable heat-treating information. You should have this catalog convenient for reference.



Our Service May Help Your Difficulties

In the manufacture of Stewart Furnaces the Chicago Flexible Shaft Company has a staff of trained metallurgists who are at your service on any job you may have trouble with.

"Something is radically wrong with the steel" is "bum logic"—it's generally the heat-treating process that's at fault.

Don't be backward about telling us your troubles. Our metallurgists are no wizards, but their special training is worth money to you—avail yourself of it.

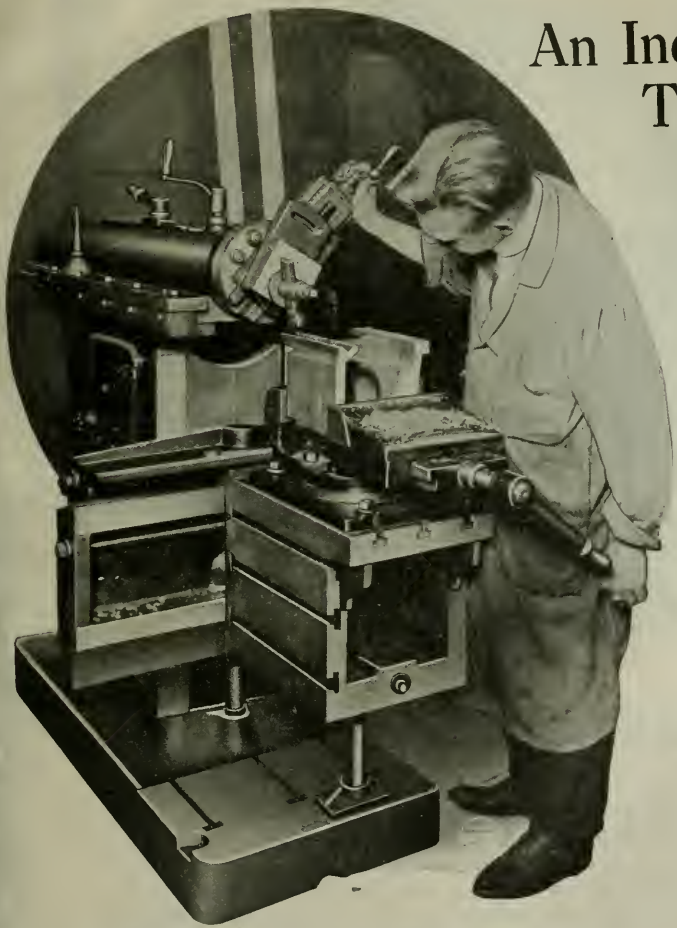
There's a Stewart Furnace for every heat-treating requirement

CHICAGO FLEXIBLE SHAFT COMPANY

1154 S. Central Avenue, Chicago

350 Broadway, New York **Railway Exchange Bldg., St. Louis**

OHIO SHAPERS



An Indispensable Tool for the Contract Shop

You can't set up a contract shop and do a successful business unless you are equipped to handle more difficult work, do speedier work and make a better job of it than the men you are doing the work for.

The accompanying photograph taken in the shops of the Springfield Tool Co., Springfield, Mass., shows an Ohio Shaper on the job in a place which makes more than ordinary demands on equipment.

Heavy and intricate parts on which close limits must be maintained, pass in succession through their machining operations on the "Ohio."

Ohio Shapers are made in sizes ranging from 14″ to 28″ — Standard and Heavy Duty Types. They will handle a wide range of work.

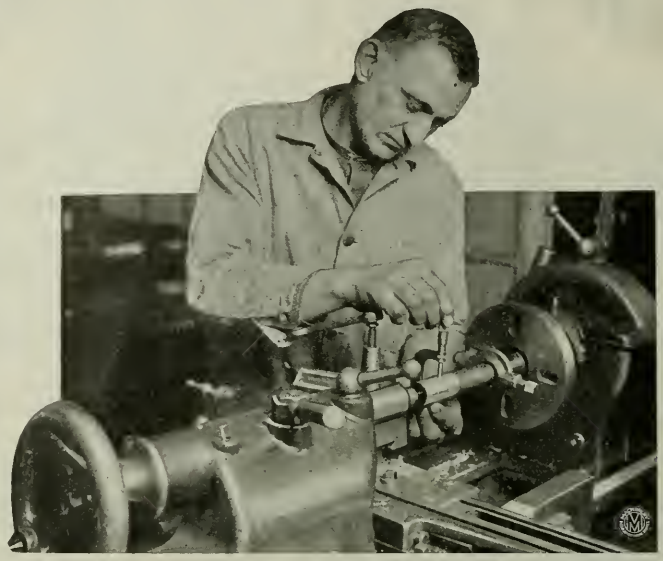
We'll be glad to know your shaper problems, and to cooperate with you in their solution. Give us the opportunity.

OHIO MACHINE TOOL CO.

Planers and Shapers Since 1887

KENTON **OHIO, U. S. A.**

DISTRIBUTING AGENTS: Pittsburgh, Laughlin & Barney Mchy. Company; Cleveland, W. M. Pattison Supply Company; Chicago, Dale-Brewster Mchy. Co.; Toledo, Coghlin Machinery and Supply Company, Providence, Brownell Mchy. Company; Hartford, Purinton & Smith Mchy. Company; Syracuse, H. A. Smith Company; Grand Rapids, McMullen Machinery Company; Detroit, English & Miller Company; St. Louis, Colcord-Wright Machinery and Supply Company; Indianapolis, Vonnegut Machinery Company; Boston, Factory and Mill Supply Company; San Francisco, General Machinery & Supply Co.; New Orleans, P. H. McArdle; Portland, Ore., Pacific Engineering and Equipment Company; Los Angeles, Shaw-Palmer-Bakewell Company; Omaha, Sunderland Machinery & Supply Company; Salt Lake City, American Machinery Company; Milwaukee, Badger-Packard Mchy. Co. (Planers); Seattle, Wash., Westcoast Mchy. Co.; Newark, N. J., Morris Mchy. Co.; New York City, Machine Tool Engineering Co.; Milwaukee, Wis., W. L. Romaine Mchy. Co. (Shapers.)



The Davis
Close Coupled Lathe

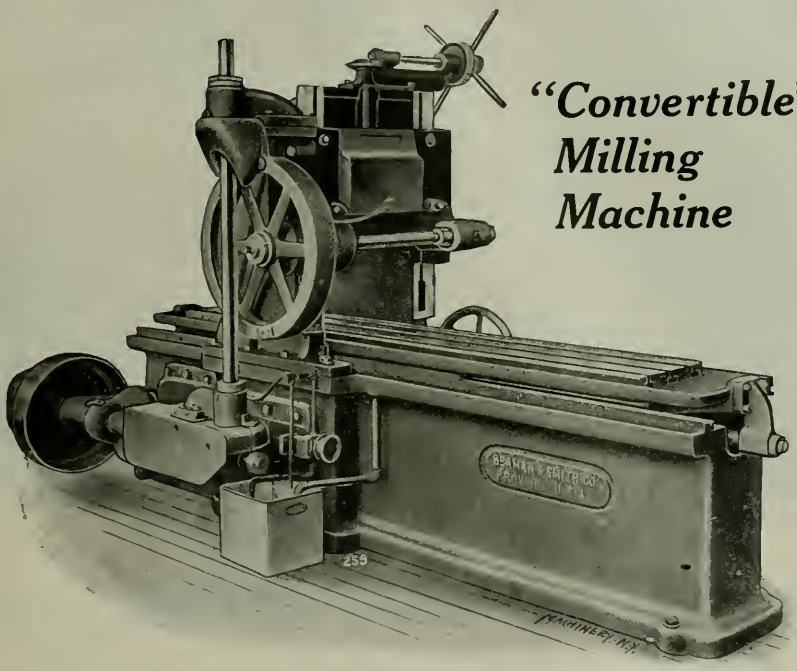
ACCURACY

"Accuracy" describes the Davis Close-Coupled Lathe in one word. A year ago the Metallic Gasket Company of New Brunswick, N. J., purchased a "Davis." After the machine had been in operation for some time, they found it so accurate they reserved it for the very best work only. Ordinary work now goes to other lathes. The coarsest operation on this lathe is to a tolerance of plus or minus .002".

It will pay you to get full details. Write us to-day.

DAVIS MACHINE TOOL COMPANY, Inc.
ROCHESTER NEW YORK, U. S. A.

BEAMAN & SMITH



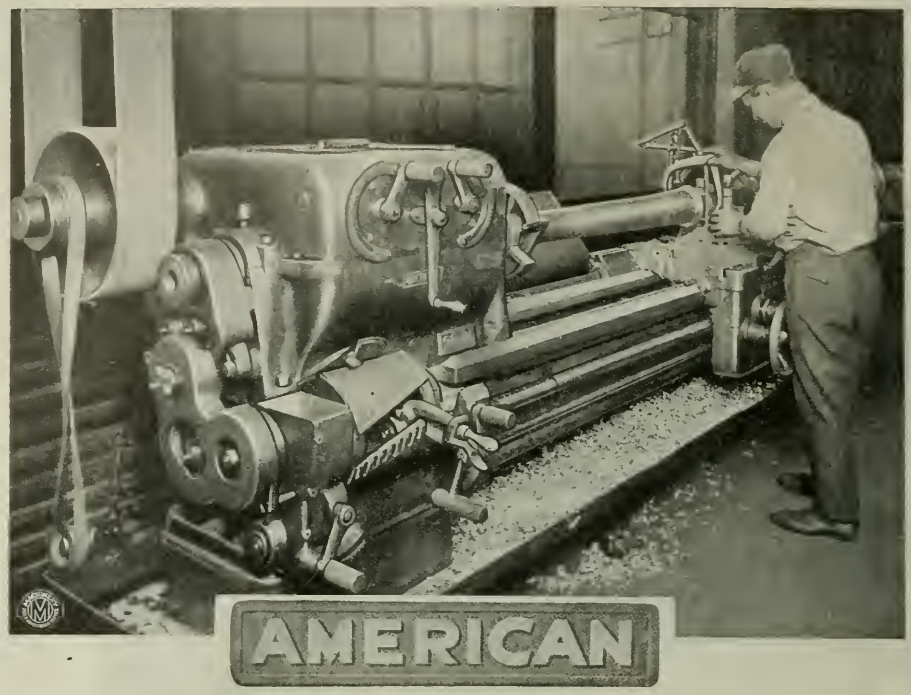
"Convertible" Milling Machine

THIS No. 1 B & S is classified as a horizontal spindle milling machine. An extra attachment can be furnished, however, which turns it into an efficient vertical miller. The horizontal spindle has horizontal adjustment and 17" vertical movement. The vertical spindle when in use is carried on the cross-head on which it travels horizontally and has vertical adjustment in the saddle. The machine carries cutters up to 8½" diameter and takes unusually heavy cuts. An adjustable dial graduated to thousandths provides for cutting to any desired depth. Table is 14" wide, 8' long, and has quick power movement of 8' to 15' per minute in either direction and 8½' movement on bed. Nine changes of feed are available, ⅝" to 7½" per minute at any spindle speed. Simple, rigid, high powered, this machine is an accurate, rapid, economical producer.

Investigate B & S machines for anything in boring, milling, drilling, tapping. Cost and production problems our special field.

BEAMAN & SMITH COMPANY

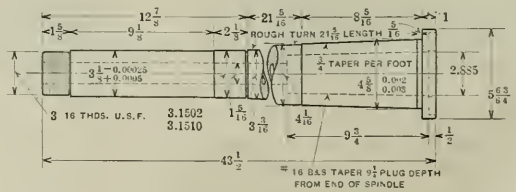
PROVIDENCE **RHODE ISLAND**



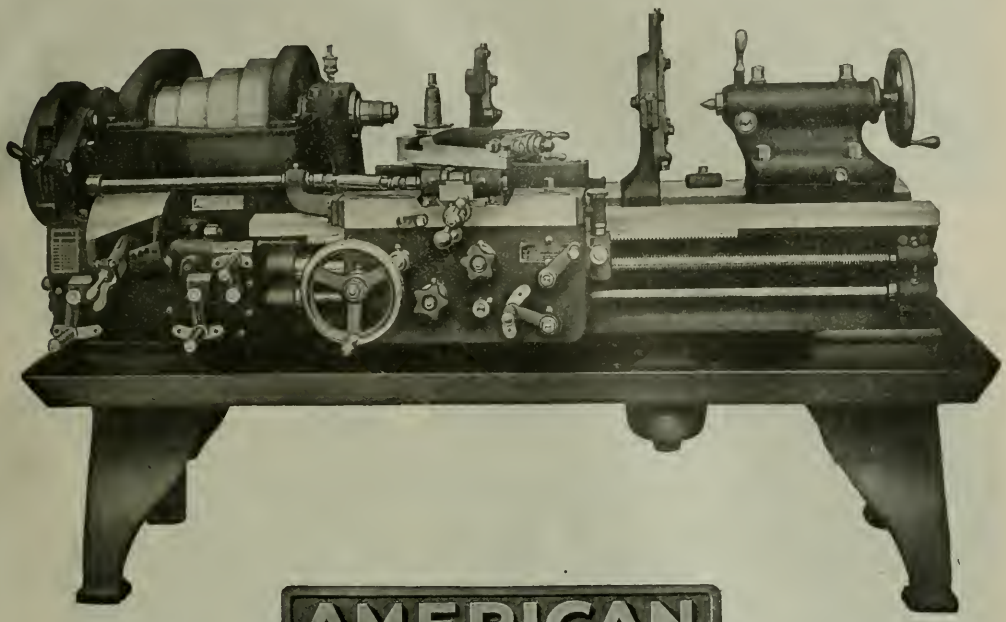
Choice of the Critical

The new Ohio Miller, a highly developed 40" Rotary which the Oesterlein Machine Company of Cincinnati, Ohio, has recently put on the market, is a powerful and highly accurate machine—the culmination of more than 40 years' experience. Only the best equipment is used to machine its many parts, which are made interchangeable and of the best material.

The spindle, for example, is a .40 carbon steel forging, weighing about 200 pounds in the rough, and to the five-year-old American Lathe here shown is assigned the responsibility of turning it ready for finish grinding. The operations, which include turning, tapering, boring, reaming and facing—9 operations in all—are clearly specified on the accompanying sketch. Production is 35 minutes per piece, *including handling time.*



THE AMERICAN TOOL WORKS
LATHES PLANERS



As Good as the Best—and Then Some

American Lathes are always picked for the particular jobs wherever they are installed; and they are installed wherever manufacturers have learned by experience to appreciate the value of "quality" equipment. Heavy duty or toolroom styles—you will find whole batteries of them in the most progressive and up-to-date shops—the ultimate in power, speed, accuracy and operating convenience.

In common with all American Lathes the toolroom machine has patent drop vee bed and double plate apron; all bearings have renewable bronze bushings and every loose running gear is lined with phosphor bronze. Equipment includes Draw-in Collet Chuck, Taper Attachment, Plain or Universal Relieving Attachments, Compound Rest, Pan and Quick Change Feeding and Thread Cutting Mechanisms.

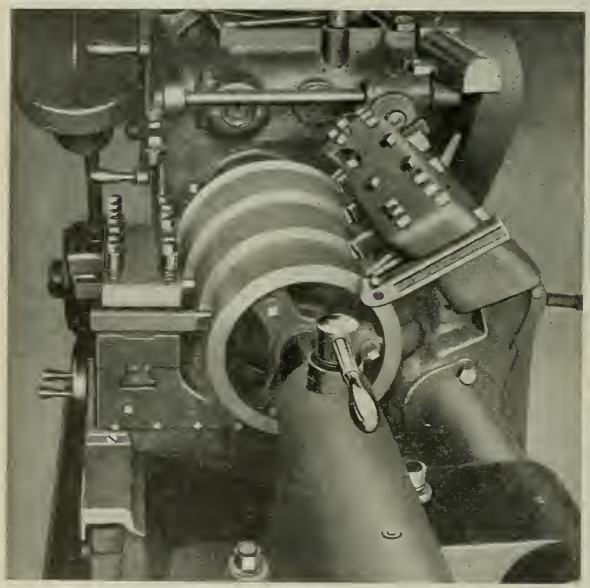
Exclusive advantages of American Toolroom Lathes are all fully described in the catalog which lists the whole line.

COMPANY, Cincinnati, Ohio, U.S.A.

SHAPERS **RADIALS**

FAY AUTOM

You Have the Work



The Pulley shown in the photograph is a 3-Step Flange Pulley being done in the plant of the Fellows Gear Shaper Company, Springfield, Vermont.

The superintendent tells us that this is the most satisfactory machine that he has ever had on this kind of work.

All turning and facing cuts are taken simultaneously. The back arm rocks in as the front carriage moves forward.

Observe the multiple tooling.

The pulley is machined complete in the time it takes to turn one step.

All roughing and finishing cuts are taken simultaneously — two machines, one operator.

All crowned faces are turned by regular mechanism of machine— no special attachments are needed.

Especial attention is called to the size of the work, requiring great pulling power on the part of the machine.

The largest step is 12″ diameter. The widest face is 3⅜″. Production is 6 per hour. This is only one of the many jobs that can be done profitably on the Fay Automatic Lathe.

You have the work, we have the machine. Let's get together

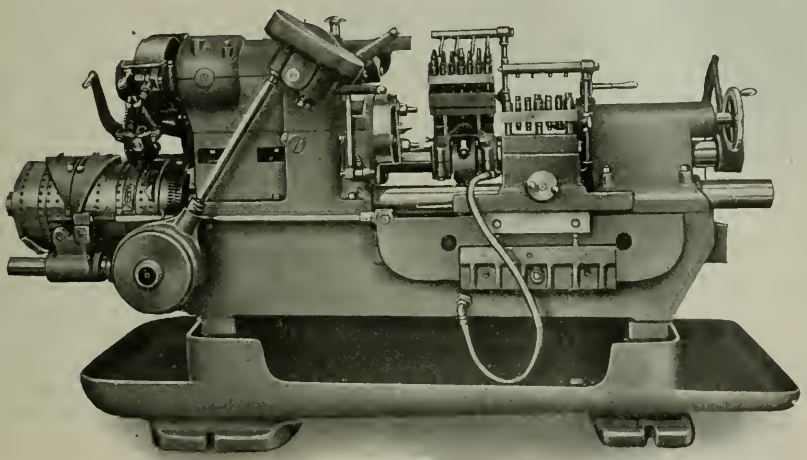
JONES & LAMSON

SPRINGFIELD, VERMONT, U. S. A.

503 Market Street, San Francisco, California. Paris, France: F. Auberty & Company, 91 Rue de Maubeuge.

ATIC LATHE

We Have the Machine



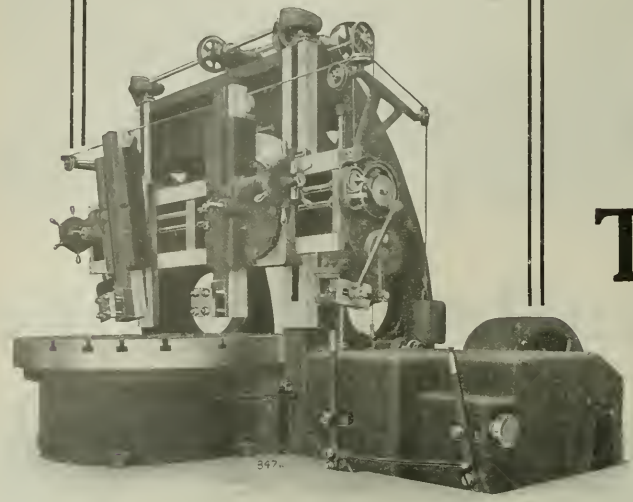
The heavy rigid construction of the Fay Lathe together with the design of multiple tool holders provided for both carriage and back arm, make it possible to use on the work all the tools that the rigidity of the work itself will permit. This is the limit with any form of machine.

Send for our Advanced Practice series. You are bound to find them interesting.

MACHINE COMPANY

9-10 Water Lane, Queen Victoria St., London, E. C.

Japan, Tokyo, Mitsui Bussan Kaisha, Ltd. Holland, Rotterdam, Spliethoff Beeuwkes & Co. Australia, Melbourne, McPherson Pty., Ltd., 554-588 Collins Street

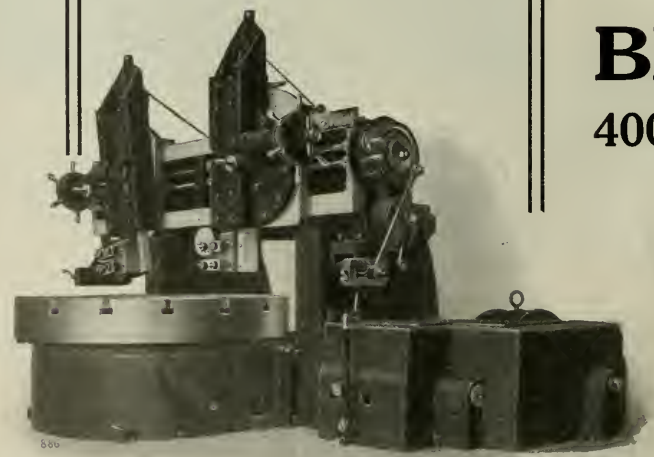


The Measu

Getting out the work; getting it out quickly, accurately, without a hitch or breakdown—these things are all that count today. Unreliable equipment may tie up hundreds, thousands, perhaps millions of dollars. A breakdown in machine tool equipment may delay the operation of an oil well, may tie up a mine, may stop a train, may close a factory.

Betts Heavy Duty Machine Tools have for nearly sixty years been the choice where conditions are unusually severe. They are always efficient, always reliable, invariably dependable — will

Planers
Boring and Turning Mills
Horizontal Boring, Drilling and Milling Machines
Tire Turning Mills
Car Wheel Borers
Slotters, Etc.



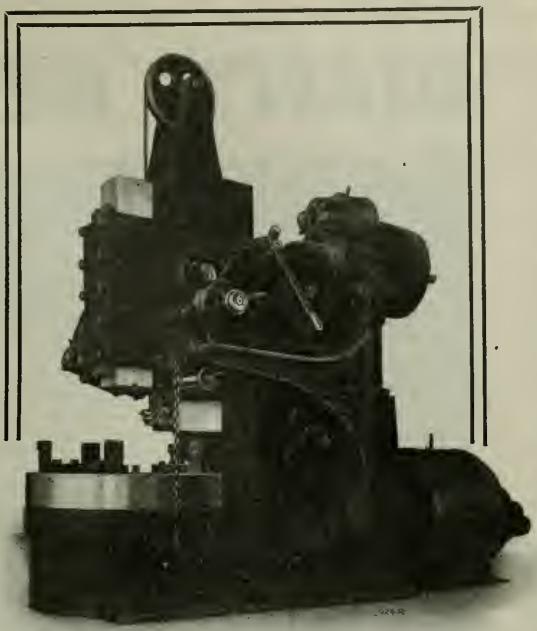
BETTS MA

400 Blossom Road

re of Value

handle with ease the overload of an emergency job. Betts Machine Tools go into remote parts of the country—to mines, wells, irrigation work, hydro-electric power plants. They are selected for this work because a breakdown in machine tool equipment might mean a long wait, a heavy loss.

Many of the best engineers throughout the world specify Betts Machine Tools, for the name "Betts" has come to be accepted as a guaranty of reliable performance under all kinds and conditions of work.



Engine Lathes
Axle Lathes

Journal Truing Lathes

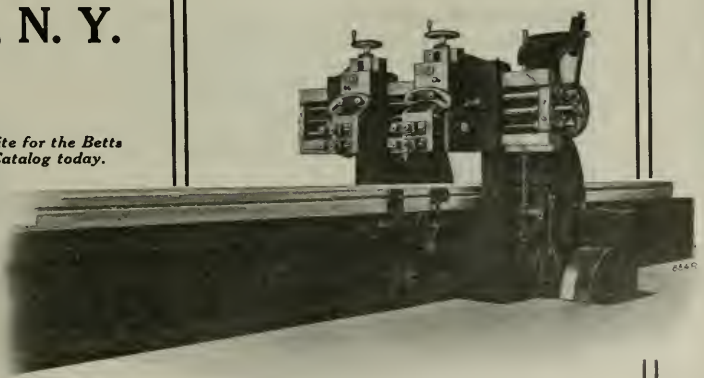
Coach and Driving Wheel Lathes

Oil Country Lathes

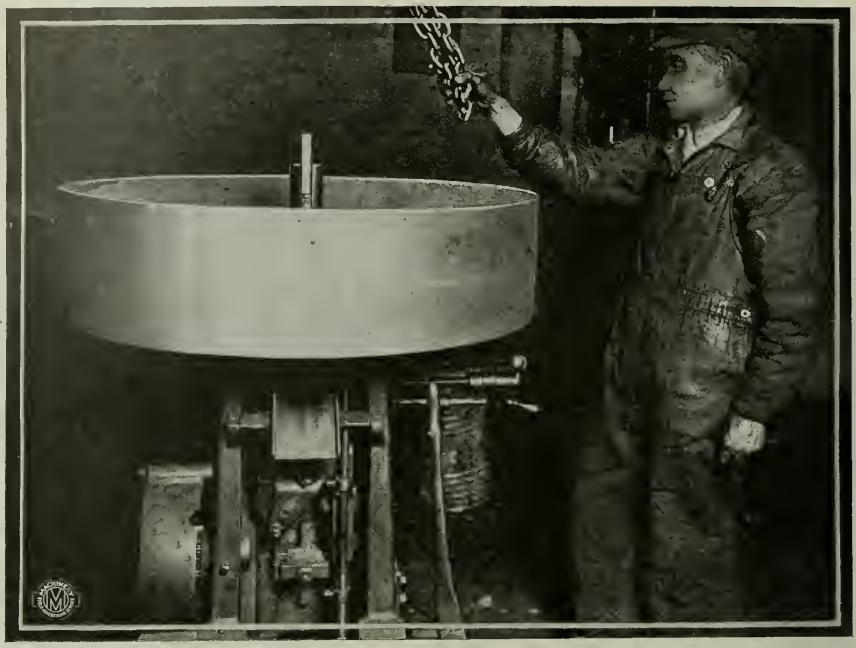
CHINE CO.

Rochester, N. Y.

Write for the Betts Catalog today.



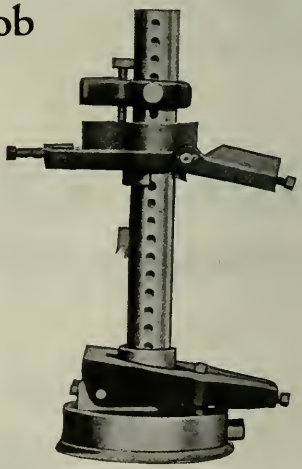
"GIANT" KEYSEATER



Five Minutes Completes This Job

There are not so many places where there's more keyseating to be done than at the great works of the Frick Manufacturing Company, Waynesboro, Pa.; there are few plants where the keyseating is more varied. So, despite the speedy work of **"GIANT"** Keyseaters, every one in the place is kept busy.

"GIANT" Keyseaters play important parts in the building of refrigeration machinery, stationary steam engines, portable engines, steam and kerosene tractors, saw mills, threshing machines, etc. The photograph shows the cutting of a standard keyway ¾" x ⅜", 6" long, through the hub of a cast-iron belt wheel—just a five-minute job for the **"GIANT"**

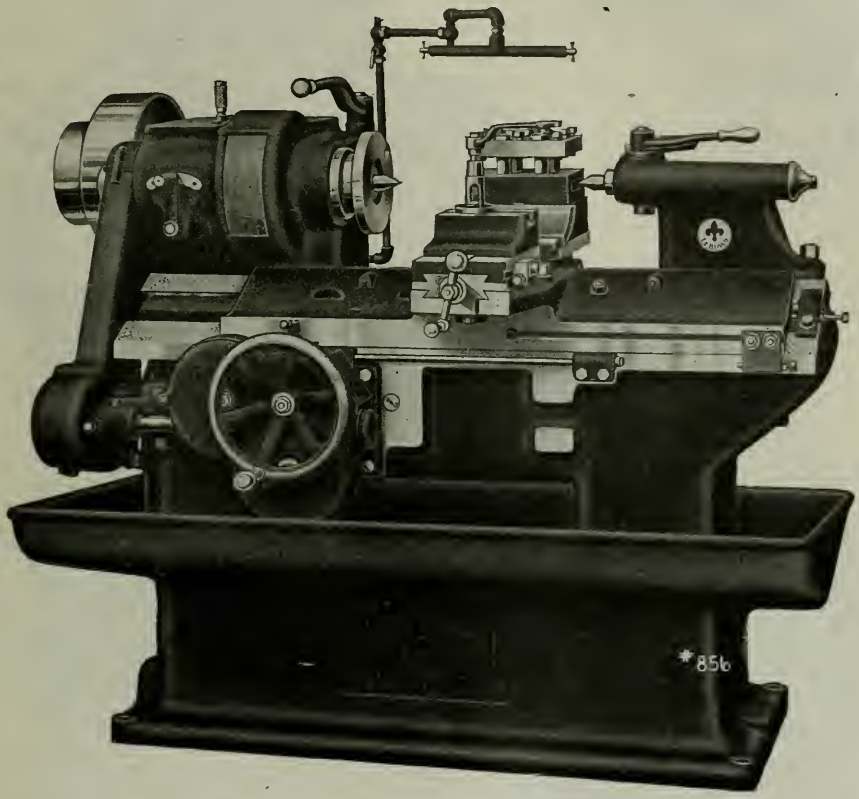


Write for Descriptive Catalog

MITTS & MERRILL, 843 Water Street SAGINAW, MICH.

FOREIGN AGENTS: Burton, Griffiths & Co., London, England. Aux Forges de Vulcain, Lyons and Paris, France. E. Isbecque & Co., Antwerp, Belgium. Nielsen & Winther, Copenhagen, Denmark, Russia, Finland, Siberia, Argentina. V. Lowener, Christiania, Norway and Stockholm, Sweden.

The Multi-Cut Does Not Displace Men It Increases Their Productivity



No. 9 Multi-Cut Lathe — Capacity 9" x 16"

The Multi-Cut releases men for other useful operations and increases the operator's earning power in a direct ratio to the extent that the multiple tool idea is applicable to your job.

The work may be centered, chucked or held on arbors. Flanges, gears, pistons, hubs and transmission shafts, on which as many as 10 tools can be cutting simultaneously, furnish the field for the Multi-Cut.

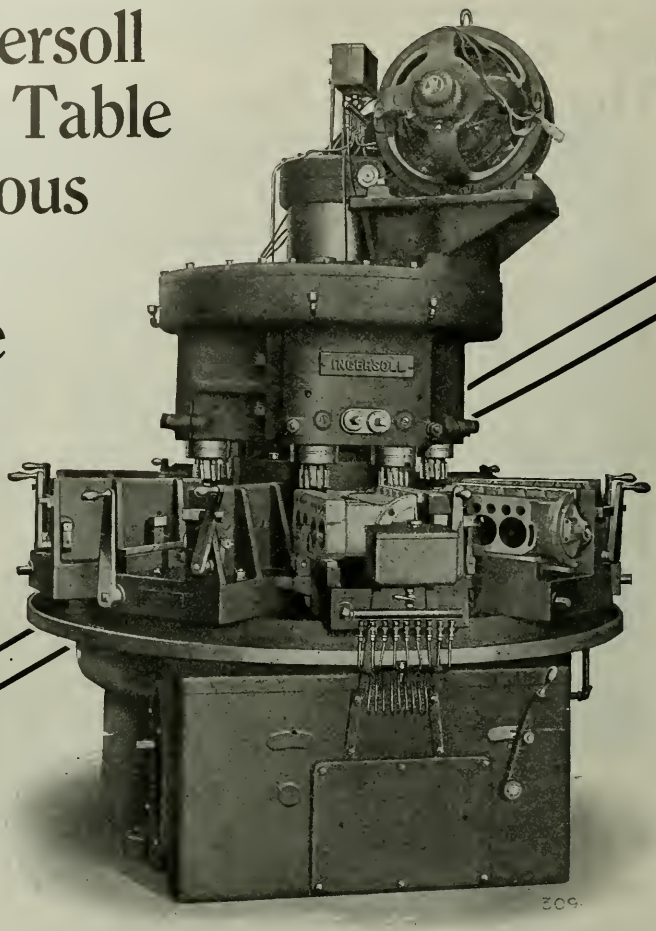
The turning and facing tools complete their work at the same time and trip to close limit of accuracy.

Capitalize the possibilities of Multi-Cutting in your shop.

The R.K.Le Blond Machine Tool Co.

Cincinnati.Ohio.

The Ingersoll Circular Table Continuous Milling Machine



THE Ingersoll Circular Table Continuous Milling Machine is a multiple-spindle, multi-station milling machine on which all the spindles are *continuously* engaged in the work. The number of spindles and stations may be varied to suit the particular work in hand.

In the machine shown above, there are three stations. Each station has two spindles, one for the roughing cutter and the other for the finishing cutter. The table carries nine fixtures, each holding a cylinder casting while the starter pad is milled. The table revolves continuously beneath the spindles. The services of three men are required to unload and reload the fixtures on this tool.

This type of Continuous Milling Machine may also be made for two or four stations, depending on the work to be performed. We would like the opportunity of submitting layout sketches and time estimate of the possibilities your work offers on Ingersoll Milling Machines.

Bulletin No. 37—"Ingersoll Face Milling Cutter Grinder."
Bulletin No. 38—"Ingersoll Milling Cutters."
Bulletin No. 39—"Ingersoll Continuous Milling Machines."

The Ingersoll Milling Machine Co.

Milling Machines and Their Equipment

Main Office and Works:
Rockford, Ill., U. S. A.

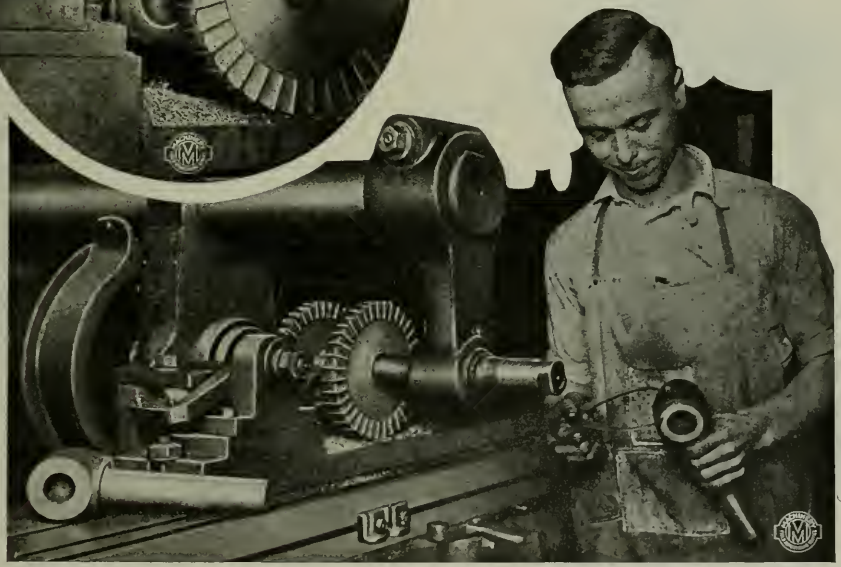
NEW YORK, 50 Church Street
DETROIT, 1457 David Whitney Bldg.
LONDON, Burton, Griffiths & Co., Ltd.
PARIS, Fenwick Freres & Company

KEMPSMITH MILLERS

Used in the Production of La Crosse Tractors



Here we are again—Kempsmith Millers on another nationally known product. This time it's La Crosse tractors. Four Kempsmith Millers are kept busy in this plant; two universal milling machines for precision tool work, etc., two plain milling machines for production. One of the latter is shown straddle milling drop forged steel steering knuckles. About 1/8" is removed from milled surfaces, and production is very good—twenty per hour. Write for the latest Kempsmith catalog.



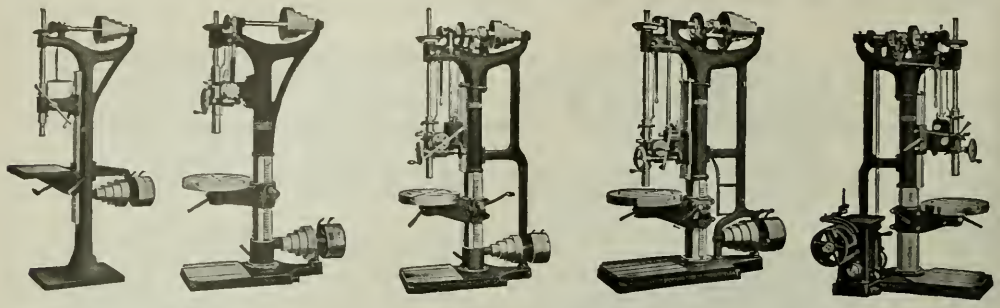
KEMPSMITH MILWAUKEE, U.S.A.

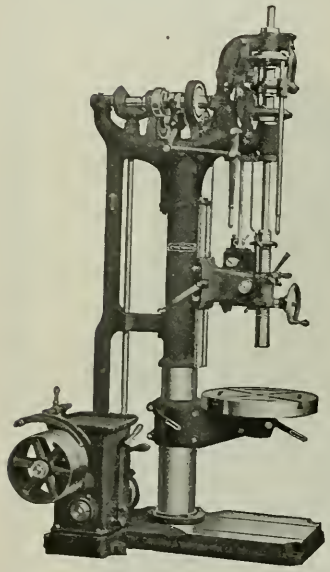
DOMESTIC AGENTS

Biggs Watterson Co., 1235 West 9th St., Cleveland, Ohio. Brownell Machinery Co., 11 Eddy St., Providence, R. I. Cadillac Tool Co., 268 Jefferson Ave., Detroit, Mich. Carolina Supply Co., Greenville, S. C. Eccles & Smith, 46 Front St., Portland, Ore. E. L. Essley Mchy. Co., 555 Washington Blvd., Chicago, Ill., 222 Grand Ave., Milwaukee, Wis. Fairbanks Co., Cor. Light and Lombard St., Baltimore, Md., 325 Colorado Bldg., Washington, D. C., 636 Builders Exchange, Minneapolis, Minn. National Supply Co., Toledo, Ohio. Osborne & Sexton Mchy. Co., Columbus, Ohio. Salt Lake Hardware Co., Salt Lake City, Utah. Smith-Booth-Usher, 228 Central Ave., Los Angeles, Cal. Smith Courtney Co., Richmond, Va. H. A. Smith Mchy. Co., 501 E. Water St., Syracuse, N. Y. Somers, Fitler & Todd, 329 Water St., Pittsburgh, Pa. Homer Strong, 301 State St., Rochester, N. Y., Ellicott Sq. Bldg., Buffalo, N. Y. Taylor Mchy. Co., 78 Batterymarch St., Boston, Mass. Thomson Tool & Supply Co., Odd Fellows Bldg., Indianapolis, Ind. Vandyck Churchill Co., Singer Bldg., Liberty St., New York, N. Y., 734 Widener Bldg., Philadelphia, Pa., 808 First National Bank Bldg., New Haven, Conn. Fred Ward & Son, 171 First St., San Fancisco, Cal. Fulton Supply Co., Atlanta, Ga. The Fairbanks Co., 115 S. 11th St., St. Louis, Mo. P. H. McArdle, 713 Carondelet St., New Orleans, La.

FOREIGN DEALERS

American Trading Co., Tokyo, Japan. Barandiaran & Co., 3-Alameda, San Sebastian, Spain. Bevan & Edwards Pty., Ltd., 117-129 King St., Melbourne, Australia. Edgar Bloxham, 12 Rue du Delta, Paris, France. Geo. F. Foss Mchy. Co., 305 St. James St., Montreal, Canada. General Supply Co., 38 Toronto St., Toronto, Ont., Canada, 356 Sparks St., Ottawa, Ont., Canada. Nielsen & Winther, Blegdamsvej 60 Copenhagen, Denmark. Parke & Lacy Co., 60 Clarence St., Sydney, N. S. W., Australia. Selson Engr. Co. (Italy), Ltd., Corso Vittoria Emanuele, 9 Turin and Piazza Castello, 5 Milan, Italy, 85 Queen Victoria St., London, E. C., England. Societe Anonyme Belge, Alfred Herbert, 35 Rue de Lacken, Brussels, Belgium. Spliethoff Beeuwkes & Co., Leurehaven, W. Z. 159, Rotterdam, Holland.





THE CINCINNATI

A 24- to 42-Inch High Speed Upright Drilling Machine Arranged for Speed Box Drive

One of the many practical styles which adapt this well-built line of machines to modern drilling needs and make the name "Cincinnati" synonymous with complete drilling service the length and breadth of the land.

We were pioneers in the drilling machine industry 46 years ago, and we are leaders today, aiming always to excel in our particular line and catering exclusively to that discriminating class of machine-tool users which looks for practical serviceability and durable efficiency in selecting its equipment.

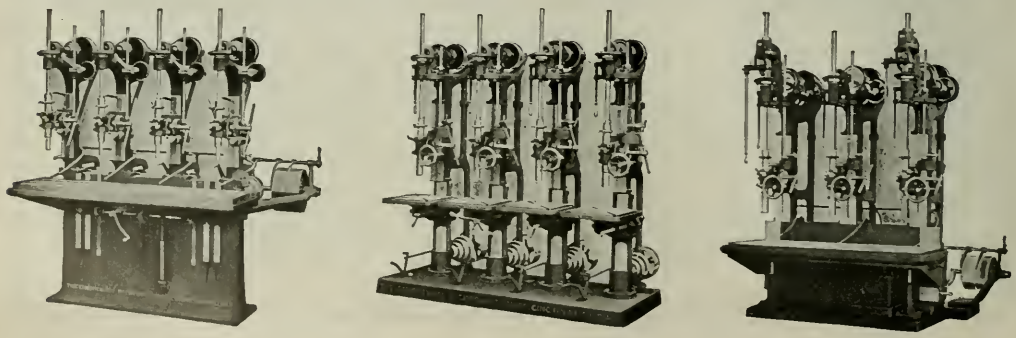
The Cincinnati Bickford Tool Co.

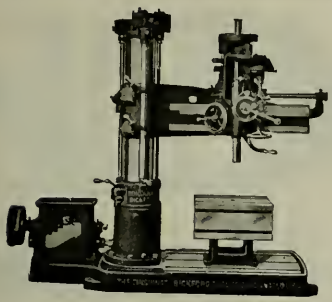
Oakley, Cincinnati, Ohio, U. S. A.

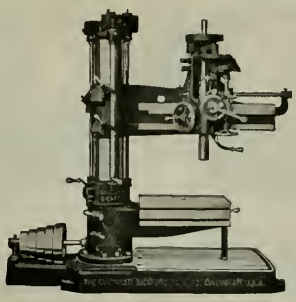
Founded 1874

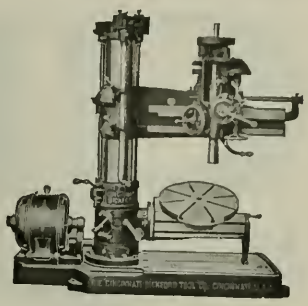
U569

DOMESTIC AGENTS: Henry Prentiss & Co., Inc., New York, Hartford, Conn.; Boston, Mass.; Buffalo, Rochester, and Syracuse, N. Y. Motch & Merryweather Machinery Co., Cleveland, Ohio; Detroit, Mich.; Cincinnati, Ohio, and Columbus, Ohio. Marshall & Huschart Machinery Co., Chicago, Ill. Brown & Zortman Machinery Co., Pittsburgh, Pa. W. E. Shipley Machinery Co., Philadelphia, Pa. Marshall & Huschart Machinery Co. of Indiana, Indianapolis, Ind. Elliott & Stephens Machinery Co., St. Louis, Mo. Harron, Rickard & McCone, San Francisco, Calif., and Los Angeles, Calif. C. T. Patterson Co., Ltd., New Orleans, La. Robinson, Cary & Sands Co., St. Paul, Minn., and Duluth, Minn. Kemp Machinery Co., Baltimore, Md. Dewstoe Machine Tool Co., Birmingham, Ala. Seeger Machine Tool Co., Atlanta, Ga. Hallidie Machinery Co., Seattle, Wash.







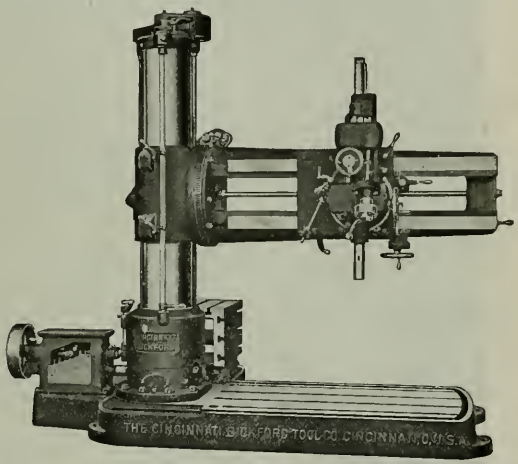


THE CINCINNATI BICKFORD

A Universal Radial Drilling Machine with 4-, 5- and 6-Foot Arm

In designing the machine here shown, we have conclusively demonstrated that universality in a drilling machine does not necessitate any less power, rigidity and durability. The machine here shown has the same double-column construction as our plain heavy duty models, the same general proportions and relative distribution of parts, and its distinctive Patented Arm offers the same resistance to spring as our less elaborately equipped mechanism.

This arm consists of two complete tubes with an opening between them. It is liberally equipped with ball bearings and readily swings, elevates or rotates to any desired angle.



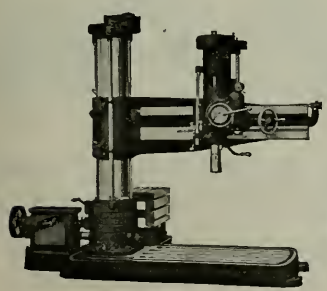
The Cincinnati Bickford Tool Co.

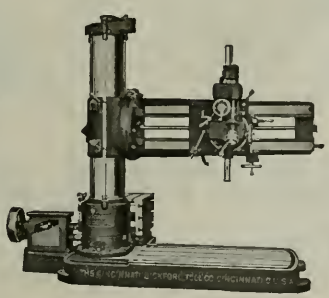
Oakley, Cincinnati, Ohio, U. S. A.

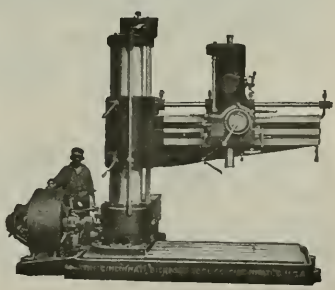
Founded 1874

R569

Zimmerman-Wells-Brown Co., Portland, Ore. **Charlotte Supply Co.**, Charlotte, N. C. **Cochran Machine Tool Co.**, Memphis, Tenn. **CANADIAN AGENTS: H. W. Petrie, Ltd.**, Toronto, Ont. **Williams & Wilson, Ltd.**, Montreal and Quebec. **FOREIGN AGENTS: Charles Churchill & Co., Ltd.**, London, Manchester, Birmingham, Newcastle-on-Tyne, England, and Glasgow, Scotland. **Aux Forges de Vulcain**, Paris, France. **Hijo de Miguel Mateu**, Barcelona, Spain. **Ateliers Demoor St. Ame**, Brussels, Belgium. **Chr. A. Herstad**, Copenhagen, Denmark and Stockholm, Sweden. **Andrews & George Co.**, Tokyo, Japan. **McPherson's Pty., Ltd.**, Melbourne, Australia. **Bartle & Co.**, Johannesburg, South Africa. **H. S. Gray Co.**, Honolulu, Hawaii. **Gustav Nielsen**, Christiania, Norway. **Maskin-Aktiebolaget E. Gronblom**, Abo, Finland.

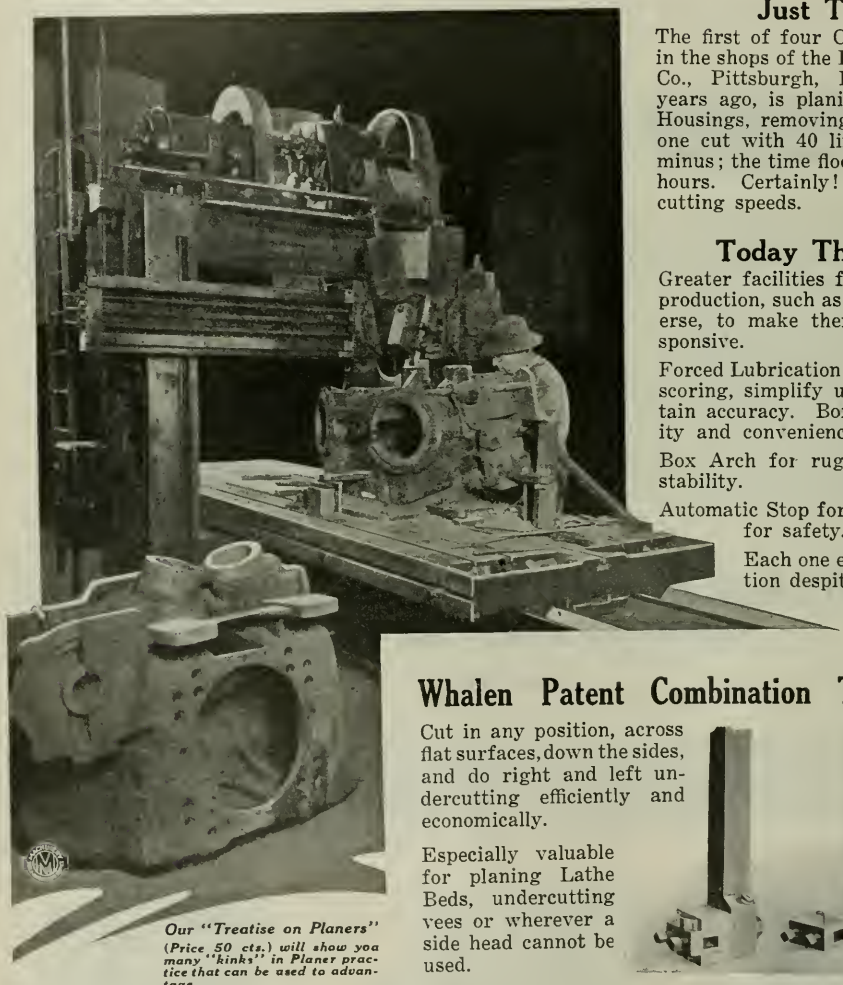






CINCI

Variable Speed Planers



Just Think!

The first of four Cincinnati Planers in the shops of the Locomotive Stoker Co., Pittsburgh, Pa., installed 10 years ago, is planing 1200 lb. Rack Housings, removing $\frac{3}{8}$" of metal at one cut with 40 limits .002 plus or minus; the time floor to floor is three hours. Certainly! It has variable cutting speeds.

Today They Have

Greater facilities for greater hourly production, such as rapid power traverse, to make them handy and responsive.

Forced Lubrication to Vees to prevent scoring, simplify up-keep and maintain accuracy. Box Table for rigidity and convenience.

Box Arch for rugged strength and stability.

Automatic Stop for Elevating Device for safety.

Each one emphasizes production despite the shorter day.

Our "Treatise on Planers"
(Price 50 cts.) will show you many "kinks" in Planer practice that can be used to advantage.
Send for our circulars.

Whalen Patent Combination Tool Holders

Cut in any position, across flat surfaces, down the sides, and do right and left undercutting efficiently and economically.

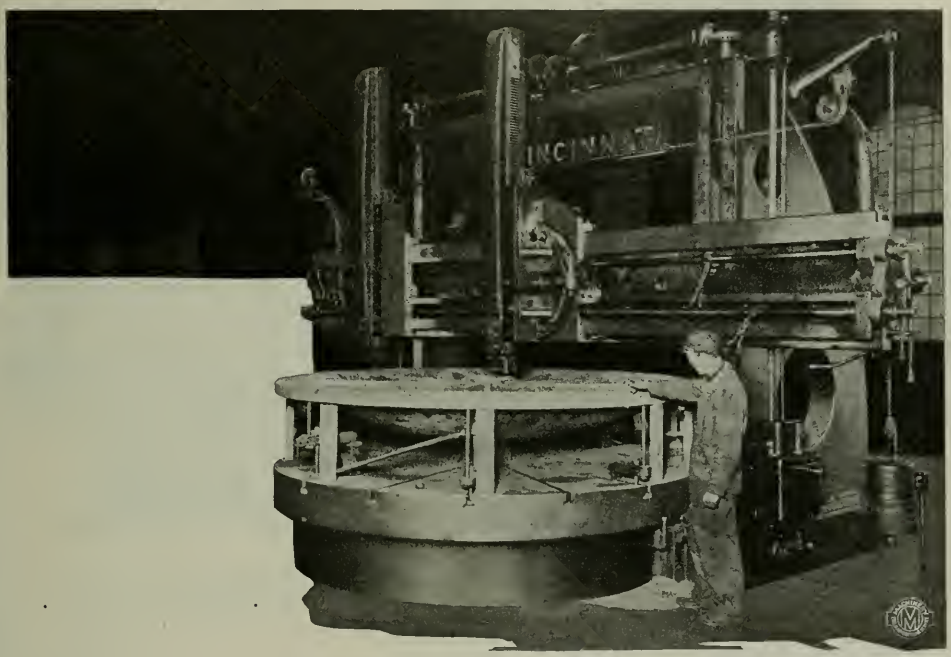
Especially valuable for planing Lathe Beds, undercutting vees or wherever a side head cannot be used.

CINCINNATI PLANER CO.

DOMESTIC AGENTS: Henry Prentiss & Co., Inc., New York City, N. Y.; Boston, Mass., Buffalo, N. Y., Syracuse, N. Y., Rochester, N. Y. Motch & Merryweather Machinery Co., Cleveland, O., Detroit, Mich., Pittsburgh, Pa., Cincinnati, O. Marshall & Huschart Machinery Co., Chicago, Ill., Indianapolis, Ind. W. E. Shipley Mchy. Co., Philadelphia, Pa. Kemp Machinery Co., Baltimore, Md. Seeger Machine Tool Co., Atlanta, Ga. C. T. Patterson Co., New Orleans, La. Eccles & Smith Co., San Francisco, Cal., Los Angeles, Cal Zimmerman, Wells & Brown Co., Portland, Oregon. Hallidie Mchy. Co., Seattle, Wash. Hendrie & Bothoff Mfg. & Supply Co., Denver, Colo. Union Iron Works, Spokane Wash. Salt Lake City Hardware Co., Salt Lake City, Utah. Henry Prentiss & Co., Inc., Hartford, Conn. Elliott & Stephens Mchy. Co., St. Louis, Mo.

INNATI

Rapid Production Boring Mills



"First-Class Machines — No Doubt About It"

Says the Foreman of this Plant

This Cincinnati Boring Mill has been in use in the Shops of the Western Gas Construction Co., (Fort Wayne, Ind.) for about a year and the foreman talks of it with all the enthusiasm a shop man feels for a big machine that "makes good."

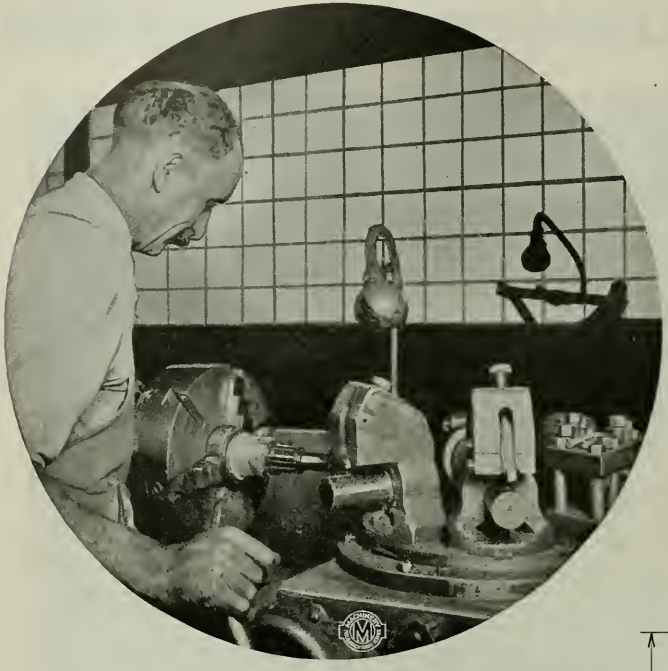
A year's use has given opportunity for all kinds of working tests—the piece shown is a digestor head to go into a large ink factory —and the satisfaction freely expressed will last as long as this machine is in use.

Do you know these big machines? Have you seen them in operation? If not, write us for details; we will tell you where you can find one in your neighborhood.

Cincinnati, Ohio, U. S. A.

CANADIAN AGENTS: Rudel-Belnap Meby. Co., Toronto, Ont., Montreal, Que. FOREIGN AGENTS: Aux Forges de Vulcain, Paris, France. C. Churchill & Co., London, England, (Planers). Geo. H. Alexander Mchy. Ltd., Birmingham, England, (Boring Mills). Ing. Ercole Varbi, Milano, Italy. J. Lambercier & Co., Geneva, Switzerland. Chr. A. Herstad, Copenhagen, Demark, Stockholm, Sweden. Gustav Nielsen, A/S, Christiania, Norway. C. Schinz, Petrograd, Russia. Maskin-Aktiebolaget, E. Gronblom, Abo Finland. Ateliers Demoor, Brussels, Belgium. Andrews & George Co., Tokyo, Japan. Benson Bros., Sydney, Australia. H. S. Gray Co., Honolulu. Hijo De Miguel Mateu, Barcelona, Spain.

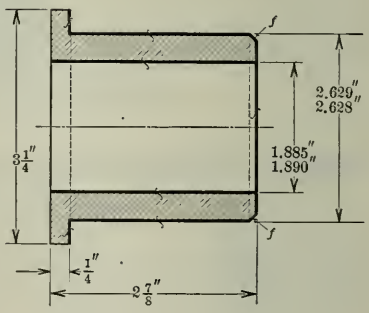
Get Cincinnati-Acme Figures
On Your Work—*It's Results That Count*



BUYING a turret lathe is a great deal like buying a motor car—both are merely a means to getting a certain kind of service; but how you get it and how much it costs, are things that are too often found out after the purchase has been completed. A better plan is to study the *work* of the machine you have in mind—study the machine in the hands of another owner, rather than in the shops of the maker.

That's the way we want you to figure on Cincinnati-Acme Lathes, for after all, it's results that count—*and they count most.*

The accompanying picture shows a Cincinnati-Acme Flat Turret Lathe in the La Crosse Tractor plant (La Crosse, Wisconsin), machining tractor wheel bushings. The operations are as follows: 1, chuck; 2, rough bore; 3, semi-finish bore; 4, ream; 5, rough turn outside diameter and rough face under side of flange; 6, finish turn outside diameter and finish face under side of flange. Production is 12 per hour, or five minutes each.



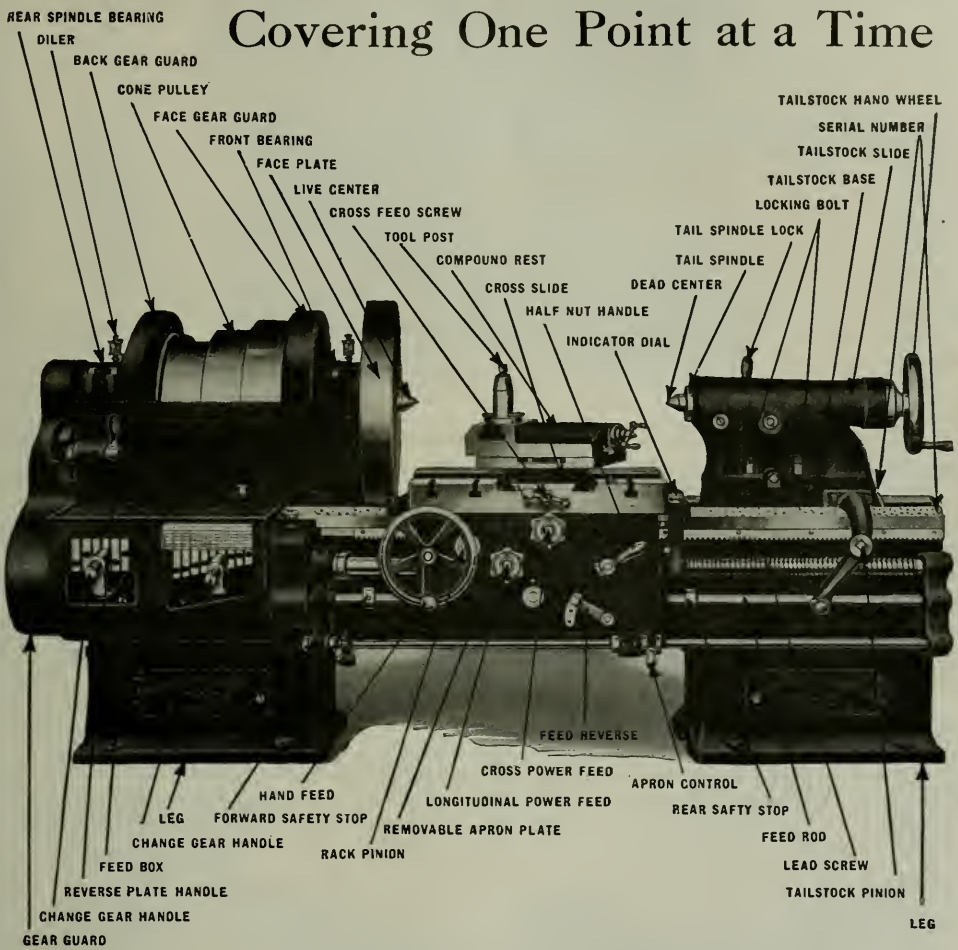
THE ACME MACHINE TOOL COMPANY
CINCINNATI, OHIO, U. S. A.

Flat Turret Lathes **Screw Machines** **Turret Lathes**

DOMESTIC AGENTS: Henry Prentiss & Co., Inc., New York City, Boston, Mass., Buffalo, N. Y., Syracuse, N. Y., Rochester, N. Y.; Motch & Merryweather Mchy. Co., Cleveland, O., Detroit, Mich., Pittsburgh, Pa., Cincinnati, O.; Marshall & Huschart Mchy. Co., Chicago, Ill., Indianapolis, Ind.; Elliott & Stephens Mchy. Co., St. Louis, Mo.; W. E. Shipley Mchy. Co., Philadelphia, Pa.; Kemp Mchy. Co., Baltimore, Md.; Seeger Machine Tool Co., Atlanta, Ga.; C. T. Patterson Co., New Orleans, La.; Hendrie & Bolthoff Mfg. & Supply Co., Denver, Colo.; Dewstoe Machine Tool Co., Birmingham, Ala.; Eccles & Smith, Seattle, Wash., Los Angeles, Cal., San Francisco, Cal., and Portland, Ore. Robinson, Cary & Sands Co., St. Paul, Minn. FOREIGN AGENTS: Aux Forges de Vulcain, Paris, France; George H. Alexander Mchy., Ltd., Birmingham, England; H. P. Gregory & Co., Sydney, Australia; J. Lambercier & Co., Geneva, Switzerland; Chr A. Herstead, Copenhagen, Denmark, Stockholm, Sweden; Gustav Nielson, A/S, Christiania, Norway; Maskin-Aktieholaget E. Gronblom, Aho, Finland. E. Isbecque & Co., Brussels, Belgium. Andrews & George Co., Tokyo, Japan. Miguel Mateu & Son, Barcelona, Spain. CANADIAN AGENTS: Rudel-Belnap Machinery Co., Montreal, Toronto.

The Greaves-Klusman Lathe

Covering One Point at a Time



This is the first of a series of advertisements to bring out "one point at a time," the constructural features of the G-K Lathe.

A glance at the above illustration tells its own story. One of the important and big problems in designing a lathe bed is to reduce the twisting and bending strains to a minimum. This has been accomplished in G-K Lathes by heavy ribbing, which extends the full depth of the bed—this is a considerable improvement over ordinary practice.

Another important improvement in G-K Lathes is the Tool Pressure Angle, which is offset between the spindle center and the center line of the bed. This construction prevents the carriage from buckling, the apron from getting out of alignment, and the tool from chattering.

We build a complete line of engine lathes, from 14″ to 30″ inclusive. All sizes are built with quick change mechanism.

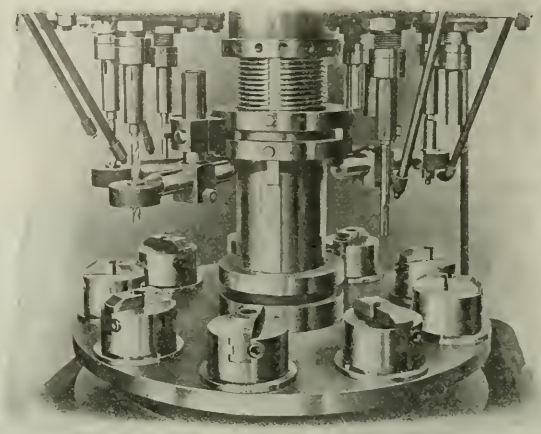
Catalog mailed apon request.

THE GREAVES-KLUSMAN TOOL COMPANY

CINCINNATI OHIO, U. S. A.

AGENTS:

The Fairbanks Co., New York City, Philadelphia, Washington, Baltimore, Albany, Boston, Buffalo, Hartford, Newark, Paterson, New Orleans, Scranton, Syracuse, Trenton, Rochester, Providence, Bridgeport. Federal Machinery Sales Co., Chicago, Ill., and Milwaukee, Wis. J. R. Stone Tool & Supply Co., Detroit, Mich. William K. Stamets, Pittsburgh, Pa., and Cleveland, O. Elliott & Stephens Machinery Co., St. Louis, Mo. Eccles & Smith, Portland, Ore. FOREIGN AGENTS: George H. Alexander Machinery, Ltd., Birmingham, England; Yamatake Co., Tokyo, Japan; Chr. A. Herstad, Copenhagen, Denmark and Stockholm, Sweden; Gustav Nielsen, A/S Christiania, Norway.



Cincinnati-Gridley Automatic Multiple Spindle Drills have proven an
I ndispensable factor in solving drilling problems.
No spring to machine or spindles, as all spindles are supported from a
Center column, the thrust on one side of which is balanced
I n having an equalizing thrust on the opposite side, thus the column receives
No undue strain or spring which may be caused by heavy feeds.
Nos. 1-2-3 Morse Taper, or their equivalents are adaptable to the spindles.
As many spindles can be built into the machine as are practical for the class of work
To be operated on, from 5 to 9 being the average number needed. This feature
I s a decided advantage in drilling pieces which are difficult to handle in any other way.

Gang drills cannot be compared with this machine when tests show a
Remarkable saving in floor space, and as much as 300% in productive time.
I t Drills, Reams, Counterbores, and Faces; in reality is a vertical screw machine; but
Differs radically from other drilling machines, inasmuch as the tools can be
Located at a common point, or at different points. Holes can be drilled cutting into
Each other or as far apart as the capacity of the machine permits; thus the handling of
Your large variety of work can be reduced to a minimum.

More work at less cost; as the various operations can be divided into as nearly
Uniform unit as possible, thus equalizing the operations, the
Longest of which governs the time to complete the piece.
There is only one position for loading; the table then moves
I n a clockwise manner; does the required cutting, and lowers from the tools. The
Performance is continuous, and when the table has completed one cycle, and the
Loading position is again reached, the finished piece is removed and a blank inserted.
Every index means a finished part.

Do not worry about your drilling problems, our engineering service department is
Ready to solve them for you.
I n requesting information relative to Drills, it will prove to mutual advantage if you
Let us have blue prints, sketches, or samples of work to be performed.
Lose no time in writing for complete descriptive catalog.

CINCINNATI AUTOMATIC MACHINE CO.

CINCINNATI Manufacturers of OHIO

Automatic Multiple Spindle Drills and Screw Machines

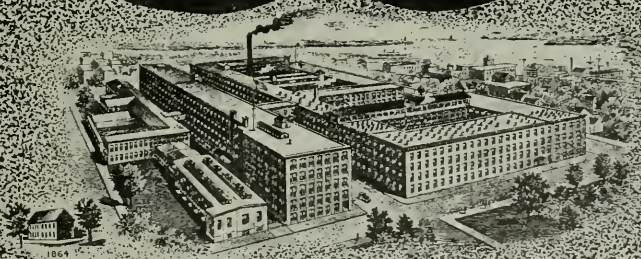
THE GENUINE MORSE DRILLS ENCIRCLE THE GLOBE

M|D

"Morse" Tools

Are proving their worth continually to users all over the world. This is being evidenced by repeat orders which tax our capacity. If it's real service you want, use

"Morse" Tools



Morse Twist Drill & Mch. Co.
New Bedford, Mass., U.S.A.



To the Man Who Demands Most X.-F. Means Most

The long experienced mechanic using files on exacting work looks for the X-F. trade mark that assures him of a Swiss Pattern file that he knows will give him superior file performance — a file that will cut perfectly from the first stroke, for every one is sharp.

Scientific Tests Protect Nicholson X.-F. Swiss Pattern Quality.

Department tests after every operation and final test for cutting quality cull out every defective file, so far as humanly possible — repeated tests not of lots but of every individual file so that sharpness, temper and smooth cutting ability are assured. Users of fine files cannot afford to be satisfied with less than the best.

NICHOLSON FILE CO.

PROVIDENCE, R.I., U.S.A.

HAMILTON LATHES



LIKE SEEKS LIKE

A man is judged by the company he keeps, so machines are likely to be judged by the standing of their selling agents and the general class of the machines they carry. Hamilton Lathes are consistently well built, accurate machines, convenient, speedy and economical, popular wherever they are used. Hamilton agents are chosen for their business integrity and their service standards and the quality of the machines they sell.

THE HAMILTON MACHINE TOOL CO.

HAMILTON, OHIO, U. S. A.

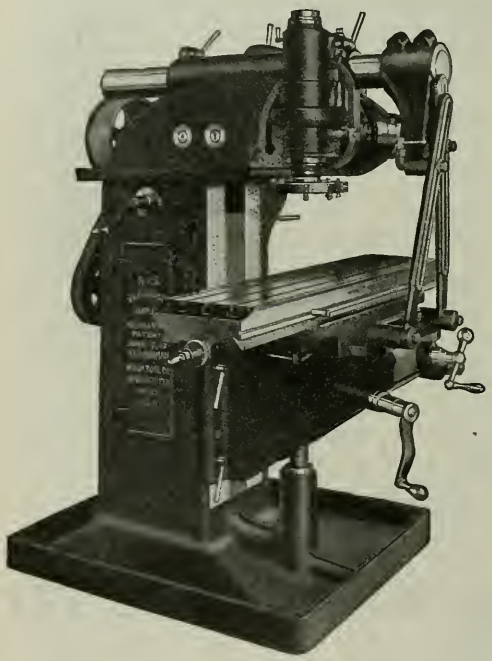
Read this list of Hamilton Agents; get in touch with the one in your district. Ask him to "show you" our Hamilton Lathes.

DOMESTIC AGENTS: Machineshop Equipment Corp'n., Boston, Mass. Barbour, Love & Woodward, Inc., New York; Syracuse Supply Co., Rochester, N. Y., Syracuse, N. Y., Buffalo, N. Y., Monarch Mchy. Co., Philadelphia, Pa.; The Thompson Machinery Co., Pittsburgh, Pa.; Cooperative Machinery Co., Cleveland, O.; Osborne & Sexton Machinery Co., Columbus, O.; Wolverine Machinery & Supply Co., Detroit, Mich.; Stocker-Rumely-Wachs Co., Chicago, Ill.; Thomson Tool & Supply Co., Indianapolis, Ind.; W. C. Johnson & Sons Mchy. Co., St. Louis, Mo.; F. E. Satterlee Co., Minneapolis, Minn.; Hendrie & Bolthoff Mfg. & Supply Co., Denver, Colo.; Herberts Machinery & Supply Co., San Francisco, Cal., Los Angeles, Cal.; M. J. Walsh Mchy. Co., Milwaukee, Wis.; Textile Mill Supply Co., Charlotte, N. C.; General Fire Extinguisher Co., Atlanta, Ga.; Oliver H. Van Horn, Inc., New Orleans, La. CANADIAN AGENTS: H. W. Petrie, Ltd., Toronto, Ont., Canada.

Rapid Production HAMILTON Machine Tools

VAN NORMAN

DUPLEX MILLER



This is the Van Norman No. 3 Duplex Miller set for vertical milling. Ask us for literature describing the extensive capacity of this machine.

Greatly Extends the Scope of Your Plant at a Small Expenditure of Space.

Rentals are high these days, and getting the most from your floor space means more than it did.

A good beginning is to install the Van Norman No. 3 Duplex Miller. Operating in both horizontal and vertical planes it gives you double efficiency, makes for maximum convenience and a minimum of setting-up time.

The adjustable cutter head, quickly set at any angle, permits the simplest forms of end mills to be used on an unusually large range of work.

The construction is such that in many instances blocking up the work is unnecessary, and a considerable reduction in the cost of fixtures and setting-up time is effected.

VAN NORMAN MACHINE TOOL COMPANY

Office and Factory
160 Wilbraham Ave.
Springfield, Mass., U.S.A.

Branch Sales Offices:
74 Brush Street, Detroit, Mich.
50 Church Street, New York, N. Y.

U. S. Portable Electrically Driven Tools

Soon Pay for Themselves

When Farrell, Kemp & Gushe Company turned its big sheet metal shop at Joliet, Ill., into a war production unit which helped make U. S. Army trucks, the U. S. Portable Electric Drill here shown was installed to drill tractor frames in process of assembling. By the time all Government orders were completed the machine had more than paid for itself.

When the shop went back to making big sheet metal tanks the U. S. Portable Electric Drill stayed right on the job and quickly made a place for itself drilling holes in tank frames of angle iron or steel such as the one shown in the illustration—ten times faster than a man with breast drill. Upkeep is negligible and the machine shows no sign of depreciation, so the company expects a good many years of "velvet."



U. S. Portable Electrically Driven Drills and Grinders are light but durably made, with air-cooled motors, hardened gears and other features which insure long and satisfactory service.

Details in Catalog.

The United States Electrical Tool Co.

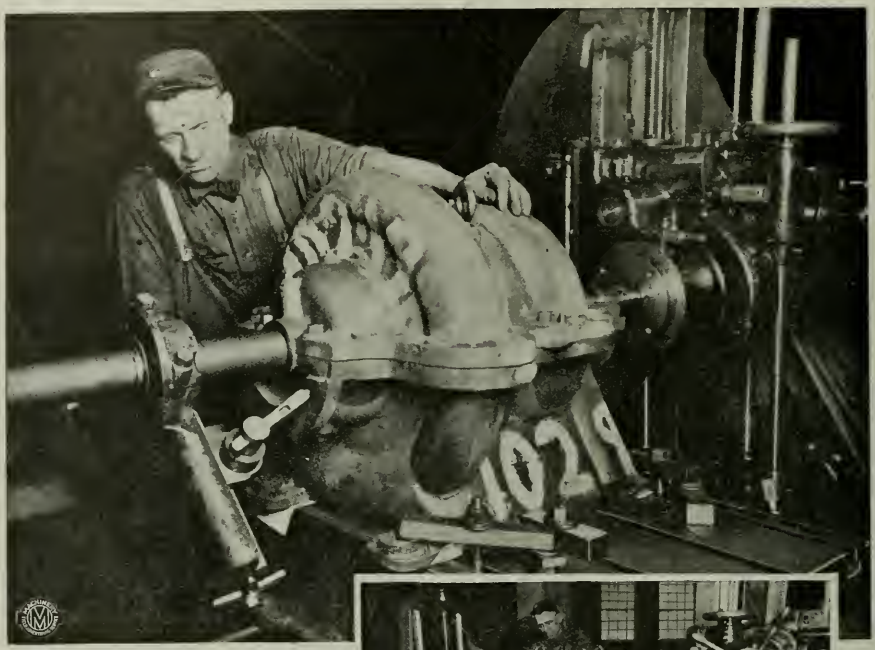
6th Ave. and Mt. Hope St. **CINCINNATI, OHIO, U. S. A.**

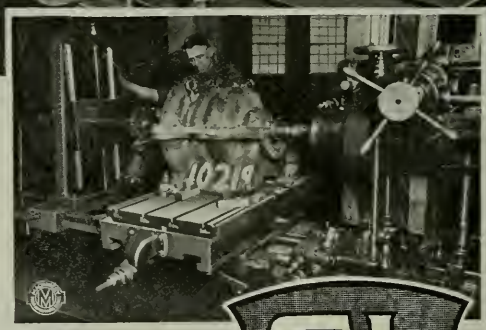
STOCK CARRIED IN BRANCHES

New York Office: 50 Church Street. St. Louis Office: 1956 W. Broadway. Detroit Office: Marquette Bldg. Chicago Office: 549 West Washington Boulevard. Boston Office: 12 Pearl St. Philadelphia Office: The Bourse. Pittsburgh Office: Bessemer Bldg. Cleveland Office: 404 Northern National Bank Bldg.

GIDDINGS & LEWIS

Horizontal Boring, Drilling and Milling Machines





This G & L Performs Many Important Operations on Centrifugal Pump Casings

Boring, recessing and facing centrifugal pump casings is important work, and becomes more important the greater the production. For these operations the Midwest Engine Company installed G & L equipment at its Hill Pump Works. Anderson, Ind., and it meets every need. Photograph shows a No. 32 G & L machining a 4" three-stage casing. There are ten bores, two outside facing operations, eight faces and eight recesses inside, all measurements being held to close limits. Top and bottom casings are clamped together with a gasket between the faces, and a complete pump casing is produced each twenty-four hours.

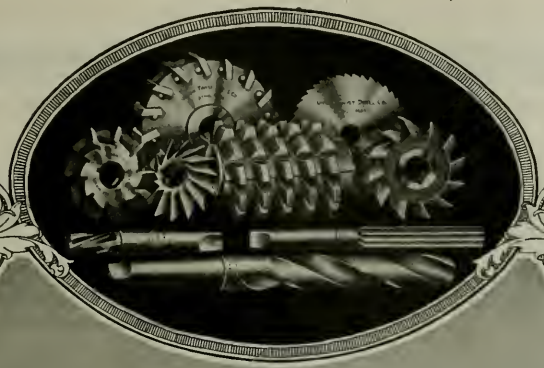
G&L

WRITE FOR CATALOG

Giddings & Lewis Machine Tool Co.

FOND DU LAC WISCONSIN, U. S. A.

DOMESTIC AGENTS: Henry Prentiss & Co., New York City, Syracuse, Rochester, Buffalo, Boston, Hartford; Marshall & Huschart Machinery Co., Chicago, Milwaukee; Swind Machinery Co., Philadelphia, Baltimore; Moleh & Merryweather Machinery Company, Cleveland, Pittsburgh, Detroit; E. A. Kinsey Company, Cincinnati, Indianapolis; Smith Courtney Company, Richmond, Va.; Young & Vann Supply Co., Birmingham, Ala.; Blackman-Hill-McKee Machinery Co., St. Louis; Eccles & Smith Co., San Francisco, Los Angeles, Portland; English Tool & Supply Co., Kansas City; Fairbanks Co., New Orleans; McMullen Machinery Co., Grand Rapids, Mich.; Manning, Maxwell & Moore, Inc., Seattle; Northern Machinery Co., Minneapolis; Salt Lake Hardware Co., Salt Lake City; Sunderland Machinery & Supply Co., Omaha. FOREIGN AGENTS: Canadian Fairbanks-Morse Co., Ltd., Toronto, Montreal, Winnipeg, Vancouver, Hamilton; Fenwick Freres & Co., Paris, Lyons, Liege, Brussels, Zurich; Burton, Griffiths & Co., England; R. L. Scrutton & Co., Ltd., Sydney, Australia; Gustav Nielsen, Christiania; A. B. Galco, Ltd., Stockholm, Sweden; Sale & Frazar, Ltd., Tokyo, Japan; American Machinery Syndicate, Spain, Portugal; Maskinbolaget Groenblom, Abo Finland; Gaston, Williams & Wigmore, Shanghai, Honkong, Hankow, Tientsin, China.



Tools of Quality

Time has proved Union Tools. Years devoted to research and experimentation have made them the standard of quality wherever metal cutting is accomplished.

The undercut tooth on High Power Milling Cutters—the accuracy of Union Hobs—these are but natural results where effort is ever directed toward a better product.

Truly—Union Cutters, Drills and Reamers are Tools of Quality.

Union Twist Drill Company

Drill and Cutter Makers

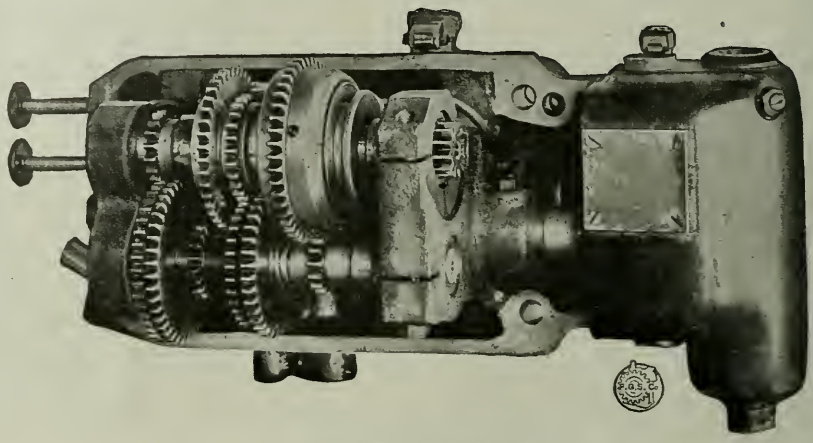
Athol, Massachusetts, U. S. A.

New York Chicago



F.G.S.Co. SERVICE, ACCURACY, PRODUCTION F.G.S.Co.

Solving the Machine Tool Builder's Problems on the Gear Shaper



Feed Box on Cincinnati "M" Type Milling Machine

The feed box of the "M" Type Milling Machine, built by the Cincinnati Milling Machine Co., Cincinnati, Ohio, represents an excellent example of compact gear design. This feed mechanism, it will be noticed, comprises a series of so-called "cluster" or "shoulder" gears grouped close together, and which can be accurately and economically produced if made from one piece.

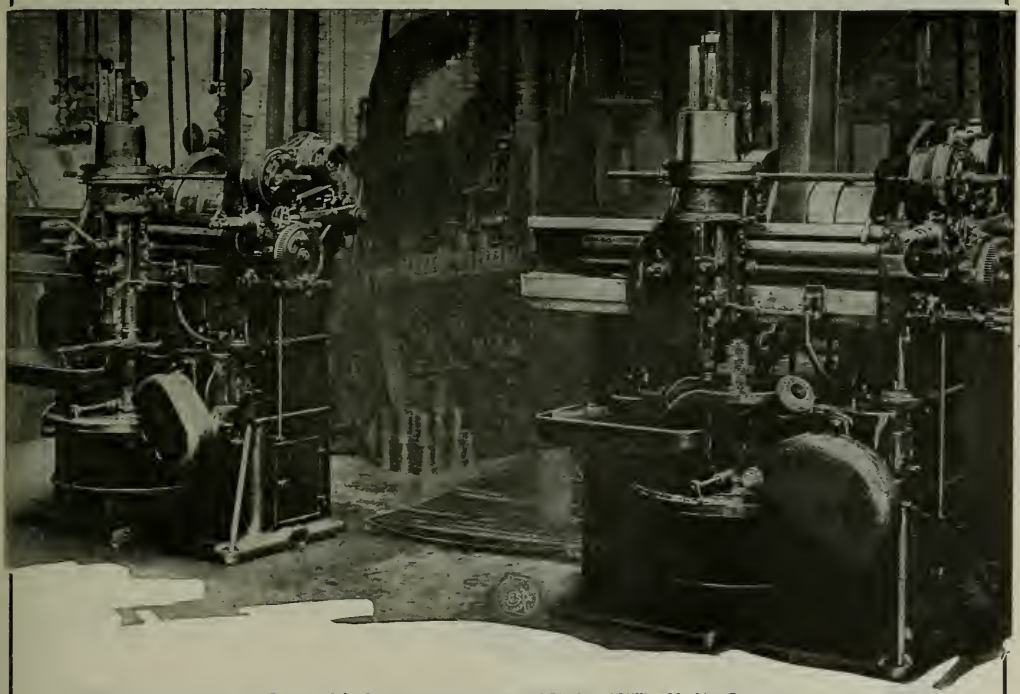
With the Gear Shaper the making of gears from one piece having a clearance groove as little as ⅛ inch between the teeth is easily possible, so that the designer is not confronted with the problem of making his design suit manufacturing requirements. In other words, he can design his product to be compact, convenient and accurate, and then produce parts in commercial quantities on the Gear Shaper.

The Gear Shaper has many possibilities that are of particular interest to machine tool builders. It will handle

SERVICE, ACCURACY, PRODUCTION

a wide range of work, and is an accurate and economical producer of gears. Furthermore, it makes possible the use of various gears that could not be economically produced by any other method.

Some of the possibilities of the Gear Shaper are illustrated in our booklet, "Commercial Gear Cutting," a copy of which we will gladly send to those interested.



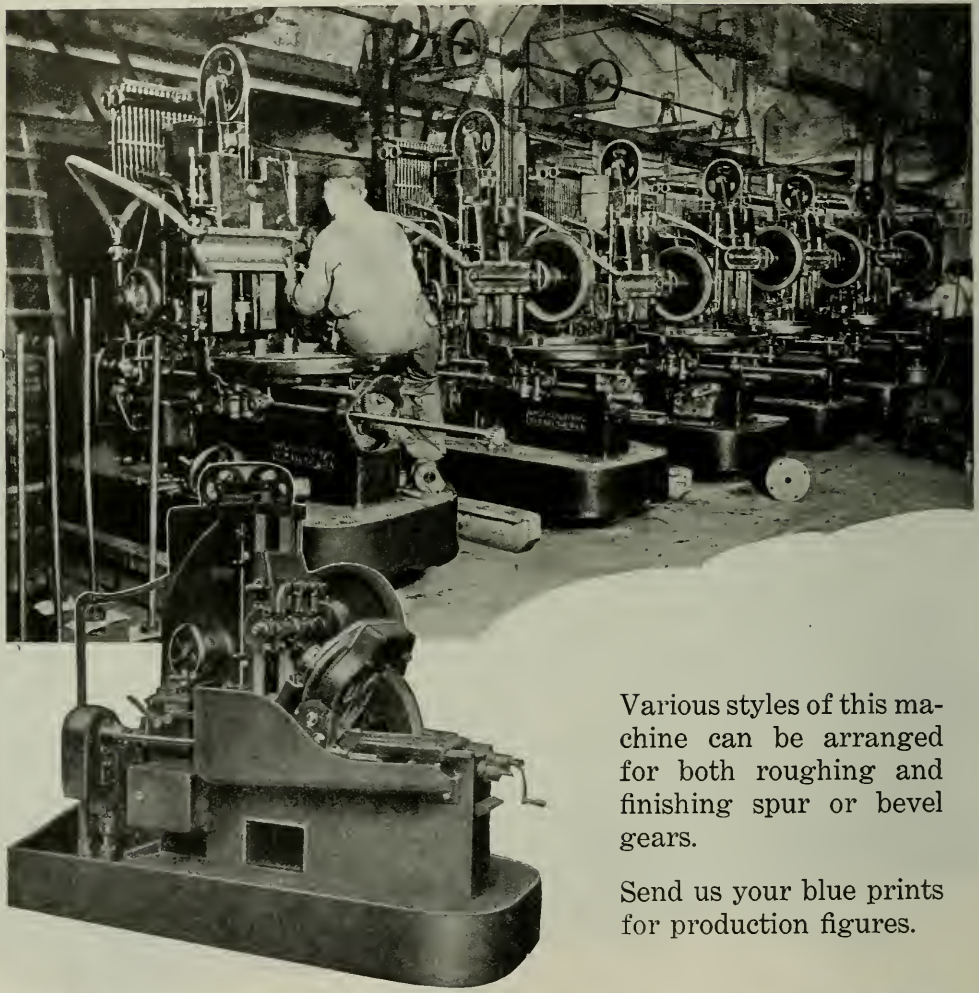
Portion of the Gear Shaper Department of Cincinnati Milling Machine Co.

The Fellows Gear Shaper Company

Springfield, Vermont, U.S.A.

FOREIGN AGENTS: Alfred Herbert, Ltd., Coventry, England; Societe Anonyme Alfred Herbert, Paris, France; Societa Anonima Italiana, Alfred Herbert, Milan, Italy; Alfred Herbert, Ltd., Yokohama, Japan; Societe Anonyme, Alfred Herbert, Barcelona, Spain; Societe Anonyme Belge, Alfred Herbert, Brussels, Belgium; Alfred Herbert (India), Ltd., Calcutta, India.

We Manufacture Gear Cutting Machinery



Various styles of this machine can be arranged for both roughing and finishing spur or bevel gears.

Send us your blue prints for production figures.

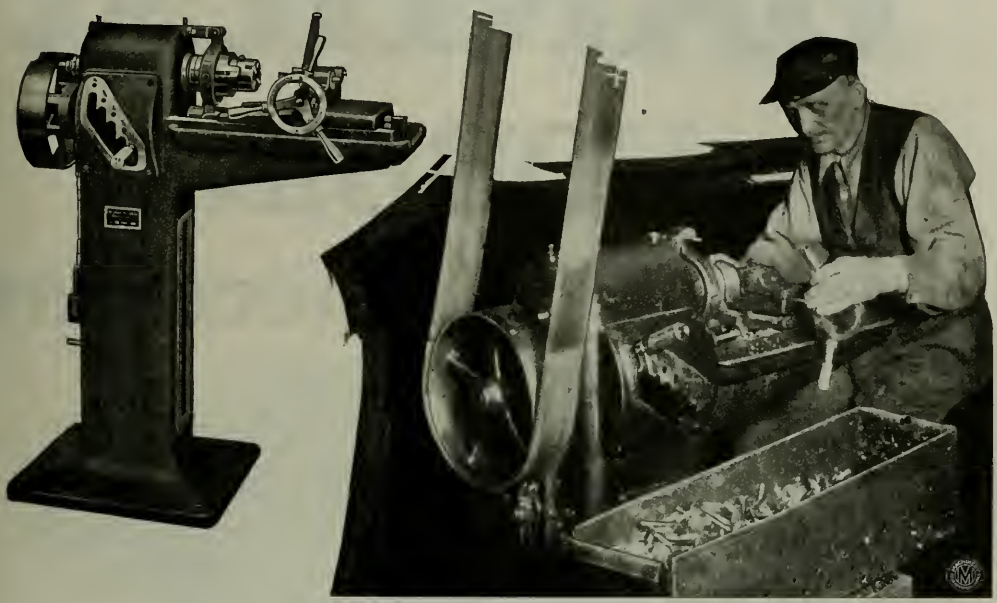
GOULD & EBERHARDT

"HIGH DUTY" SHAPERS
AUTOMATIC GEAR AND RACK CUTTING MACHINERY

ESTABLISHED 1833 NEWARK, N.J. U.S.A.

DOMESTIC AGENTS: Motch & Merryweather Machinery Co., Cleveland, Pittsburgh, Detroit, and Cincinnati; Henry Prentiss & Co., New York, Boston, Buffalo, Syracuse, Rochester, Scranton; Marshall & Huschart Machinery Co., Chicago and Milwaukee; Marshall and Huschart Machinery Co. of Indianapolis, Indianapolis, Ind.; Elliott & Stephens Machinery Co., St. Louis; W. E. Shipley Machinery Co., Philadelphia; Kemp Machinery Co., Baltimore and Richmond; Hallidie Machinery Co., Seattle; Dewstoe Machine Tool Co., Birmingham, Ala.; Seegar Machine Tool Co., Atlanta, Ga.; Robinson, Cary & Sands Co., St. Paul and Duluth, Minn.; Eccles & Smith Co., Los Angeles, San Francisco, and Portland, Ore.; Salt Lake Hardware Co., Salt Lake City, Utah; Oliver H. Van Horn Co., Inc., New Orleans, La. FOREIGN AGENTS: C. W. Burton, Griffiths & Co., London, England; R. S. Stokvis & Zonen, Ltd., Rotterdam; R. S. Stokvis & Fils, S. A., Paris and Brussels; D. Drury & Company, Johannesburg, S. Africa; A. R. Williams Machinery Co., Canada; Horne Co., Ltd., Tokyo, Japan; Victor G. Mendoza, Havana, Cuba; Allied Machinery Co. of America, Switzerland, Italy, China, Spain and Portugal; Chr. A. Herstad, Copenhagen, Denmark; Pedro Martinto, Lima, Peru, South America.

Geometric Threading Machines



One Man—One Machine
Two Thousand Bolts Per Day

A glance at the figures—two thousand bolts per day—conveys the impression of unusually speedy production.

The plant of the Mitchell Motors Company, Inc., Racine, Wis., is as a matter of fact, noted for its careful choice of production units, and the selection of Geometric Threading Machines some five years ago was merely to help carry out this speed-plus-quality policy.

These body bolts are 5/16" diameter, have threads running 18 to the inch, the threaded portion being 1⅛" long. Production averages 200 per hour, or, as previously stated, 2000 per ten-hour day.



Ask for the full line of Geometric literature.

THE GEOMETRIC TOOL COMPANY

NEW HAVEN — **CHICAGO OFFICE** 627 West Washington Boulevard — **CONNECTICUT**

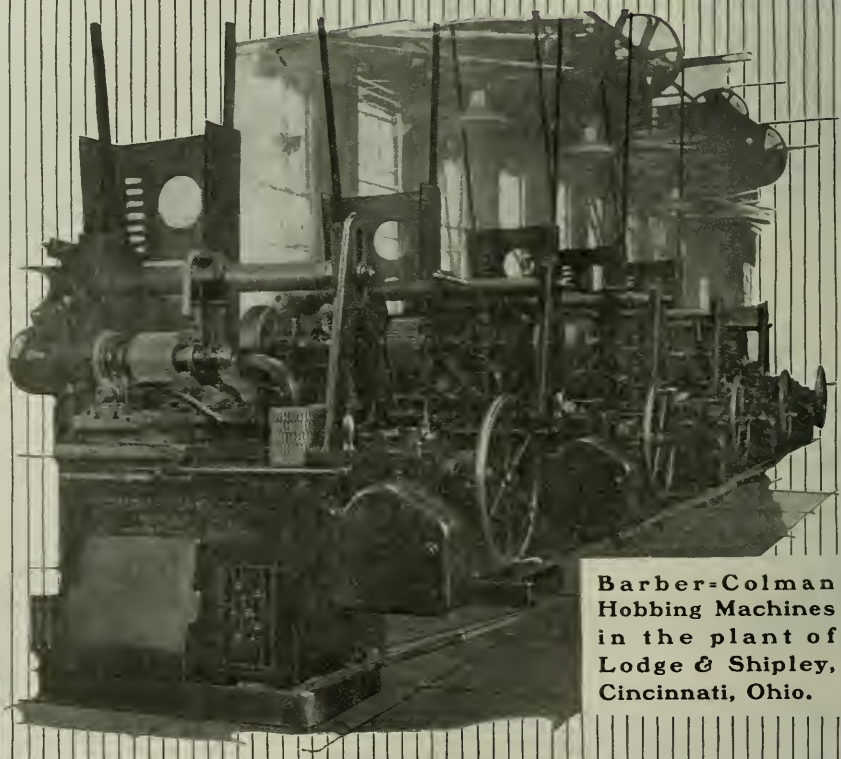
General Distributors for Michigan, The Chas. A. Strelinger Co., Detroit.

WESTERN SALES AGENTS: Blackman-Hill-McKee Mchy. Co., St. Louis, Mo.; Hill, Clarke & Co., Inc., Boston; Kemp Machinery Co., Baltimore, Md.; The National Supply Co., Toledo, Ohio; The W. M. Pattison Supply Co., Cleveland, Ohio; Root, Neal & Co., Buffalo, N. Y.; F. E. Satterlee Co., Minneapolis, Minn.; Somers Filter & Tool Co., Pittsburgh, Pa.; The Tool Equipment Co., San Francisco; Vandyck Churchill Co., New York and Philadelphia; Vonnegut Machinery Co., Indianapolis, Ind.; The C. H. Wood Co., Syracuse, N. Y. CANADA: The Canadian Fairbanks-Morse Co., Ltd., Manitoba, Saskatchewan and Alberta; The A. R. Williams Mchy. Co., Ltd., Toronto, Winnipeg and St. John (N.B.); Williams & Wilson, Ltd., Montreal. FOREIGN AGENTS: Allied Mchy. Co. of America, France, Italy, Switzerland, Spain, Portugal; Andrews & George, Tokyo, Japan; Bevan & Edwards, Melbourne; Chas. Churchill & Co., Ltd., London, Birmingham, Manchester, Glasgow; J. Horstman, Paris; E. Isbecque & Co., Brussels, Belgium; V. Lowener, Denmark, Norway, Sweden, Copenhagen, Christiania, Stockholm; R. S. Stokvis & Zonen, Rotterdam, Holland; White & Rae, Sydney.

BARBER-

HOBBING

ACCURATE



Barber-Colman Hobbing Machines in the plant of Lodge & Shipley, Cincinnati, Ohio.

BARBER-COLMAN COMPANY

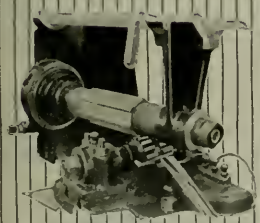
HOME OFFICE & PLANT

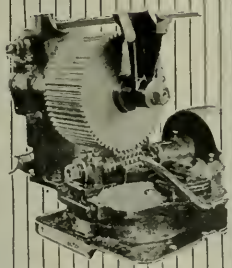
ROCKFORD, ILL., U.S.A.

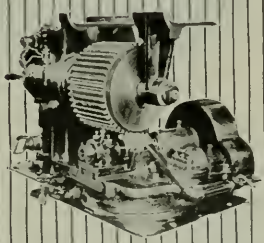
1920-14

COLMAN MACHINES

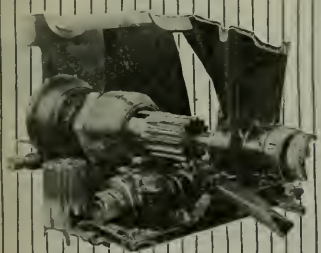
DEPENDABLE

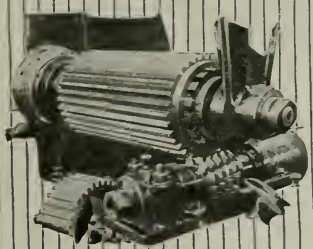






Barber-Colman Hobbing Machines are used in the Lodge & Shipley Plant for cutting gears and spline shafts to be used in Lodge & Shipley machine tools.





BRANCH OFFICES

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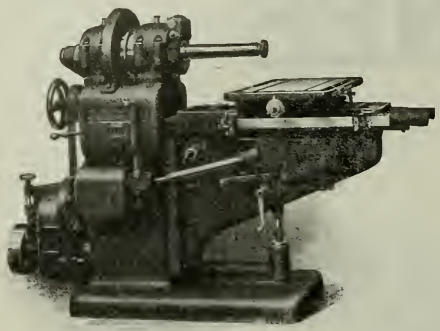
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020-14-A

HEALD



STYLE No. 60 CYLINDER GRINDER

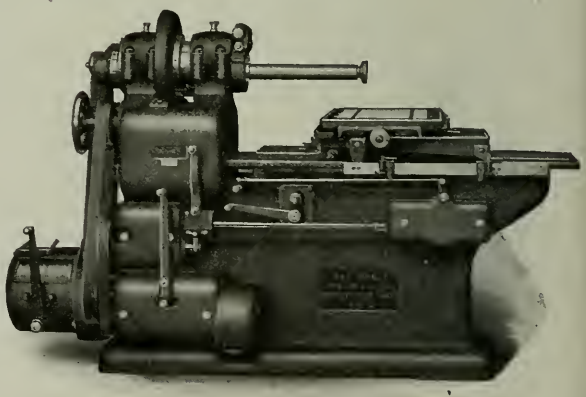
The Heald Cylinder Grinders are especially designed for internal grinding of holes in work of such shape that it is inconvenient or impossible to rotate in the usual manner when machining.

These machines are especially valuable for grinding airplane, marine or automobile engine cylinders. The ordinary method of smooth boring and reaming results in inaccuracies due to hard and soft spots in the casting, as well as springing of the thin cylinder wall. In grinding, the wheel revolves at a high speed in a true circular path, getting hard and soft spots alike, leaving an absolutely round hole.

Railroad shops are now using them to grind bearings in valve motion parts and piston rods, valve rods or brake parts, such as triple valves, etc.

Machine Style No. 60, as shown above, has a large vertical adjustment of 3½ inches, obtained by movement of the knee casting clamped to the bed. This machine is particularly suited to garage work or any shop where a variety of different sized work requires a large vertical adjustment.

Machine No. 65 is our latest style, built for precision and production work. Notice the massiveness, giving rigidity,—centralized control of levers, giving convenience of operation, and that it is self-contained.



STYLE No. 65 CYLINDER GRINDER

THE HEALD MACHINE CO.

BRANCH OFFICES: New York, 839 Singer Bldg.; Philadelphia, 1308 Commonwealth Bldg.; Chicago, 26 South Jefferson St.; Detroit, 401 Marquette Bldg.; Cincinnati, 311 Provident Bank Bldg.; Cleveland, 721 Engineers' Bldg. WESTERN AGENTS: Eccles & Smith Co., Los Angeles, San Francisco, Seattle and Portland; Salt Lake Hardware Co., Utah and Idaho; Hendrie & Bolthoff Mfg. & Supply Co., Denver, Colo.

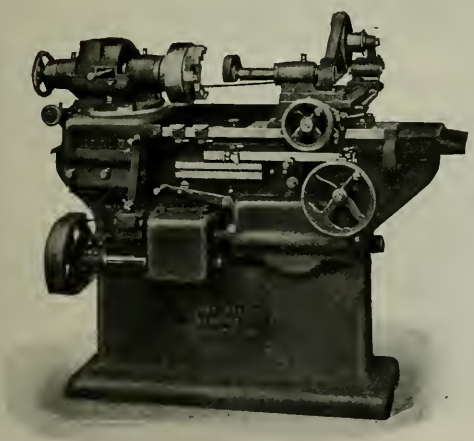
INTERNAL GRINDERS

Heald Internal Grinders are built to handle work which can be easily revolved, such as bushings, cutters, ball races, hardened gears, gauges, cones, etc.

Each wheelhead is made up in a separate unit, instantly interchangeable. Twelve sizes of heads enable these machines to cover a wide range of work, which, together with the swivelling of the workhead, makes this machine indispensable in tool-rooms for grinding straight and tapered holes.



STYLE No. 85 INTERNAL GRINDER



STYLE No. 70 INTERNAL GRINDER

Style No. 85, as shown above, and whose capacity is 10″ swing by 2″ long, was built for small short work. The construction is very simple, and a large number of mechanical features have made it exceptionally well suited for rapid production. It works best on holes smaller than ¾ dia. x 1½ long.

Style No. 70 handles work 15″ dia. x 11″ long. It has both automatic and hand feed for the table. Several new features have been lately added, including friction clutch workhead for starting and stopping the work, longer base to enable the operator to run the wheelhead back when plugging. Also the guard over the wheel has been re-designed so that it entirely covers the wheel.

Let us send you catalogues, together with literature showing these machines working in various factories.

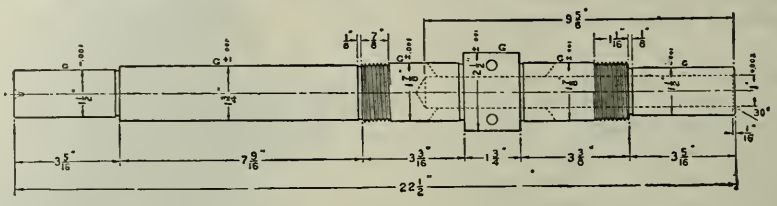
16 New Bond St., Worcester, Mass., U.S.A.

HEALD

FOREIGN AGENTS: Alfred Herbert, Ltd., England; Societe Anonyme, Alfred Herbert, France, Switzerland, and Societa Anonima Italiana, Alfred Herbert; Alfred Herbert, Ltd., Sydney, Australia; Horne Co., Ltd., Japan; Wilh. Sonesson & Co., Sweden, Denmark and Norway; Henri Benedictus, Brussels, Belgium; American Machinery Syndicate, Spain and Portugal.

Foster Production Results

FRICTION CLUTCH SHAFT-A.3.S.



JUST A "FEW COLD FIGURES"

This shaft was machined on the engine lathe in 82 minutes at a total cost, including wages and factory overhead, of $2.22 per piece.

It is now being machined on a Foster 2-B Universal Turret Lathe in 35 minutes at a total cost of 95 cents per piece.

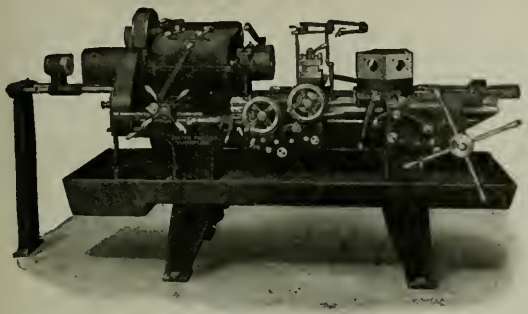
NET SAVING PER PIECE, $1.27

NET SAVING PER DAY'S PRODUCTION, $17.78

Are you interested?
Send us your blue prints for estimate.

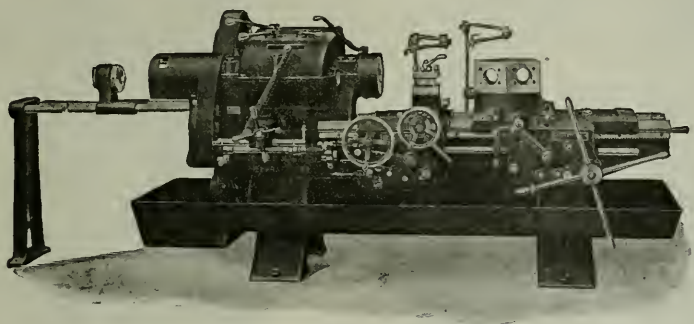
FOSTER MACHINE CO.,

The Foster Universal Turret Lathe

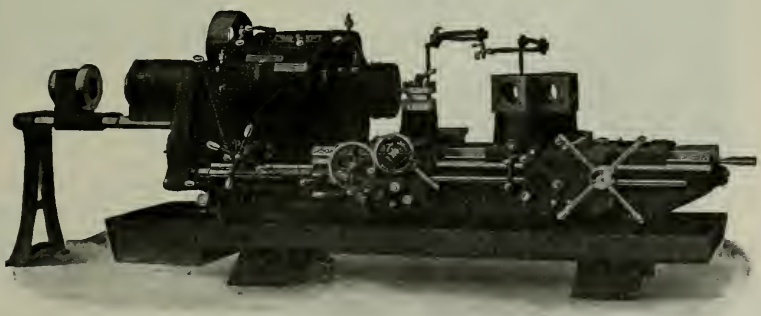


For Bar Work and Chucking Work

1-B Universal Turret Lathe



2-B Universal Turret Lathe



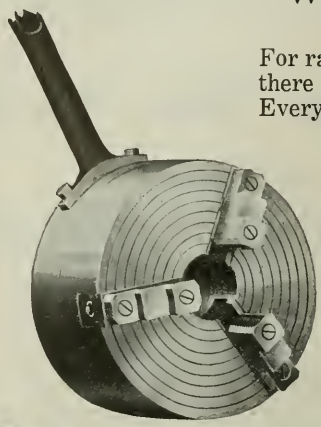
3-B Universal Turret Lathe

There is a reason for their tremendous production capacity

Is our latest catalog in your file?

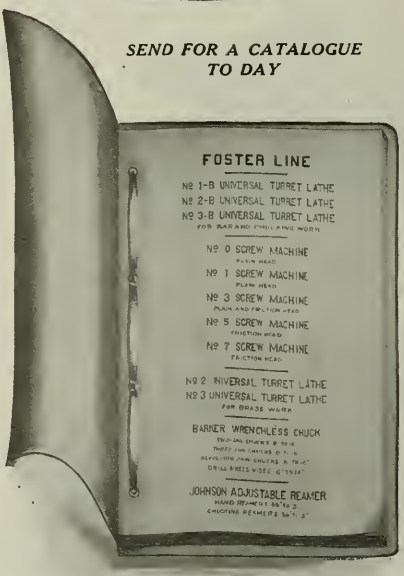
ELKHART, IND., U. S. A.

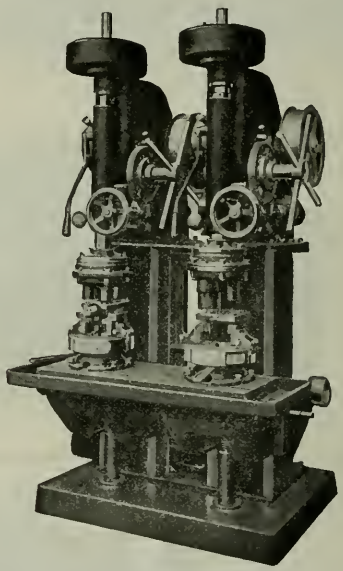
Barker Wrenchless Chucks and Drill Vises with Steel Bodies Qualify.



For rapid production on lathe, drill or milling machine, there is none more productive than the BARKER. Every movement and every moment a productive one. You can increase your production and eventually will. Why not start the investigation now. A Barker Chuck or Vise will start you right.

SEND FOR A CATALOGUE TO DAY





A Two-jaw Barker Jigged for Action on a BAKER BROS. TWO-SPINDLE DRILL.

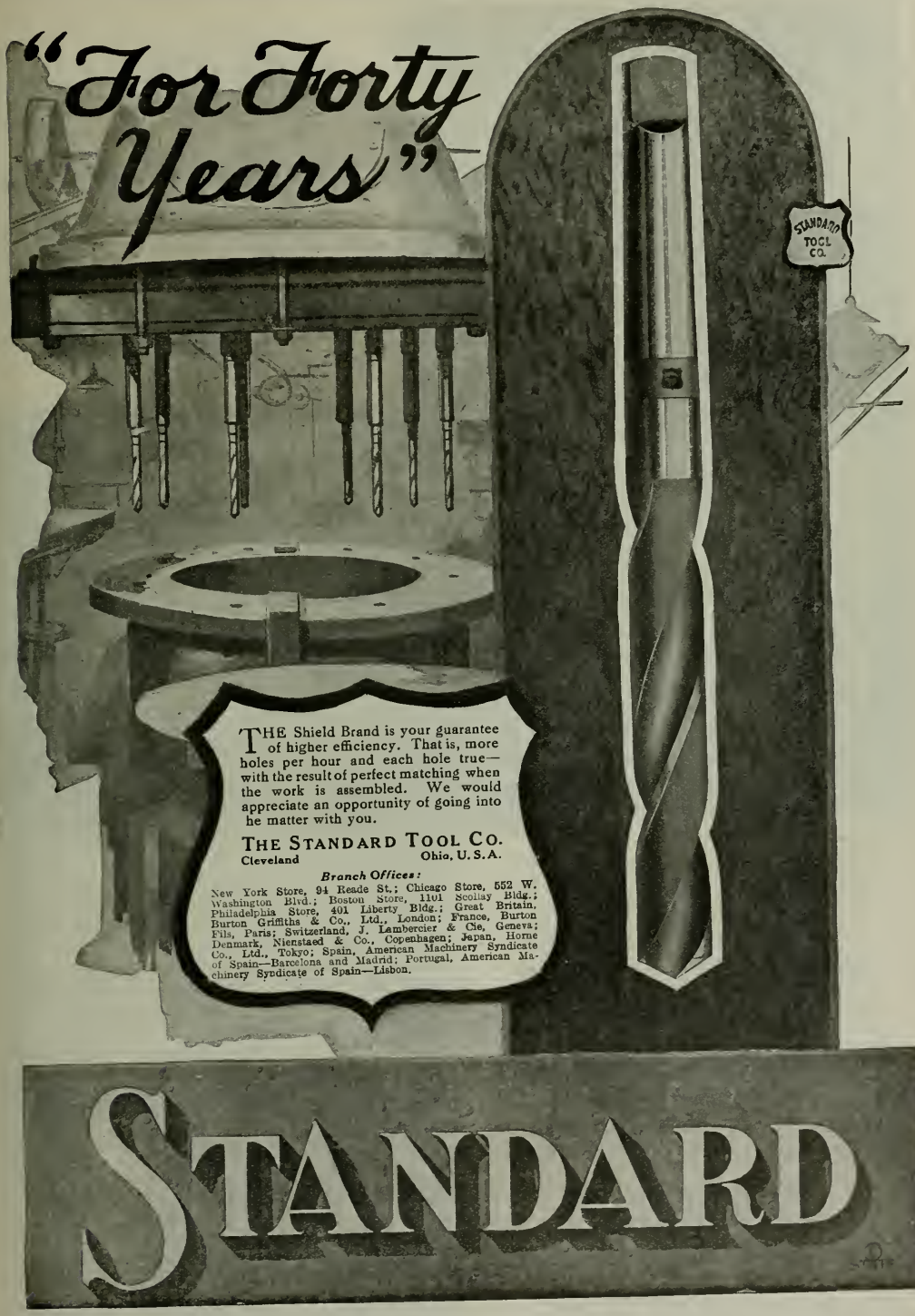
A movement on the lever and work is instantly held with unshakable grip, again and all is released. Jaws are adjusted to any size. Can you recall a set up more complete?

FOSTER MACHINE COMPANY

ELKHART **Chuck Department** **INDIANA, U.S.A.**

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THE Shield Brand is your guarantee of higher efficiency. That is, more holes per hour and each hole true—with the result of perfect matching when the work is assembled. We would appreciate an opportunity of going into the matter with you.

THE STANDARD TOOL CO.
Cleveland Ohio, U. S. A.

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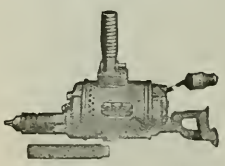
STANDARD



"CINCINNATI" Portable Electric Drills Speed Up Production



Drilling Automobile Body Frames



Portable Electrical Hand or Breast Drill

Made in 5 sizes, ¼", 5/16", ⅜", ½", ⅝" capacities in steel. Single and two speeds. Weight from 8 lbs. up. Armature mounted on ball bearings. Ball thrust bearing for end thrust. Gears hardened and operate in grease. Patented switch in handle.

"Cincinnati" Portable Electric Drills find a wide field of usefulness in the Buffalo plant of the American Body Company, and drill both wood and metal with equal facility. There is a great deal of drilling done in the manufacture of automobile bodies, and the handy "Cincinnati" is just the thing to do it.

In the upper photograph is seen the drilling of a body frame with a "Cincinnati" Electric Drill. The top is put on as shown in lower photograph, further drilling is done, and the structure pegged together.

There's nothing to beat "Cincinnatis" for handiness, economy and general utility. They'll go anywhere—you don't have to move the work around; current consumption is negligible—they use power only when they're working.

Introduce "Cincinnati Electrics"—Drills and Grinders—to your men and plant. You'll find it a paying proposition.

THE CINCINNATI ELECTRICAL TOOL CO.

1501-3-5 FREEMAN AVENUE CINCINNATI, OHIO

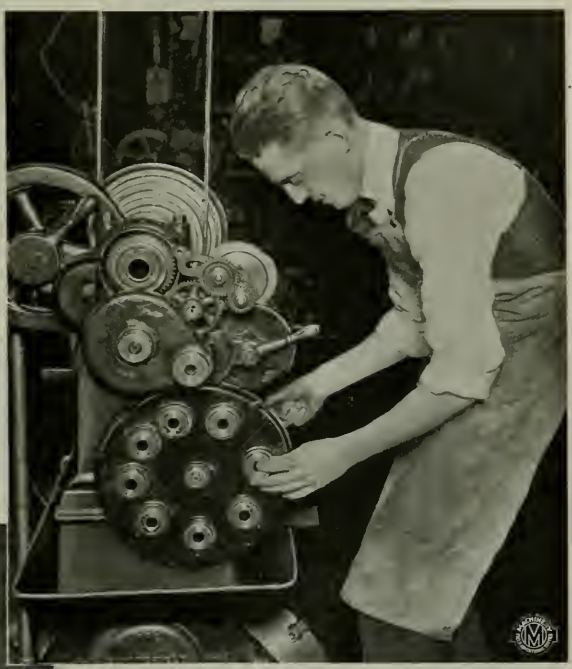
New York Office: 50 Church Street *Boston Office:* 259 Franklin Street *Detroit Office:* 2 Goebel Building

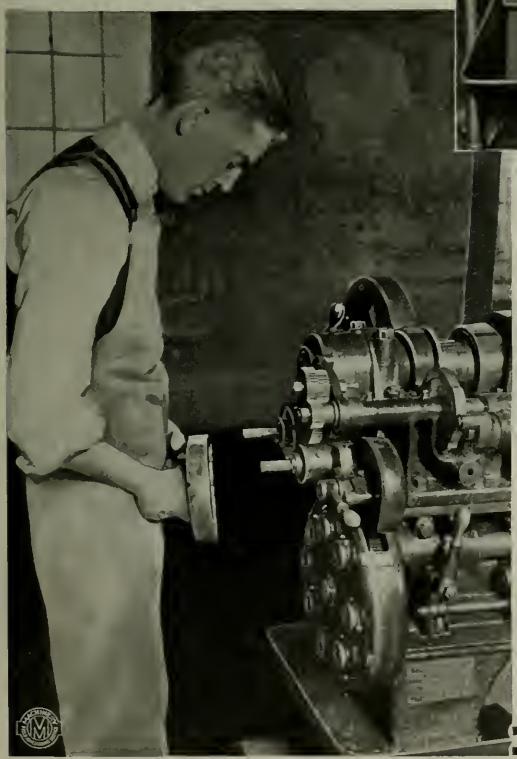
FOREIGN AGENTS: England, S. Wolf & Co., London. Australia, Parke & Lacy Co., Ltd., Sydney. France, R. S. Stokvis & Fils, Paris. Holland, R. S. Stokvis & Zonen, Ltd., Rotterdam. Japan Yamatake & Co., Tokyo. Spain, American Machinery Syndicate, New York City. China, Andersen, Meyer & Co., Ltd., Shanghai.

Adjustments Are Quick and Easy On SPRINGFIELD "IDEAL" LATHES

The Change Gears, For Example—

are mounted on a pivoted disc, as shown in the accompanying photograph. Rotating this disc brings any desired change gear into alignment with the lead screw, the intermediate gear and lead screw extension being readily disconnected and re-engaged by moving two levers. This whole operation requires only three or four seconds and the mechanism is practically fool-proof.





The ratio or case gears are equally simple to adjust. Each pair is enclosed in a case in which their bearings are mounted, making a complete unit, readily removed by hand without even a wrench.

The young operator at the left has just slipped off the 1-2 ratio case to reverse it and so obtain a 2-1 ratio. Two more ratio gear units are regularly furnished with the machine, neatly fitted into the cabinet leg, and a glance at the index plate shows which case and disc gears are necessary to obtain any desired speed and feed.

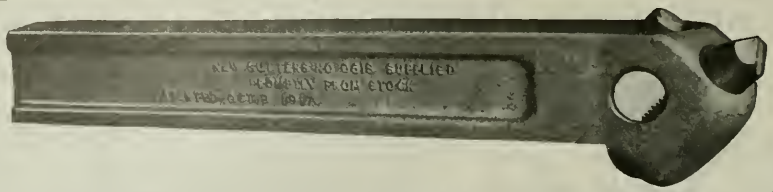
Let us tell you more about it

THE SPRINGFIELD MACHINE TOOL COMPANY

631 Southern Ave. Springfield, Ohio

Manufacturers of

Springfield Lathes and Shapers



TOOLS FOR PRODUCTION—LOVEJOY INSERTED CUTTERS

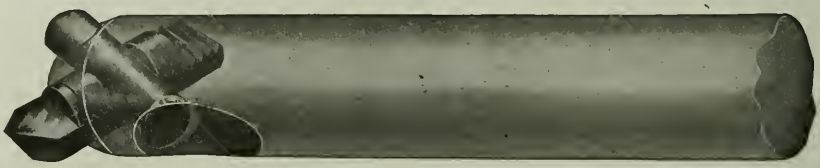
The rigid Lovejoy Inserted-Cutter Tool has all the merits of the solid tool, plus thrift. Its construction overcomes the waste of high speed steel characteristic of the solid type tool.

We have used the solid tool for comparison, because a properly forged, correctly shaped solid tool has been our ideal in the absence of anything better. One can readily see, however, the great waste of expensive material, performing no other function than to support a cutting edge.

The Lovejoy cutter won't slip in the holder—won't break at set screw or clamping point—won't clog with chips. It is heat-treated to the highest efficiency—has no unnecessary overhang—no objectionable projections—none of the defects of the welded tool. Lovejoy inserted cutters represent the last word in tool efficiency. Write for lists.

THE LOVEJOY TOOL COMPANY, Incorporated

SPRINGFIELD *Metal Cutting Tools* VERMONT

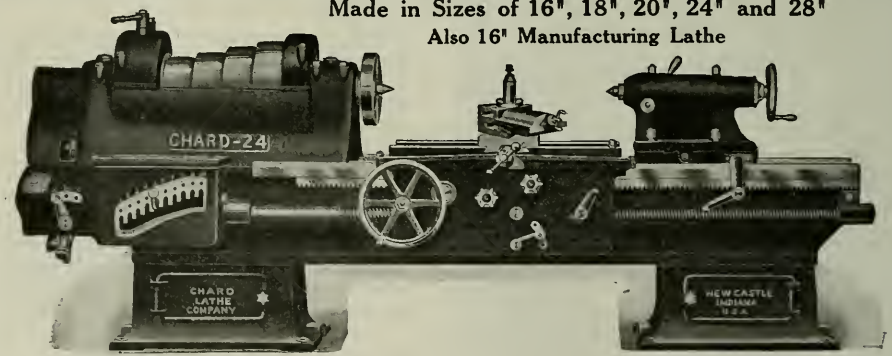


The Culmination of 37 Years' Experience in Lathe Building

THE CHARD 24" QUICK CHANGE DOUBLE BACK-GEARED ENGINE LATHE

Made in Sizes of 16", 18", 20", 24" and 28"

Also 16" Manufacturing Lathe



WE ARE REPRESENTED BY Biggs Watterson Co., Cleveland, O., Dayton, O., Detroit, Mich.; Thompson Mchy. Co., Pittsburgh, Pa.; Monarch Mchy. Co., Philadelphia, Pa.; F. O. Stallman Supply Co., San Francisco, Cal.; Vonnegut Mchy. Co., Indianapolis, Ind.; McMullen Mchy. Co., Grand Rapids, Mich.; Manning, Maxwell & Moore, Inc., New York, N. Y.; Boston, Mass., Seattle, Wash.; Cincinnati, O., Buffalo, N. Y., Milwaukee, Wis., Chicago, Ill., Rochester, N. Y., St. Louis, Mo.; Saxer Mchy. Co., Erie, Pa.; Societe Anonyme Belge, Alfred Herbert, Ltd., Brussels, Belgium.

CHARD LATHE CO. **Newcastle, Ind., U. S. A.**

Absolute accuracy and speed in performance, linked with superior design and construction, have made the

CHARD THE LATHE OF GOOD JUDGMENT

in representation the world over. For over thirty-seven years Chard lathe development has produced superior features to assure its demand by discriminating shop men. These years of eminently satisfactory performance are the real test. Let us prove these claims. Details of whole line on request.

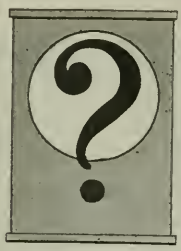
They have a STANDARD





When business men wish to keep an appointment they set their watches by the same standard clock. They will then be sure to meet without wasting any valuable time. Not only would a business man be at a loss without his watch, but unless he had a standard by which to keep that watch accurate, he would be greatly handicapped throughout his busy day.

How about YOU?



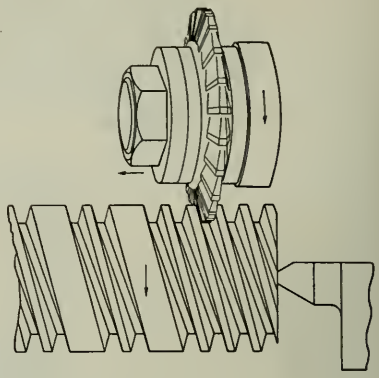


A micrometer is to the mechanic what a watch is to a business man. Unless mechanics have some accurate standard of measurement however, for constantly checking their measuring instruments, close accuracy cannot be depended upon. A set of Johansson Gages serves as an acknowledged standard on which mechanics can absolutely rely. Several sets in different parts of the shop insure greater accuracy in the plant.

Johansson
ACCURACY

C·E·Johansson·Inc·Poughkeepsie·N·Y·

Thread Milling —an L-B Job



When you want accurate threads, worms or lead screws—and each one must be like each other one—the answer is

LEES-BRADNER

Pitches—from the finest threads, up to 2½-inch Circular Pitch worms.

Leads—from 1/32-inch to 100 inches.

Lengths—up to 8 feet, 6 inches.

Diameters—up to 12 inches on Standard Lees-Bradner Thread Millers.

Maximum Swing—up to 27½-inches over bed on Collet Type Lees-Bradner Thread Millers.

Multiple Threads—any number of starts.

Single Cutters—(disc type) up to 7 inches diameter.

Multiple Cutters—(hob or ring type) cutting complete thread at one rotation.

Internal and External Threads.

Possibly you resort to chasing threads on a lathe when you want them accurate—send us your blueprints and we will tell you how to make them still more accurate at lower cost.

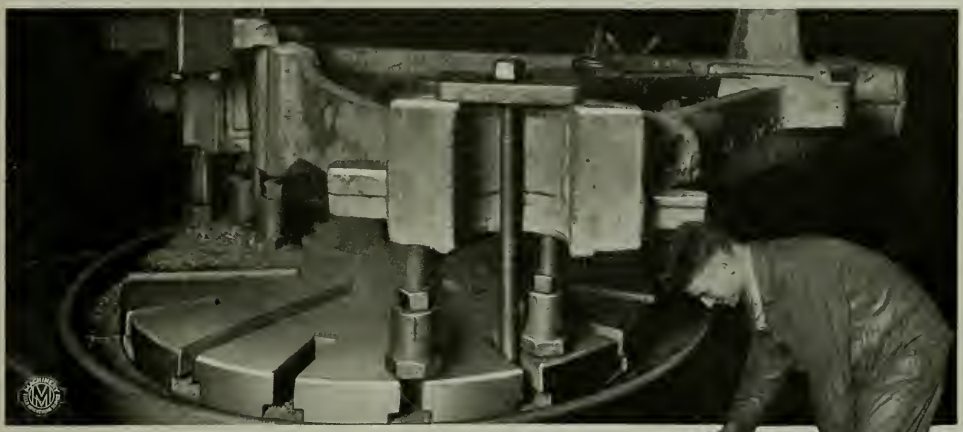
The LEES-BRADNER Co., Cleveland, O.

"To thread or hob is an L-B job"

NEWTON

(REGISTERED TRADE MARK)

SLOTTING MACHINES



Fourteen NEWTON Tools In This Plant





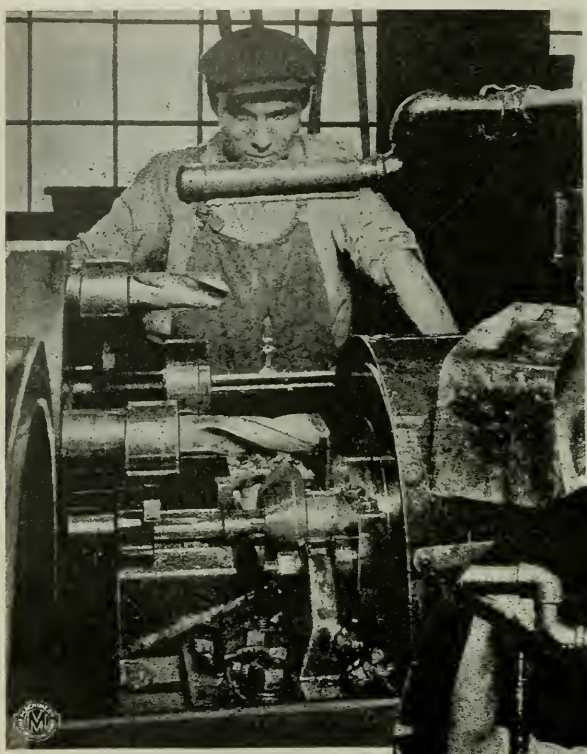
THE American Hoist & Derrick Co. (St. Paul, Minn.) has a number of NEWTON machines—including two NEWTON Slotters. The first Slotter was purchased in 1905—the second installed in 1917. The photograph shows one of them finishing a crank box fit in a frame for a hoisting engine, work that would ordinarily require the services of a planer, but that is finished accurately, speedily and more economically by this method.

We also manufacture Cold Saw Cutting-off Machines, Milling Machines (both horizontal and vertical), Rotary Planers, and Special Machine Tool Equipment for Railway, Electrical Equipment and Automotive shops.

NEWTON MACHINE TOOL WORKS, Inc.

Twenty-Third and Vine Streets **Philadelphia, U. S. A.**

CLEVELAND



Where Every Machine Is Picked for Accuracy, Durability and Production

There's no finer shop in the country than the Cincinnati-Bickford Tool Co.'s plant at Cincinnati, Ohio—a model establishment in every way and equipped throughout with the best that can be obtained.

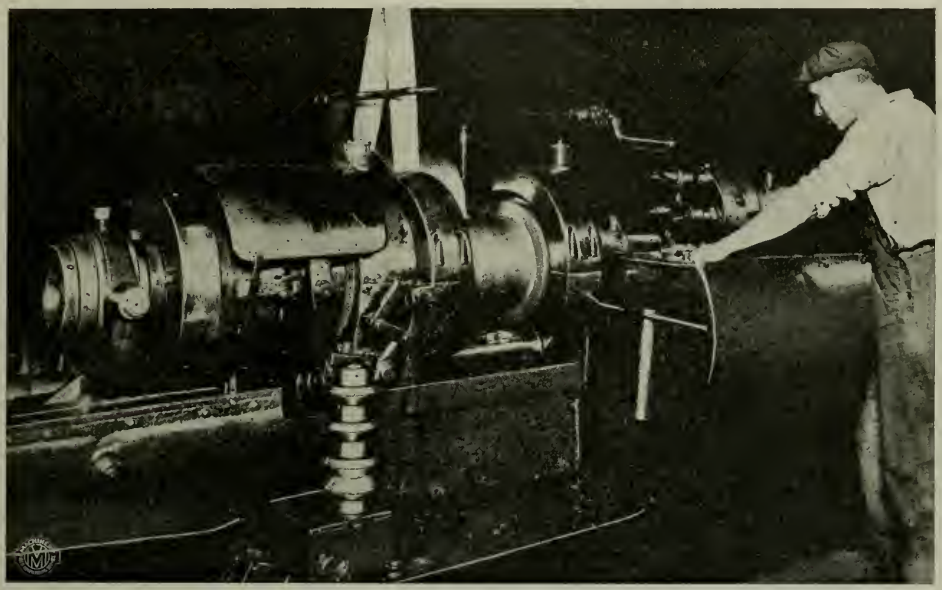


The accompanying photographs show the Cleveland Automatic in this up-to-date plant, machining bevel gear blanks for Cincinnati-Bickford No. 3 Radial Drills. Material is cold rolled steel, 30-point carbon, and the operations (see sketch on the opposite page) are performed in the following sequence: 1st, feed; 2nd, center; 3rd, drill and form; 4th, ream and cut off.

THE CLEVELAND AUTOMATIC

AGENTS: J. B. Anderson, 211 Gowan Avenue, Mt. Airy, Philadelphia, Pa. Herbert E. Nunn, 565 West Washington Street, Chicago, Ill. England, Chas. Churchill & Co., London, England. Japan, Andrews & George Co., Tokyo, Japan. Belgium, Henri Benedictus, Brussels, Belgium.

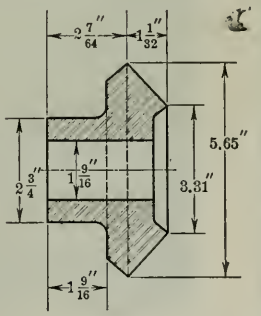
AUTOMATICS



Output is Limited Only by the Capacity of the High Speed Cutting Tools

Production is one completed blank every 16 minutes, and accuracy and finish are all that could be desired.

Simplicity and accuracy, low maintenance costs and a wide and practical range of application to modern manufacturing problems are the basis of our claim for the pre-eminence of Cleveland Automatics. These machines are made in styles and sizes to handle bar work from 1/8" to 7 3/4" diameter up to 18" long; they are also readily adaptable to a wide variety of special second operation jobs.



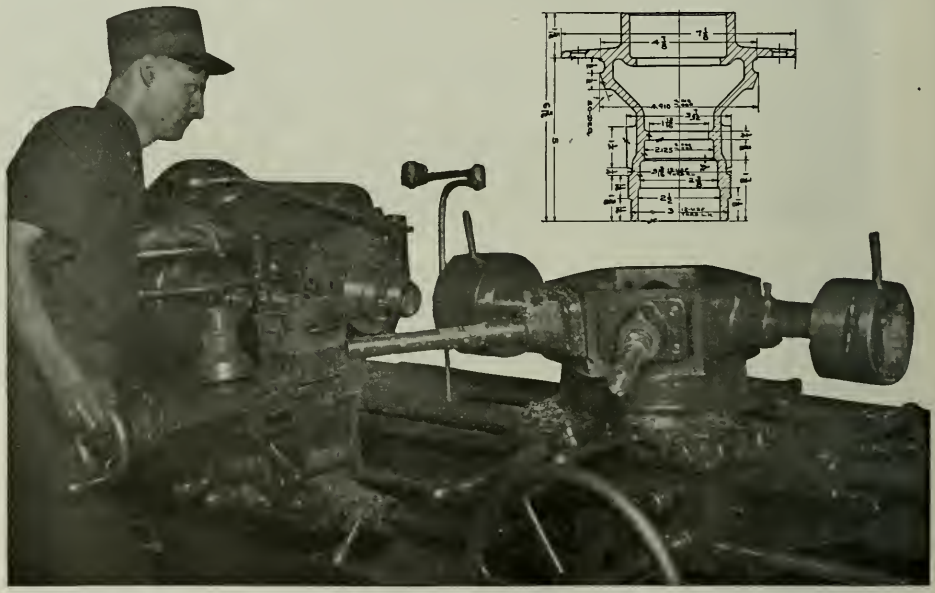
We are always glad to furnish estimates from samples or blueprints. Complete description of all standard and many "special" machines in catalog.

MACHINE CO., Cleveland, O., U.S.A.

AGENTS: Denmark and Norway, Chr. A. Herstad, Copenhagen, Denmark. France, Holland and Colonies, R. S. Stokvis & Zonen, Paris, France and Rotterdam, Holland. Switzerland, J. Lambercier & Co., Geneva, Switzerland. Spain and Portugal, American Machinery Syndicate, 35 West 39th Street, New York, N. Y.

W & S Turret Lathe

The manufacturer in whose plant this photograph was taken gave us permission to show it, but asked us not to mention his name or the time needed to finish the wire wheel hub. They make them so fast on their W & S 2-A they don't want to give their cinch away.



No. 2-A Finishing a Wire Wheel Hub

THE WARNER & SWASEY

BRANCH SALES OFFICES: **NEW YORK: Singer Building** **BOSTON: Oliver Building**

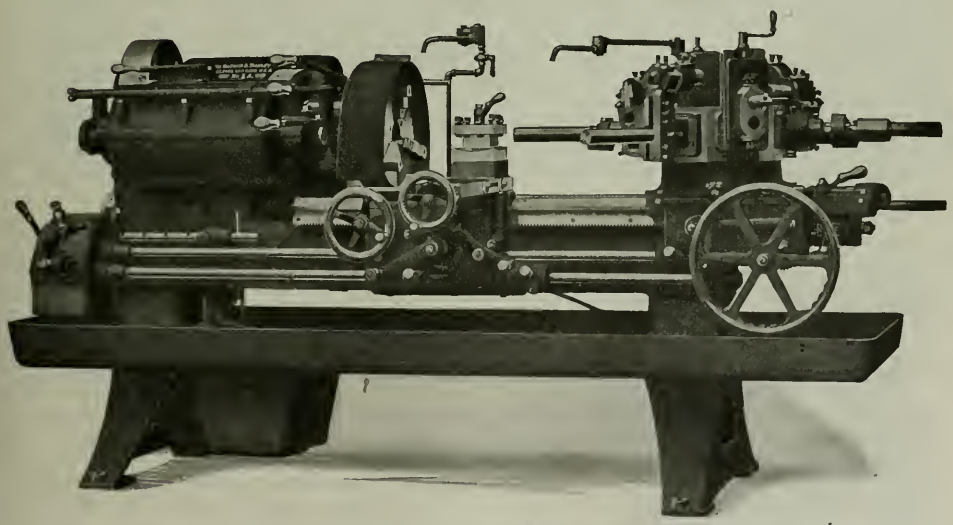
DOMESTIC AGENTS:
Fulton Supply Co., Atlanta, Ga.
Young & Vann Supply Company, Birmingham, Ala.
Woodward, Wight & Company, New Orleans, La.
Salt Lake Hardware Company, Salt Lake City, Utah.
Smith-Booth-Usher Company, Los Angeles, Cal.
Fred Ward & Son, San Francisco, Cal.
Portland Machinery Company, Portland, Ore.
Hallidie Machinery Company, Seattle, Wash.
Henry & Bolthoff Mfg. & Supply Co., Denver, Col.
Peden Iron & Steel Co., Houston, Texas.

CANADIAN AGENTS:
A. R. Williams Machinery Company, Ltd., Toronto, Winnipig Vancouver and St. John.
Williams & Wilson, Ltd., Montreal.

Pays Big Dividends

Every day more manufacturers are finding that the accuracy and speed of W & S Turret Lathes pay large dividends when used to finish hubs, gear blanks, fly wheels, pistons, piston rings and a lot more automobile parts. How about your turret lathe work?

Send us your blue prints and let us show you



No. 2-A Universal Hollow Hexagon Turret Lathe

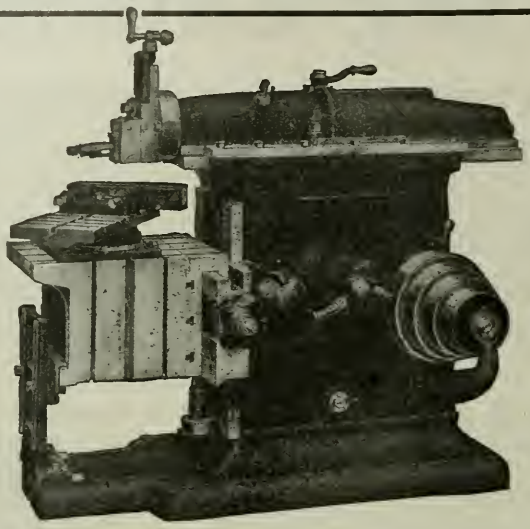
COMPANY, Cleveland, Ohio

BUFFALO: Iroquois Building DETROIT: Ford Building CHICAGO OFFICE and SHOW ROOM: 618-622 Washington Blvd.

FOREIGN AGENTS:

Charles Churchill & Company, Ltd., London, Birmingham, Manchester, Bristol, Newcastle-on-Tyne, Glasgow.
Allied Machinery Company, Paris, Turin, Zurich, Barcelona, Brussels, Wilhelm Sonesson Company, Malmo, Copenhagen, Stockholm, Gothenburg.
R. S. Stokvis & Zonen, Rotterdam.
Benson Brothers, Sydney, Melbourne, Adelaide.
McLeod & Company, Calcutta.
Yamatake & Company, Tokyo.
Andersen, Meyer & Company, Ltd., Shanghai, Tientsin, Pekin, Hankow, Canton, Yamanfu, Changhau, Kalgan.
Brossard, Mopin & Company, Saigon, Singapore, Haiphong.

Can You Answer These Questions?



WHICH IS THE BETTER?

Soft Machinery Steel Shafts; or High Grade Spindle Steel Shafts locally Hardened at Journals?

Squirt Can Methods of Oiling; or Ring-oiling Removable Bushings?

Gray Iron Castings; or Semi-steel (10 to 30% McLain Process)?

Plain Countershaft Bearings with dirty drip cups; or Hyatt Roller Bearings in Loose-pulley and Boxes, oil-tight?

Spur; or ALL Helical Driving Gears (Generated)?

A Prop under the Table; or a Real Table Support, self-adjusting, self-aligning and closely gibbed to Table at its extreme end, holding firmly on upward and lateral thrusts, as well as on downward pressure?

The usual inefficient Feed (awkward and dangerous for operator); or the Queen City Quick Change Feed (absolutely safe with NO moving handles), always on the return stroke and as easy to control as an electric switch?

Queen City Shapers are neither new and untried, nor so old that they are depending on past reputation; designed in 1903, just after the advent of High Speed Steel, and improved up to the minute.

Queen City Shapers are Superior to ALL others in every one of the following features: Accuracy, Handiness, Durability and Power, and, these features being combined in our shapers, make them Far Superior.

Champions in Appearance, Construction, Rigidity and Production.

16- 20- 24- and 28-inch Back Geared Crank Shapers, Cone or Single Pulley, Constant or Adjustable Speed Motors, Plain or Universal Table, etc. Investigate!

THE QUEEN CITY MACHINE TOOL COMPANY

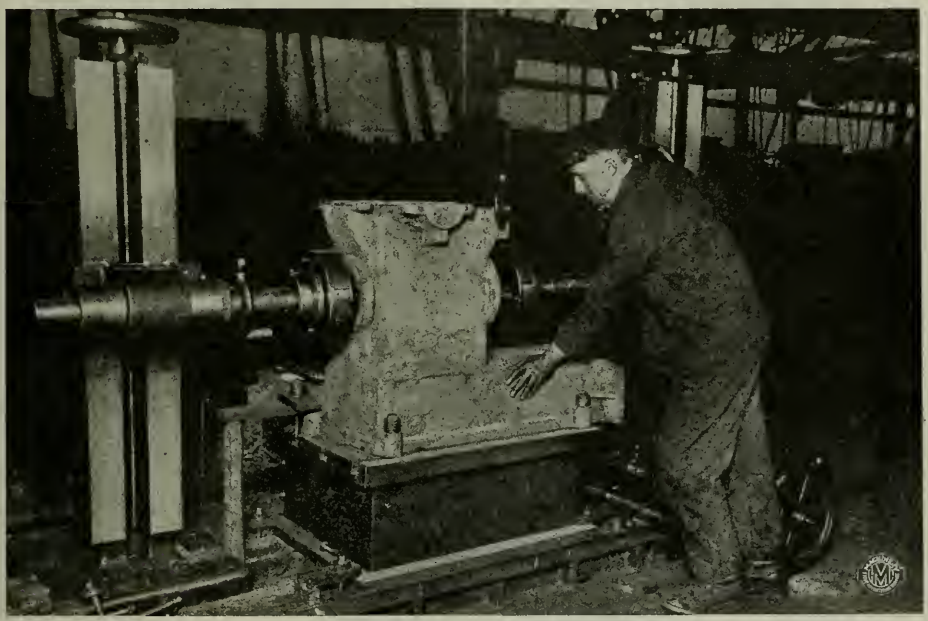
1401-7 Sycamore Street CINCINNATI, OHIO, U. S. A.

Agents in the principal cities of the world. We sell direct to user in Cincinnati District; send us your inquiries and you will get prompt and efficient service.

Foreign Agents: Alfred Herbert, Ltd., for Great Britain, India, Belgium, France and Spain.

PEDRICK COLUMN BORING MACHINE

Chosen for the Most Particular Work



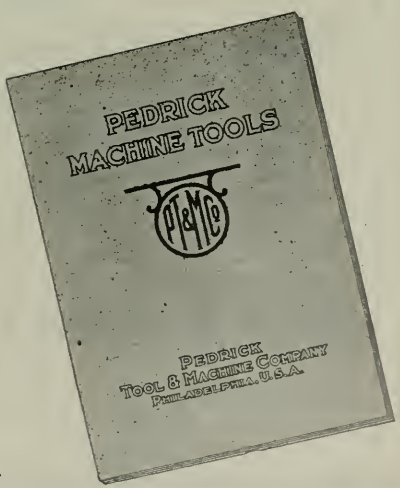
It is a significant fact that when the boring and facing operations in the Albro-Clem Elevator Company, Philadelphia, Pa., are more important than usual, the Pedrick Column Boring Machine is generally selected for the work.

In the Pedrick No. 1 Column Boring Machine shown, a cast-iron electric elevator worm gear housing is bored, reamed and faced.

The first operation is the facing of a boss 10½" diameter on each side of the housing. Boring is next performed, starting from a cored hole, and finishing to 7" in diameter. Hole is bored through, *i.e.*, two bearings are formed, one in each side of the casting. These are for the worm shaft. The worm wheel shaft is also bored on this machine and the location of the center distance must be extremely accurate in order that worm and worm wheel shall mesh properly.

Tell us your problems and we'll advise you which units of the Pedrick line will best solve them.

Send for a copy of our New Catalog. It contains a List of Unusual Tools, Machines and Appliances for Shop and Factory.



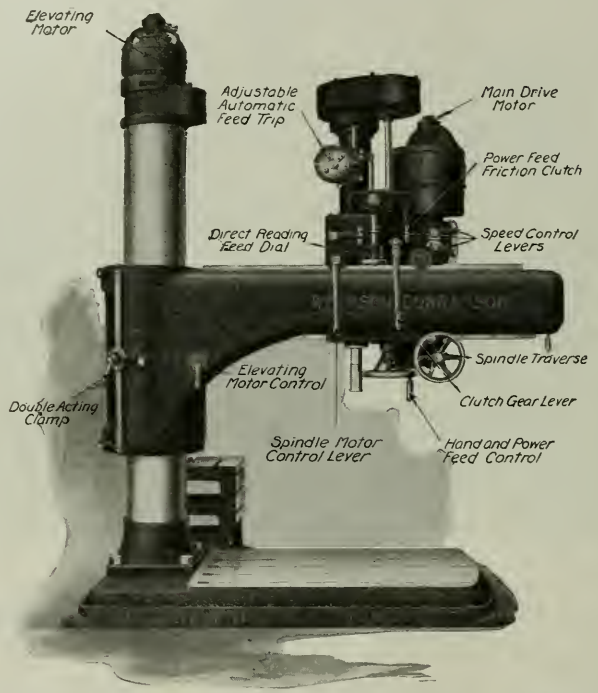
PEDRICK TOOL & MACHINE CO.

3639 N. LAWRENCE STREET

Philadelphia **Pa., U. S. A.**

The Ryerson-Conradson Four-Purpose Radial

U. S. AND FOREIGN PATENTS



Drilling—Tapping—Boring—Reaming

Can be performed on this machine with equal efficiency

Power consumption practically 40% less than that of other radial drills.
All shafts concentrated in head.
Splash oiling system.
All bevel gears and friction clutches for tapping, eliminated.
Exceptional feed range. Sixteen feeds from .005" to .370".

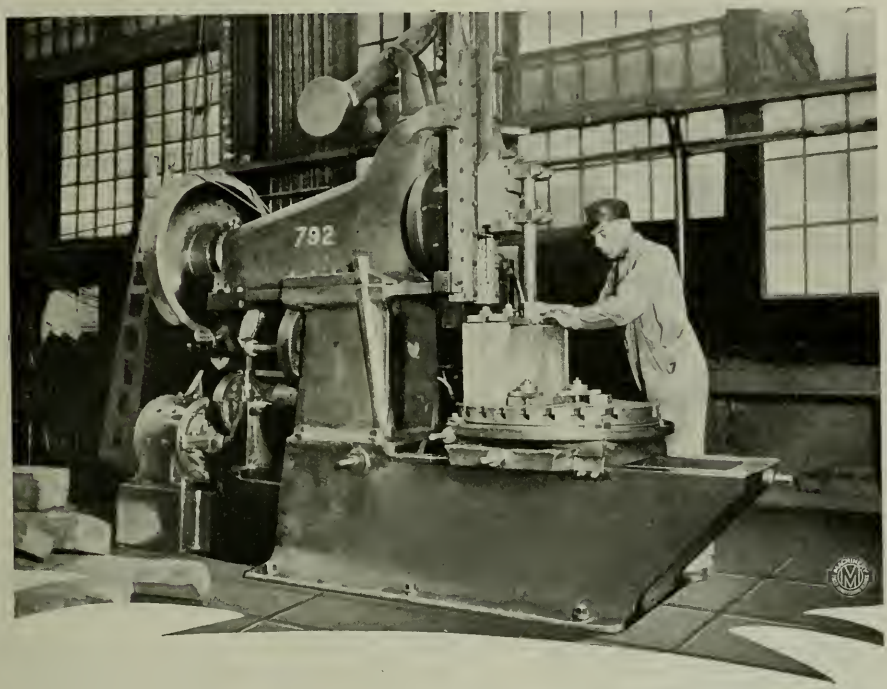
The new Bulletin No. 4001 describes completely, the special features and advanced design of the Ryerson-Conradson Radial. Write for it!

JOSEPH T. RYERSON & SON

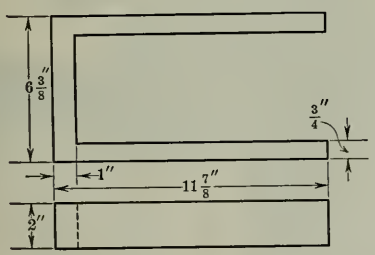
MACHINERY

CHICAGO ST. LOUIS DETROIT BUFFALO NEW YORK

THE DILL SLOTTER



Installed to Solve One Problem, It Solved Many



Write for your copy of "The Dill Slotter in Action"

When this Dill Slotter was ordered by the Struthers & Wells Co., of Warren, Pa., it was scheduled to perform a specific piece of work which might otherwise have necessitated expensive special equipment. That work was machining deep fork-shaped sections of large castings. The Dill traveling head, of course, made this operation a simple one, but it was soon seen that the Dill was equally suitable for a great many other varieties of work, and its operations were soon extended.

The photograph shows the machining of connecting rod straps. These steel forgings are machined both inside and out. About 1/16" of stock is removed on the inside and 3/16" from the outside. Dimensions are shown in sketch. These parts are clamped in a fixture, six being machined at a time.

T. C. DILL MACHINE COMPANY

THE DILL SLOTTER PEOPLE

PHILADELPHIA, PA.

FOREIGN AGENTS: Alfred Herbert, Ltd., British Isles. Alfred Herbert, Ltd., Yokohama, Japan. Societe Anonyme Belge, Alfred Herbert, Brussels Belgium. Societe Anonyme, Alfred Herbert, Ltd., Paris, France. Societa Anonima Italiana, Alfred Herbert, Ltd., Milan, Italy. Allied Machinery Co., S. A. E., Barcelona, Spain. Monteiro Gomes, Ltda., Lisbon, Portugal. Allied Machinery of America, Shangbai, China. Benson Brothers, Ltd., Sydney, Australia.

Don't Scrap a Set of Hartness Chasers because of the breakage of a single chaser; *replace the broken chaser*

It is only necessary to grind the set to uniformity.

HARTNESS CHASERS Are Interchangeable

This Interchangeability of Hartness Chasers is possible because of our special method of manufacture.

JONES & LAMSON MACHINE COMPANY

DIE DIVISION

SPRINGFIELD VERMONT, U. S. A.

AMERICAN AGENTS FOR DIES AND CHASERS

Boyer-Campbell Co., Detroit
Carey Mchy. & Supply Co., Baltimore
E. L. Essley Mchy. Co., Chicago, Milwaukee and Moline
The E. A. Kinsey Co., Cincinnati, Indianapolis and Columbus
Machinists Supply Co., Pittsburgh
Robinson, Cary & Sands Co., St. Paul and Duluth
A. V. Wiggins & Co., Syracuse
The Fairbanks Company, Albany, New York; Buffalo, New York; Bridgeport, Connecticut; Hartford, Connecticut; Providence, Rhode Island, Boston, Massachusetts; New York, New York; Newark, New Jersey; Scranton, Pennsylvania; St. Louis, Missouri; Birmingham, Alabama; New Orleans, Louisiana.

FOREIGN AGENTS:

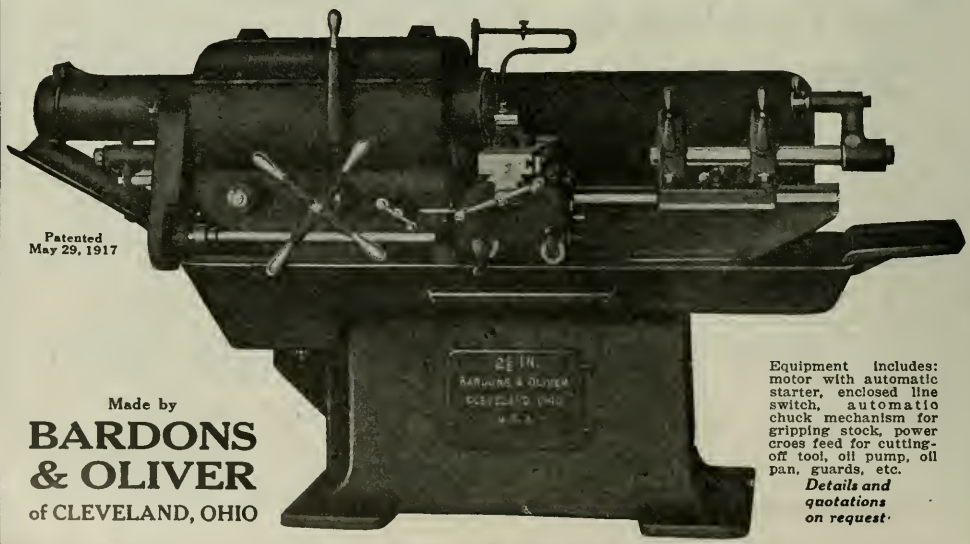
For France, Spain and Belgium: F. Auberty & Co., 91 Rue de Maubeuge, Paris.
For Holland: Spliethoff, Beeuwkes & Co., Rotterdam
For Australia: McPherson's Pty., Melbourne
Japan, Manchuria, Korea, Formoso Mitsui Bussan Kaisha, Ltd., Tokyo, Japan

Accelerated Speed Cutting-Off Machine

—the Best on the Market

The method of "acceleration" on which we base our claims is a special arrangement of the variable speed motor which automatically increases the spindle speed as the cutting tool approaches the center.

This feature, coupled with the high-grade material and workmanship used in manufacturing this powerful and accurate cutting-off machine, has made it the standard in many leading shops.



Patented May 29, 1917

Made by
BARDONS & OLIVER
of CLEVELAND, OHIO

Equipment includes: motor with automatic starter, enclosed line switch, automatic chuck mechanism for gripping stock, power cross feed for cutting-off tool, oil pump, oil pan, guards, etc.

Details and quotations on request



Boyer Chipping Hammer, Type K, finishing large cast-steel gear

Do you chip pneumatically?

HERE is a widely popular Boyer Chipping Hammer—the Type K—that is ideal for general machine shop, foundry and allied work.

Boyer Chipping Hammers have the same built-in qualities as the famous Boyer Riveting Hammer itself; fast-hitting power, freedom from wasteful vibration, accurately fitted air-tight parts made from finest materials carefully heat treated, and day-in-day-out dependability that spells *low upkeep.*

Boyer Chipping Hammers are made in a wide variety of types and sizes for every conceivable chipping, calking, beading, scaling or light riveting job. And *stock delivery* is procurable from any Company Branch.

Ask for new instructive Pneumatic Tool Catalog 560.

Chicago Pneumatic Tool Company

Chicago Pneumatic Building · 6 East 44th Street · New York

*Sales and *Service Branches all over the World*

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P 62

BOYER PNEUMATIC HAMMERS··LITTLE GIANT PNEUMATIC AND ELECTRIC TOOLS
CHICAGO PNEUMATIC AIR COMPRESSORS··VACUUM PUMPS··PNEUMATIC HOISTS,
GIANT OIL AND GAS ENGINES ROCK DRILLS ·· COAL DRILLS

BOYER HAMMERS

The world's standard *wherever rivets are driven*

TRADE W.F. & J.B. MARK

Complete Line

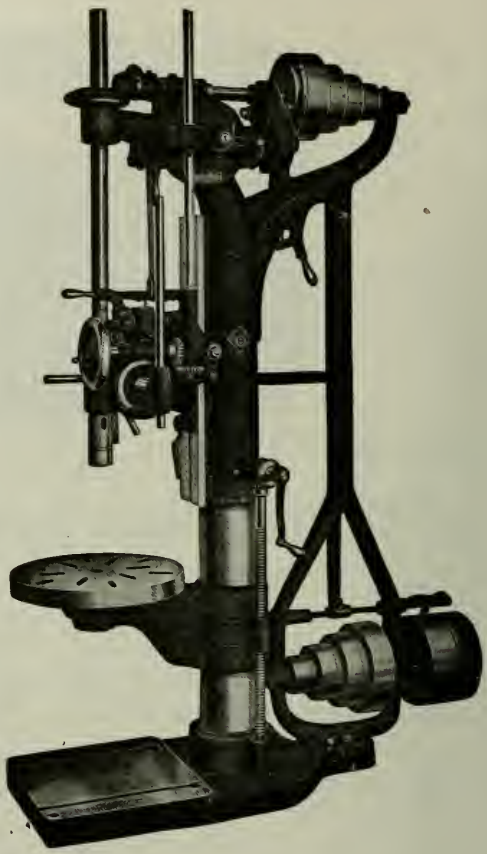
8-inch to 50-inch Swing

(With or without Tapping Attachment)

Upright Drills

Horizontal Drills

Gang Drills



BARNES DRILLS

Accuracy
Convenience of Operation
Strength

MADE BY

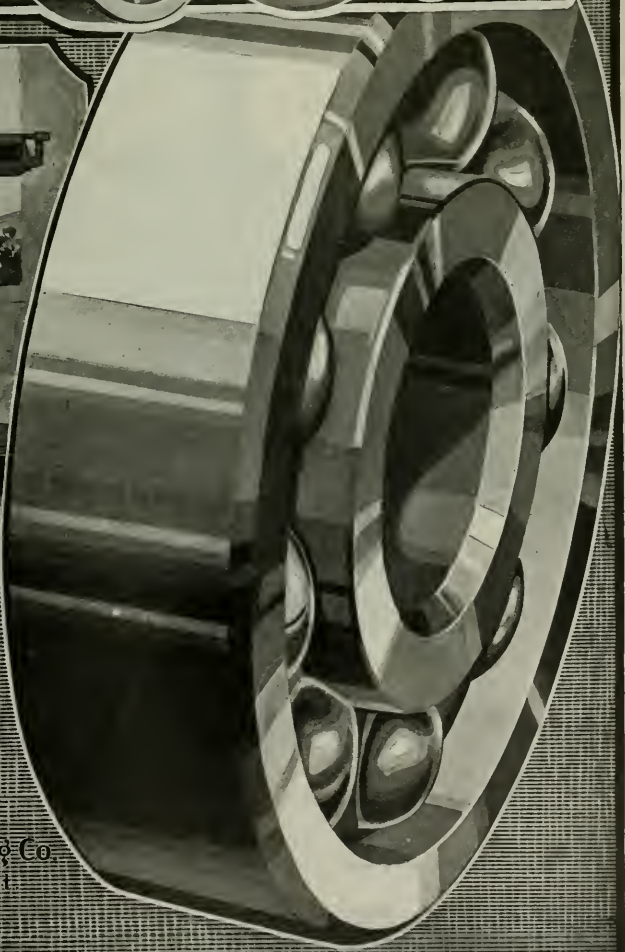
W. F. & JOHN BARNES CO.

231 RUBY ST. ROCKFORD, ILL., U.S.A.

NEW DEPARTURE

Ball Bearings

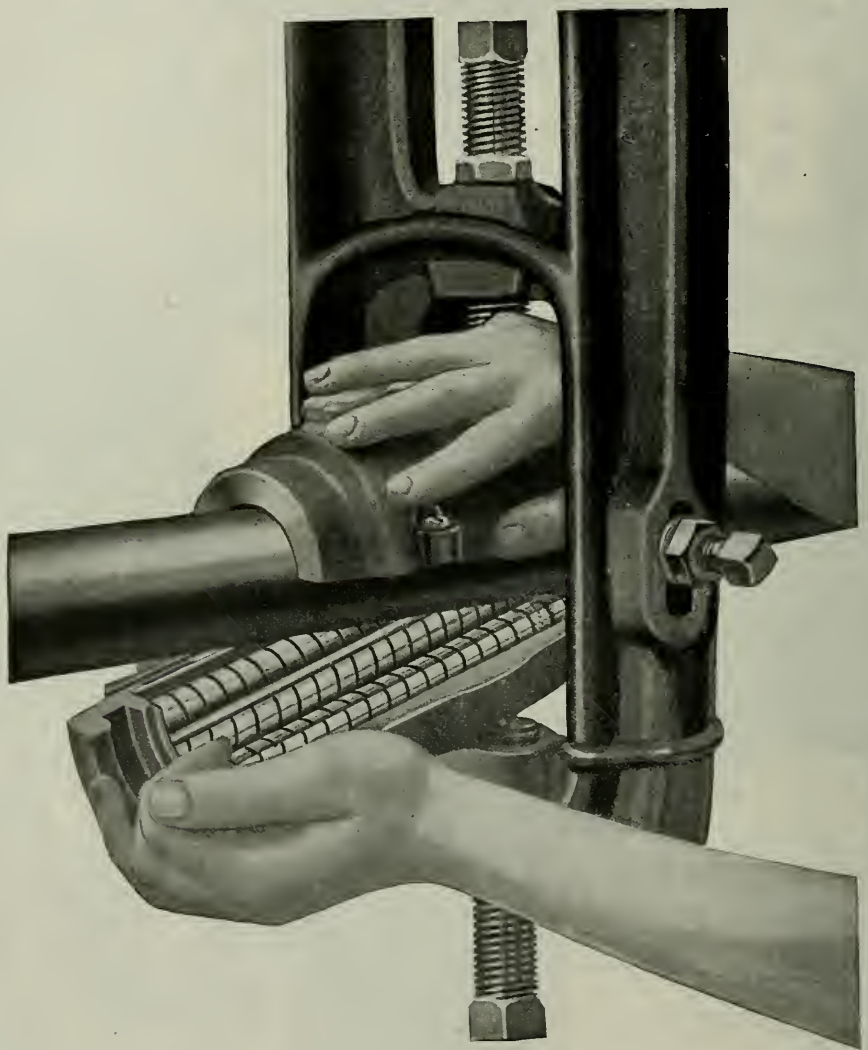




Machine designers prefer New Departure Ball Bearings because they not only eliminate friction to the utmost and have superlative endurance, but New Departure Engineering Data Bulletins are most helpful to those who lay out new installations. Are you receiving the monthly bulletin service? 614.

New Departure Manufacturing Co.
Bristol Connecticut
Chicago Detroit
Conrad Patent Licensee

WHY ARE MODERN MEN'S SHIRTS



HYATT BEARINGS

LIKE HYATT BEARING HANGERS?

THEY'RE SPLIT!

to Make Them Easy to Put On

HYATT Roller Bearing Hangers are split throughout and can be applied to any shaft at any time without disturbing couplings, collars or pulleys. The box is opened, applied around the shaft and the two halves screwed together. Any millwright can properly apply the bearing.

Specify Hyatt Roller Bearing Hangers—their simplicity makes them trouble proof.

Write at once for Bulletin No. 125

MOTOR BEARINGS DIVISION
DETROIT, MICHIGAN

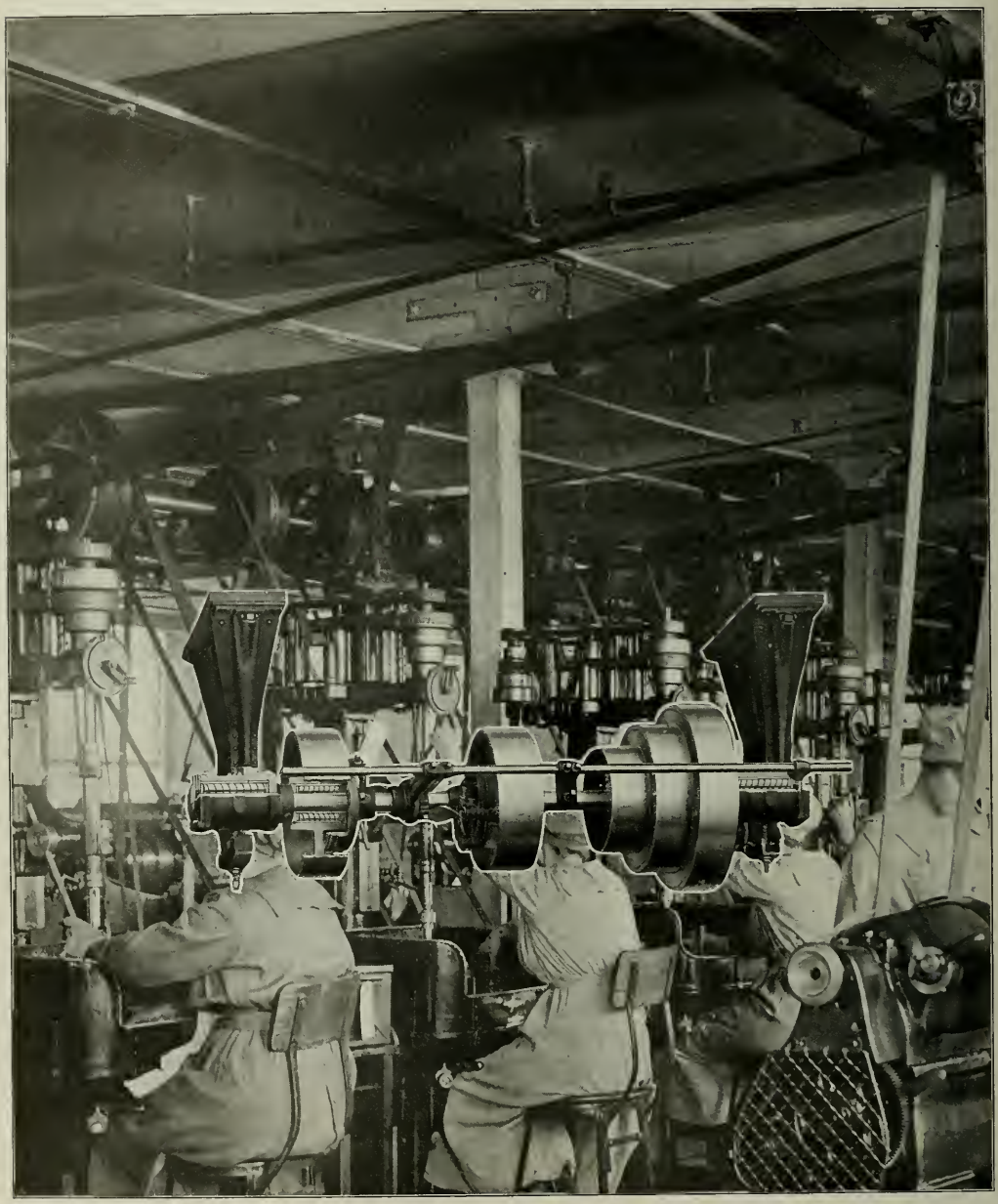
HYATT ROLLER BEARING COMPANY
INDUSTRIAL BEARINGS DIVISION
NEW YORK, N. Y.

TRACTOR BEARINGS DIVISION
CHICAGO, ILL.

D-158

FOR LINE SHAFTS

Are Your Countershafts



HYATT BEARINGS

Assets or Liabilities?



Hyatt Bearings Are Assets

If you are furnishing your customers old-fashioned, plain bearing countershafts with your modern, improved machine tools, you are selling them liabilities—expenses—additional burdens to carry.

Much of the time and money spent in refining the design and construction of a good machine tool is lost when your customers connect it to an inferior, power and lubricant wasting countershaft.

Hyatt Roller Bearing Countershafts are assets—they save power, lubricant, and are dependable. They deliver maximum power for useful work, and operate for years with no appreciable wear.

Satisfied customers are assets. See to it that you satisfy your customers by supplying Hyatt equipped countershafts.

HYATT ROLLER BEARING COMPANY
Industrial Bearings Division

Motor Bearings Division
DETROIT, MICH.

NEW YORK, N.Y.

Tractor Bearings Division
CHICAGO, ILL.

Manufacturers of Bearings for Mine Cars, Ore Cars, Steel Mill Cars, Roller Tables, Trolleys, Cranes, Hoists, Machine Tools, Line Shafts, Countershafts, Concrete Machinery, Textile Machinery, Conveyors, Lift Trucks, Industrial Trucks, Railway Service Cars, Storage Battery Locomotives, etc.

489

FOR COUNTERSHAFTS

SCHIEREN
DUXBAK BELTING
TRADE MARK
LEATHER BELTINGS

Graphic Story of Belt Making

The Chas. A. Schieren Company announce that the moving pictures of actual Belt Making—from the hide to the finished belt—are now completed and will be shown free of cost.

These moving pictures have been prepared for us by the "Universal," under the guidance of our experts at our tanneries, Bristol, Tenn., and at our factories in New York City, and are strictly industrial, educational and interesting to every belt buyer and user.

They are under our own supervision and will be shown in your offices, factories, etc., only on request.

If you are interested, please advise our Advertising Department and bookings will cheerfully be made to comply as near as possible with your wishes.

CHAS. A. SCHIEREN COMPANY
Advertising Department

73 FERRY STREET NEW YORK, N. Y.

20-8



Hundreds of "Pierce Arrow" Parts Are Measured With

SLOCOMB MICROMETERS

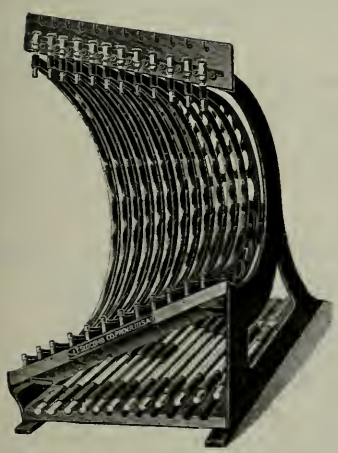
SLOCOMB MICROMETERS ARE STANDARD THE WORLD OVER

Reg. U. S. Pat. Office

THIS photograph shows a 16-17″ Slocomb Micrometer being used to measure a brake shoe—one of hundreds of automobile parts measured with Slocomb Micrometers at the Pierce Arrow Motor Car Company's big plant at Buffalo, N. Y.

Slocomb Micrometers are used in practically every department throughout this entire plant—their unusual durability being well adapted to the hard service involved.

This is due to their distinctive one-piece hardened tool steel screw with four times the usual bearing on the nut, I beam construction insuring rigidity without undue weight, a solid tool-steel anvil, one-piece sleeve, an exclusive uniform tension spring between the adjusting nuts and other practical advantages which have given the "Slocomb" the reputation of being *"the longest lived micrometer that can be bought."*



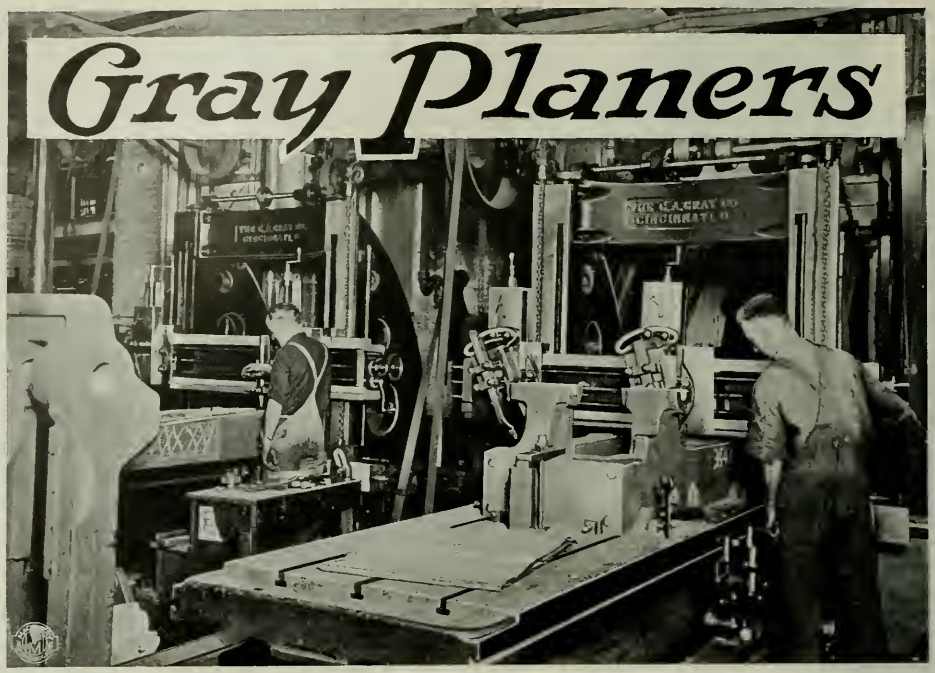
Catalog 16 for details

J. T. SLOCOMB CO.

PROVIDENCE **R. I., U. S. A.**

CHICAGO REPRESENTATIVE: R. R. Street & Company, Machinery Hall. PACIFIC COAST REPRESENTATIVES: The Charles A. Dowd Sales Co., 320 Market St., San Francisco. FOREIGN AGENTS: England: Chas. Churchhill & Co., Ltd., London, Birmingham, Manchester, Newcastle-on-Tyne and Glasgow. Japan: Alfred Herbert, Ltd., Yokohama. Italy: Chas. Civita, Milan. Australia: Edwin Wood, Pty., Ltd., Melbourne and Sydney.

Gray Planers



Are Standard Equipment at Waterbury Farrel

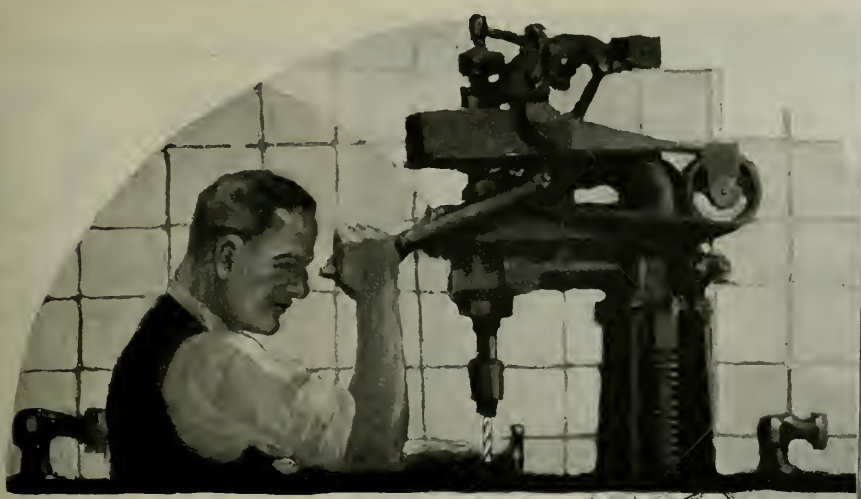
These are two of the twenty-two Gray Planers in the plant of the Waterbury Farrel Foundry and Machine Co., at Waterbury, Connecticut. The right hand machine is planing up to a shoulder—a job where accurate reversal is absolutely essential. The operator isn't worried; he has confidence in his Gray.

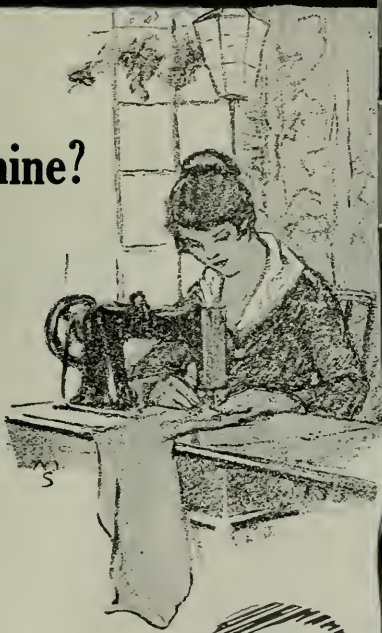
Exceptionally wide belts give these planers great driving power without excessive belt speeds. A simple powerful belt shifting mechanism gives easy control of reversing without a slam. Aluminum pulleys contribute as well to speedy reversal.

There are many other good reasons why so many Gray Planers are working in this shop and our catalog gives them all. Why not investigate?

THE G. A. GRAY COMPANY

CINCINNATI OHIO, U. S. A.





How Many Holes Are Drilled in a Sewing Machine?

Merely look at the arm, the bed plate, the face plate, and the stand of a sewing machine and count the number of drill holes in them.

This will increase your appreciation of the twist drill's importance in helping to fashion the utilities which contribute to the comforts of your daily life. Also, it will emphasize how Detroit Twist Drills serve you by serving those who build these utilities.

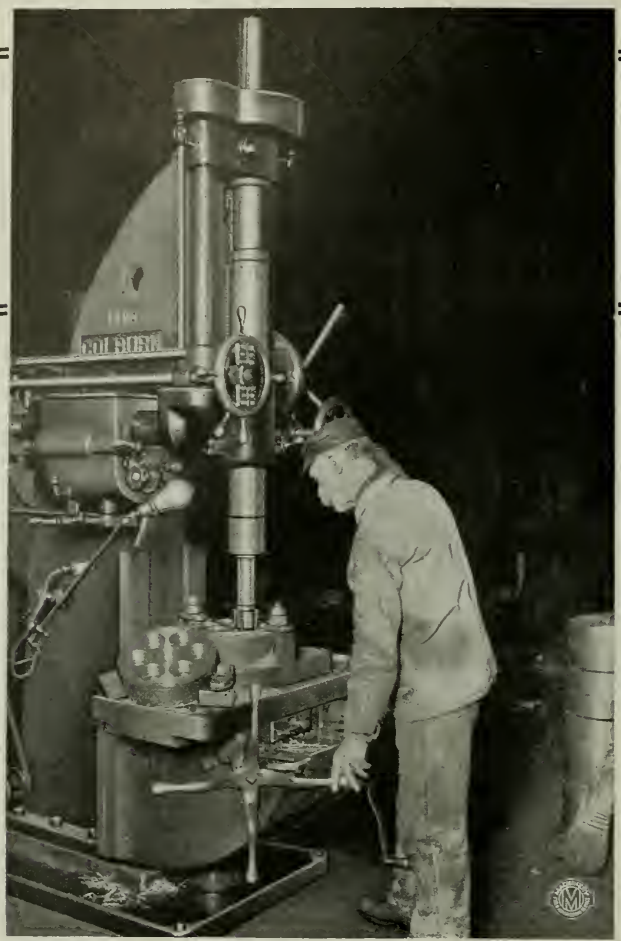
And in the sewing machine industry, too, Detroit Twist Drills are used because they give more accurate holes with less regrinding and less cost for power.

In Your Next Order Specify
Detroit Twist Drills

Detroit Twist Drill Company, Detroit, Mich.



DETROIT TWIST DRILLS



CO

Builders of

The Capacity of the D-4 Colburn Heavy Duty Drill Press is Limited Only by the Tools it Drives

THE work-in-process when the above photo was taken was valve cages of forged steel, 11½" outside diameter and 3⅜" thick, with seven 2¼" holes rough punched through them—one in the center, the rest centering on a circle 7⅛" diameter. The operations performed on these parts with the help of the Colburn Heavy Duty Drill Press are as follows: 1st, rough bore the seven holes to $2\frac{15}{16}$" diameter; 2nd, rough ream with stepped tooth taper reamer; 3rd, finish ream to size. This is no light task, for the material is so tough that the tools will not stand hard driving; but in spite of this handicap, the operator completes four of these valve cages—28 holes, bored, reamed and finish reamed—per nine-hour day, thanks to the power and rigidity of the Colburn Drill.

The above operation is typical of the service this machine has performed for over three years for the National Transit Pump & Machine Company, Oil City, Pa., typical also of the efficiency with which all Colburn Machines—Vertical Boring and Turning Mills as well as Drill Presses—handle difficult and exacting operations on a wide variety of work.

Let us tell you more about them.

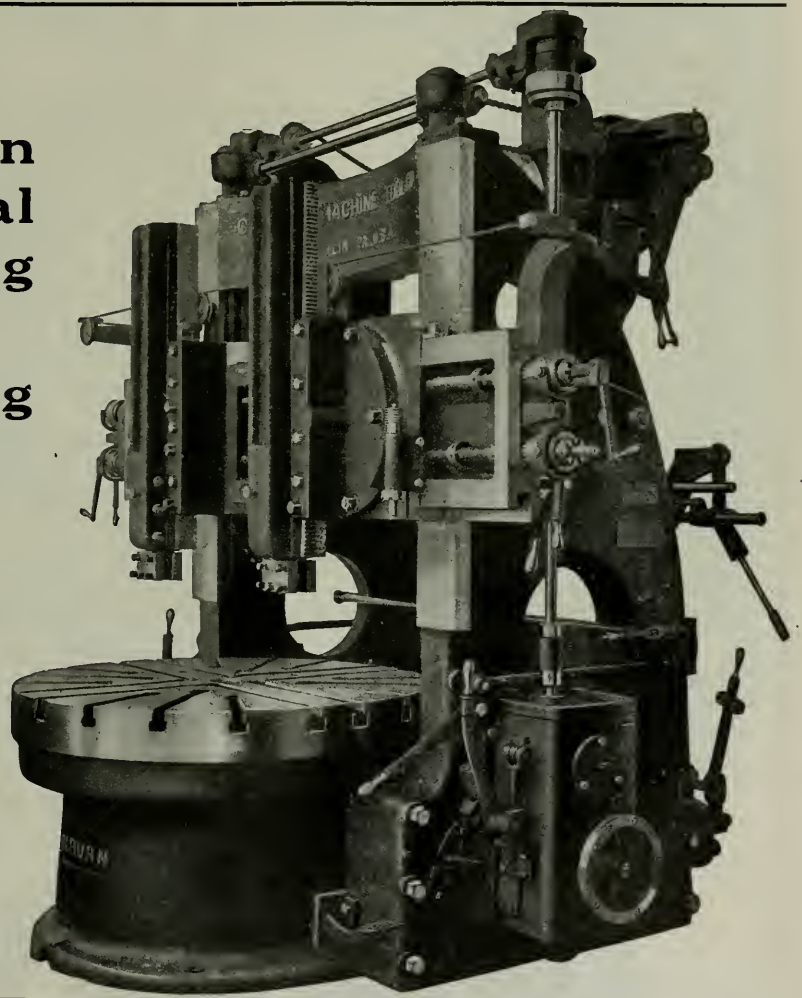
COLBURN MACHINE TOOL

DOMESTIC AGENTS: Henry Prentiss & Co., Inc., New York, Boston, Hartford, Conn., Buffalo, Rochester, Syracuse, N. Y., Scranton, Pa.; Strong, Carlisle & Hammond, Cleveland and Detroit; Brown & Zortman Mach. Co., Pittsburgh; Sherritt & Stoer Co., Philadelphia; Dale Brewster Co., Chicago; Northern Machinery Co., Minneapolis and Duluth; Seifreat-Woodruff Co., Cincinnati and Dayton, Ohio; Berger & Carter, San Francisco and Los Angeles, Cal.; Hallidie Machinery Co., Seattle, Wash.; Young & Vann Supply Co., Birmingham, Ala.; C. T. Patterson Mach. Co., New Orleans, La.; Ralph B. Bowman, St. Louis, Mo., Mills & Lupton, Chattanooga, Tenn.; Fulton Supply Co., Atlanta, Ga.; Marshall & Huschart Mchy. Co., Indianapolis, Ind. (Drill Presses only). CANADIAN AGENTS: H. W. Petrie, Toronto, Ont.; Rudel Belnap Mchy. Co., Montreal, Que. FOREIGN AGENTS: Fenwick Freres, France, Switzerland, Italy; E. Isbecque & Co., Belgium; American Machinery Syndicate, Spain and Portugal; Charles Churchill & Co. (Boring Mills only), England; Alfred Herbert, Ltd. (Drill Presses only), England, Australia, Japan, India.

L B U R N

Heavy Duty Drill Presses and Vertical Boring and Turning Mills

Colburn Vertical Boring and Turning Mill

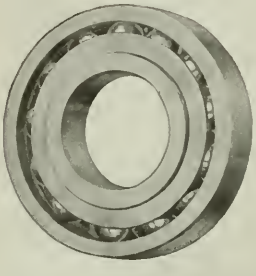


Machines with the capacity to take fine, finishing cuts with a high degree of accuracy and heavy, roughing cuts without chatter.

Machines with a reputation for power, speed and operating convenience coupled with a range of adaptability well worth investigating.

COMPANY, Franklin, Pa., U.S.A.

DOMESTIC AGENTS: Henry Prentiss & Co., Inc., New York, Boston Hartford, Conn., Buffalo, Rochester, Syracuse, N. Y., Scranton, Pa.; Strong, Carlisle & Hammond, Cleveland and Detroit; Brown & Zortman Mach. Co., Pittsburgh; Sherritt & Stoer Co., Philadelphia; Dale Brewster Co., Chicago; Northern Machinery Co., Minneapolis and Duluth; Seifreat-Woodruff Co., Cincinnati and Dayton, Ohio; Berger & Carter, San Francisco and Los Angeles, Cal.; Hallidie Machinery Co., Seattle, Wash.; Young & Vann Supply Co., Birmingham, Ala.; C. T. Patterson Mach. Co., New Orleans, La.; Ralph B. Bowman, St. Louis, Mo., Mills & Lupton, Chattanooga, Tenn.; Fulton Supply Co., Atlanta, Ga.; Marshall & Huschart Mchy. Co., Indianapolis, Ind. (Drill Presses only). CANADIAN AGENTS: H. W. Petrie, Toronto, Ont.; Rudel Belnap Mchy. Co., Montreal, Que. FOREIGN AGENTS: Fenwick Freres, France, Switzerland, Italy; E. Isbecque & Co., Belgium; American Machinery Syndicate, Spain and Portugal; Charles Churchill & Co. (Boring Mills only), England; Alfred Herbert, Ltd. (Drill Presses only), England, Australia, Japan, India.



The Area Contact in Gurney Bearings

A ball in a Gurney Ball Bearing does NOT have "Point contact."

Because the contour of the Gurney races very closely approaches that of the balls, and because all balls are slightly compressed under load, a larger portion of their circumference coincides with the contour of the race-ways. Thus the spots of contact are of quite an appreciable area, and increase at a rapid rate with increased load.

In fact, in some Gurney Bearings, each ball is capable of carrying as much load with safety as 26 balls of this same size rolling between two plane surfaces.

The Gurney Idea of "area of contact," together with the Gurney Method of assembling which permits maximum size and number of balls, accounts for the greater load capacity of Gurney Ball Bearings.

GURNEY BALL BEARING COMPANY

Conrad Patent Licensee

Jamestown, N. Y.

GURNEY

BALL BEARINGS



GODDARD TOOL COMPANY

PLANT Chicago PLANT Detroit

Branch Offices

Philadelphia Bourse, Philadelphia—404 Mutual Home Bldg., Dayton, Ohio

Stock of Standard Cutters and Hobs Carried at Both Branch Offices

CARD



Taps of Uniform Quality for All Purposes

The CARD Quality

Everyone has his preferences and his own reasons for them. The machinist prefers Card Taps because they make his work easier and better; the foreman requisitions them because they enable him to "get production"; and the boss endorses them because they insure interchangeability to his threaded parts—at a handsome profit.

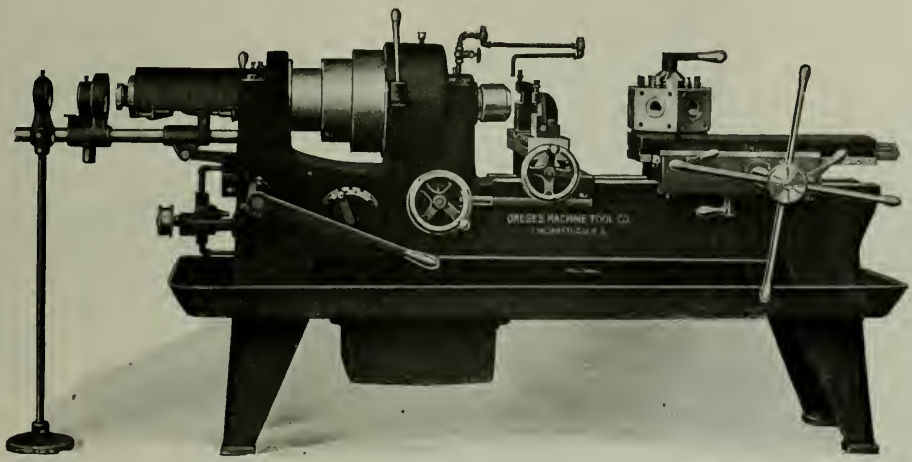
Standard for 46 years. Catalog 29 lists full line.

S. W. CARD MANUFACTURING COMPANY

Division of Union Twist Drill Co.

NEW YORK OFFICE, 62 READE ST. MANSFIELD, MASS., U. S. A.

EUROPEAN AGENTS: Chas. Churchill & Co., London, Birmingham, Manchester, Glasgow and Newcastle-on-Tyne. Markt & Co., Ltd., Paris. V. Lowener, Vesterbrogade 9 B, Copenhagen, Denmark. V. Lowener, Drottinggattan 90, Stockholm, Sweden. V. Lowener's Maskinforretning, Sverre Mohn, Christiania, Norway. R. S. Stokvis & Zonen, Ltd., Rotterdam. J. Lambercier & Co., Geneva. C. Civita, Milano, Italy. R. D'Aulignac, Barcelona, Spain. Ateliers Demoor, Brussels, Belgium. A. M. Papasideris & Co., Athens, Greece. Andersen, Meyer & Co., Ltd., Shanghai, Changsha, Hankow, Harbin, Hongkong, Kalgan, Pekin, Tientsin, and Vladivostock. Mestre & Blatge, Rio de Janeiro, Brazil; Buenos Aires, Argentine Republic.

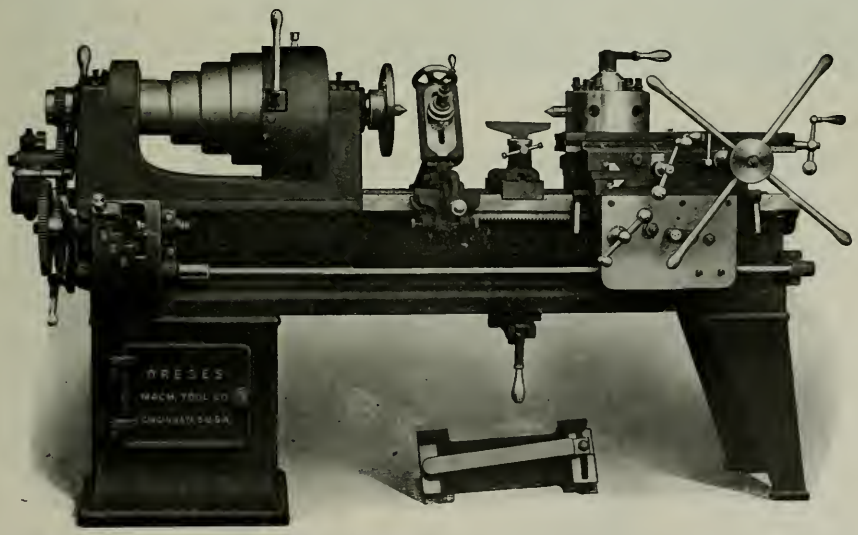


1", 1¼" and 2¼" SCREW MACHINES

DESIGN and QUALITY

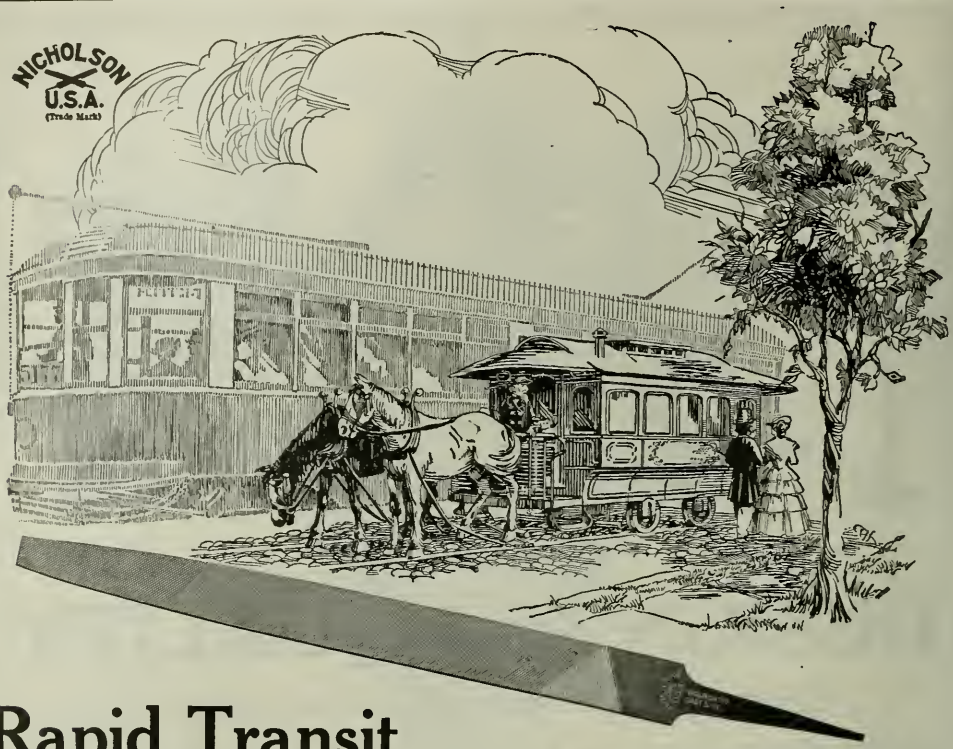
Distinguish our complete line of

SCREW and TURRET MACHINERY



15" 18" and 20" UNIVERSAL MONITORS

DRESES MACHINE TOOL CO., Cincinnati, Ohio

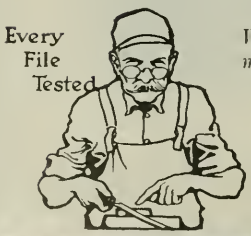


Rapid Transit

A great mechanical industry of itself, yet multiplied in importance in the industrial world because it enables the strategical concentrations of workers that are essential to today's production in unprecedented volume.

NICHOLSON FILES

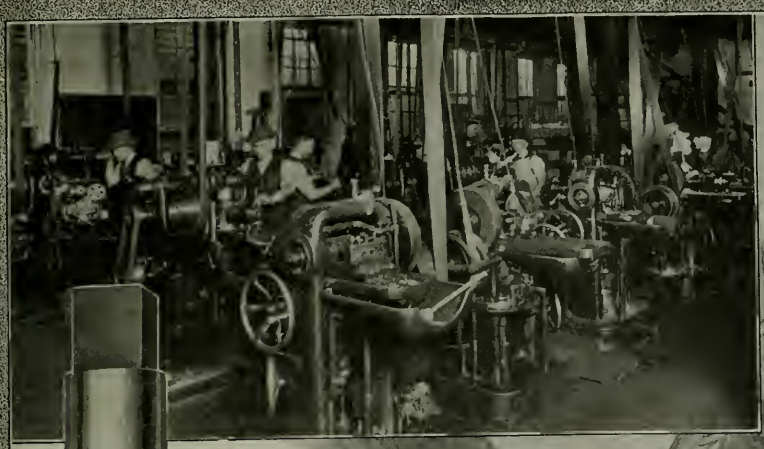
have kept apace with the manufacturing developments that have built up modern interurban and street railways and have served faithfully in car building and repairing plants. Day by day, year by year, better files, more of them. And always of the uniformity of cutting quality that has won them staunch friends among those who know and value good files.



Write for our Catalog and for File Filosophy—a most instructive booklet about files and their use.

NICHOLSON FILE CO.

PROVIDENCE, R.I., U.S.A.







Flutes and Production

The depth and the width of the flute and its angle determine a tool's production value. The flutes in Ampco reamers are milled unusually deep without sacrificing, in the slightest degree, toughness and endurance.

Deep flutes mean more holes reamed per tool.

Ampco reamers last longer—and they always guarantee a re-order.

If you have not tried Ampco reamers order some and get all the holes from a reamer that you should.

Because we specialize we always carry a complete stock of standard sizes—3- and 4-lip drills, reamers, cutters and end mills.

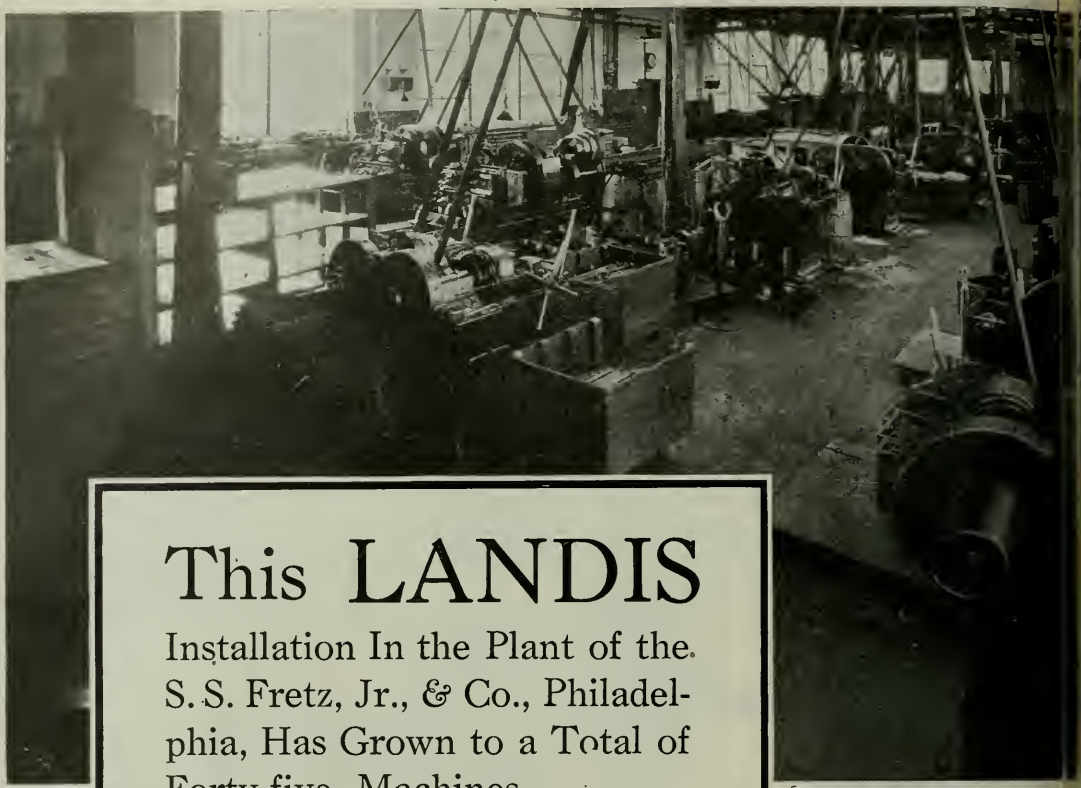
Ampco means Endurance and Accuracy.

AMERICAN MACHINE PRODUCTS CO.
DETROIT

Cleveland Office:
716 Superior Ave., N. W.

Canadian Plant:
Ingersoll Machine Co., Ingersoll, Ont.

Chicago Office:
524 Madison Terminal Bldg., 9 South Clinton St.

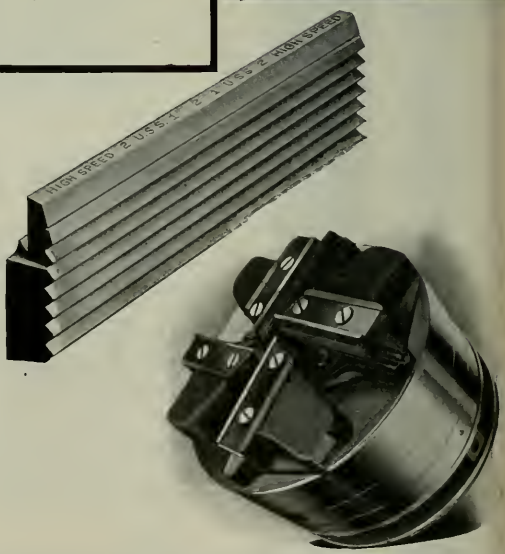


This LANDIS

Installation In the Plant of the S. S. Fretz, Jr., & Co., Philadelphia, Has Grown to a Total of Forty-five Machines.

A period of four years separates these two installation photographs, both taken in the plant of S. S. Fretz, Jr., & Co., Philadelphia, Pa. The smaller one shows this company's Landis installation as it was in 1916—the larger as it is today; twenty-six and forty-five machines respectively.

Since this company ordered its first two Landis Threading Machines in 1914 its growth has been enormous and its Landis installation correspondingly great.



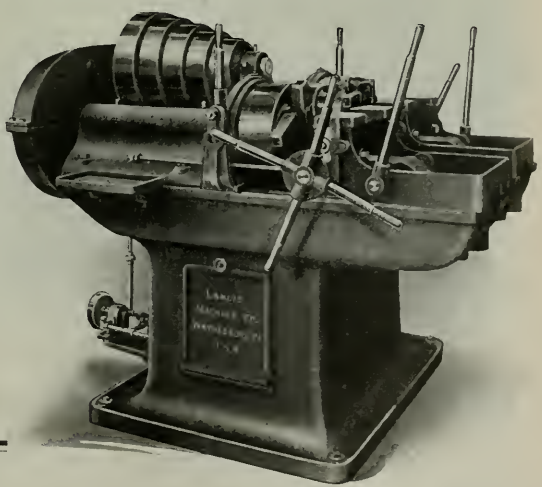
LANDIS MACHINE COMPANY, Inc.,



Landis Threading Machines are used by many concerns, large and small, as standard threading equipment. They have many distinctive features which make for ease of operation, accuracy of product and economy in bulk production.

Remember that Landis Threading Machines will cut both right- and left-hand threads from the same chasers by simply using right- or left-hand holders; and there's no hobbing, re-tempering, etc.

We shall be glad to give you full particulars of Landis Threading Machines, and to advise you regarding choice of threading equipment for your own particular problems. Write.



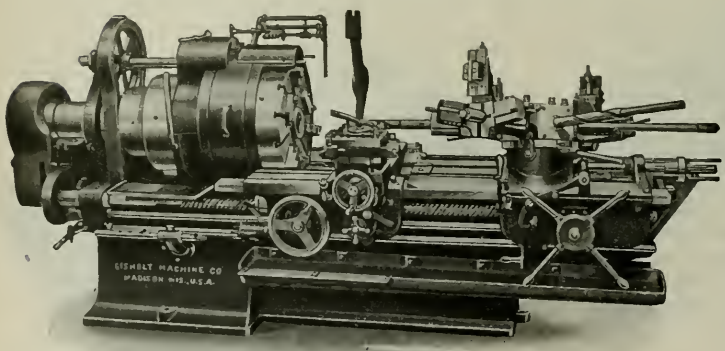
Waynesboro, Pa., U. S. A.



Some Gisholt Turret Lathe Advantages

Get this! Gisholt Standard Turret Lathes are high production machines, but because they are, it does not follow that large quantities of the same piece must be produced in order to make the Gisholt a paying investment. You can set up the Gisholt turret lathe and produce three or four pieces in the identical time required for turning out the same number of pieces by the single tool method. And once the Gisholt is set up, its multiple cutting tools and automatic stops make it possible to turn out the work fast and accurately. Study these economic advantages:—

1. More work can be produced with the same amount of labor and floor space than is possible with machines using single tools. 2. Work will be more accurate, more nearly duplicate and will flow in a faster stream through the machine shop. 3. Quicker delivery of finished parts to your assembly floor, and in larger lots. 4. In addition to producing more parts of a kind at a time, in the machine shop, the work will be greatly simplified, as less fitting is required on the assembly floor, due to more accurately machined parts. 5. More economical routing of work, permitting of earlier shipments and making it easier to keep delivery promises.



GISHOLT MACHINE COMPANY

30 CHURCH STREET *Eastern Sales Office:* **NEW YORK CITY**

AGENTS: Atlanta, Ga., Seeger Machine Tool Co.; Buffalo, N. Y., J. L. Osgood; Chattanooga, Tenn., James Supply Co.; Chicago, Ill., Stocker-Rumely-Wacha Co.; Denver, Colo., Hendrie & Bolthoff Mfg. & Supply Co.; Detroit, Mich., Chas. A. Sterlinger Co.; Indianapolis, Ind., Vonnegut Machinery Co.; Los Angeles, Cal., Smith-Booth-Usher Co.; New Orleans, La., P. H. McArdle; Philadelphia, Pa., Swind Machinery Co.; Portland, Ore., Portland Machinery Co.; St. Louis, Mo., Colcord-Wright Mchy. & Supply Co.; Minneapolis, St. Paul, Minn., Savage & Winter Co.; Salt Lake City, Utah, Salt Lake City Hdwe. Co.; San Francisco, Cal., F. O. Supply Co.; Seattle, Wash., Perine Machinery Co. CANADA: Canadian Fairbanks-Morse Co., Calgary, Hamilton, Montreal, Ottawa, Quebec, St. John, Toronto, Vancouver, Winnipeg.



Let a Boy Grind the Tools

A boy can grind all the tools for your plant, and grind them better than your skilled mechanic can do it by hand, if you will install a *Gisholt Tool Grinder.*

Why permit your men to waste time, their time and yours, at the old style tool grinder? Install a *Gisholt Tool Grinder* and you will do away with the present unnecessary and frequent interruptions in production.

With the Gisholt, a boy can grind your tools quickly and accurately, and without waste of stock, time or effort. With this grinder he can satisfactorily take care of all your lathe, planer, shaper, slotter, turret lathe, automatic, or boring mill tools.

There is no reason in the world for dull tools—dull tools mean inefficient machines. Every machine in your plant should have its properly ground quota of tools ready for instant use the moment they are needed.

Ask a Gisholt representative to tell you more about these interesting cost-cutting machines.



GISHOLT MACHINE COMPANY

General Offices: 9 S. Baldwin St., Madison, Wisconsin
Works: Madison, Wisconsin; Warren, Pennsylvania

FOREIGN AGENTS: Australia, Benson Bros., Sydney, Melbourne; Belgium, Ateliers Demoor, Brussels; British Isles, Burton, Griffiths & Co., London, Birmingham, Manchester and Glasgow, Scotland; France, Aux Forges de Vulcain, Paris; Italy, Emanuele Mashcherpa, Milan; Japan, Andrews & George, Tokyo; Norway, Union Machine Co., Christiania; Sweden, Axel Ryden, Stockholm; Switzerland, J. Lambercier & Co., Geneva.

Thor Pneumatic Grinder

Six Years Without Hint of Trouble

In the big lathe manufactory where this picture was taken, they believe that all castings, large and small, must have a thorough snagging to make them suitable as a foundation on which to build fine, accurate machines.

In this connection the Thor No. 72 Portable Pneumatic Grinder here shown has been an important factor for more than six years, being used on a variety of parts. It has never balked or required any attention other than occasional cleaning and overhauling.

Thor Portable Pneumatic Tools are used in practically all leading shops—from foundry to assembling department. They are considered indispensable because of the time and trouble they save. Let us send the catalog

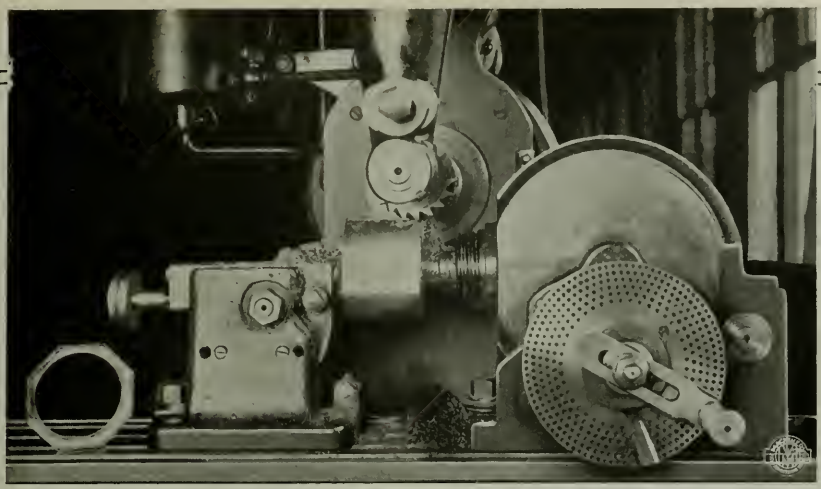


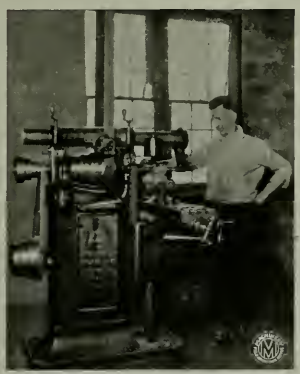
No. 72 Portable Air Grinder

INDEPENDENT PNEUMATIC TOOL COMPANY

Branch Offices:

Chicago New York Philadelphia Boston St. Louis Detroit
Pittsburgh Cleveland San Francisco Birmingham Montreal Toronto



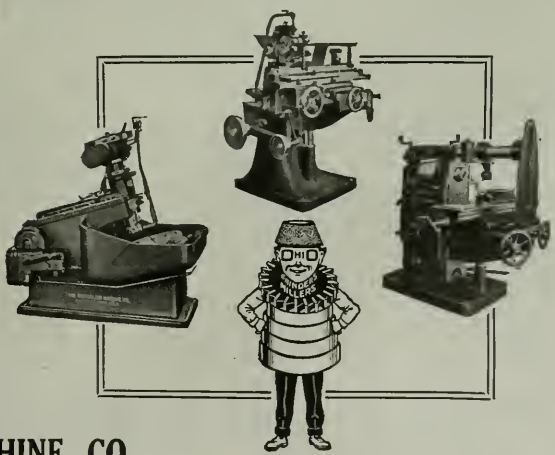


This Ohio Miller

Is "Accurate and Dependable"

So they say at the Valley Machine Works, Connersville, Indiana, where they have used the machine shown continuously for more than two years in manufacturing dies and tools. When photographed it was being used in making a tool-steel punch for an automobile tail-lamp door.

The door—shown at the extreme left of upper photo—is made of 20 gage brass and is 3⅜" across inside. The octagonal punch must, of course, be accurately indexed, so they use the Ohio Dividing Head—one of the many practical Ohio attachments described in the story of Ohio "Specialized Construction" furnished on request.



THE OESTERLEIN MACHINE CO.

CINCINNATI OHIO, U. S. A.

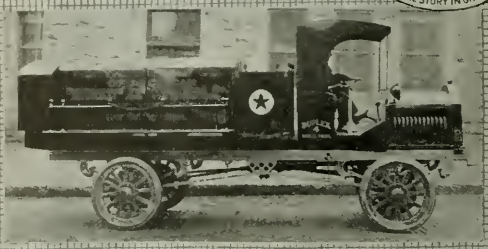
MILLERS OHIO GRINDERS

Tools in Which Every Ounce Works

O. S. Terlein says: "I don't suppose there is any part of an automobile that one or another of the 'Ohio Trio' doesn't have a hand in making somewhere along the line."

MULTI-DRILLERS NATCO MULTI-TAPPERS

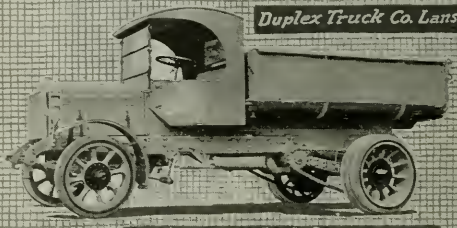
THE HOLE STORY IN ONE WORD



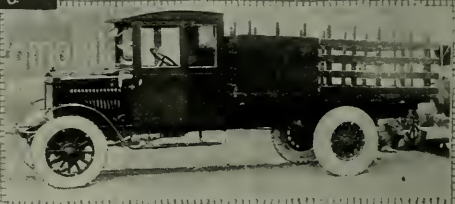
Duplex Truck Co. Lansing Mich.



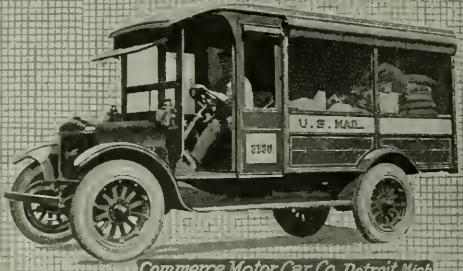
The Autocar Company Ardmore Pa.



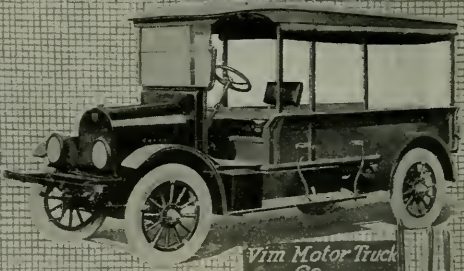
Sterling Motor Truck Co. Milwaukee Wis.



Kissel Motor Car Co. Hartford. Wis.



Commerce Motor Car Co. Detroit Mich



Vim Motor Truck Co. Philadelphia Pa.

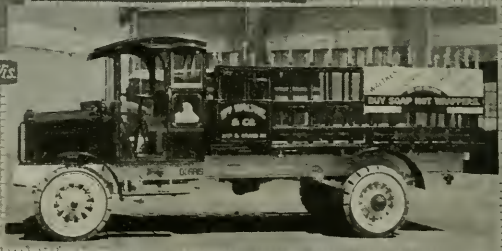


The Four Wheel Drive Auto Co. Clintonville Wis.



Bethlehem Motor Corp. Allentown Pa.

NATCO Multi-Drillers and Multi-Tappers have served most economically and efficiently in the manufacture of these popular motor trucks.



Dorris Motor Car Co. St. Louis Mo.

The NATIONAL AUTOMATIC TOOL CO., Richmond, Ind., U.S.A.

MULTI-DRILLERS NATCO MULTI-TAPPERS

THE HOLE STORY IN ONE WORD

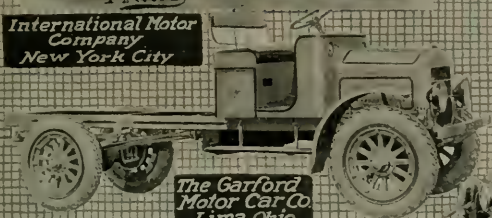


Mack

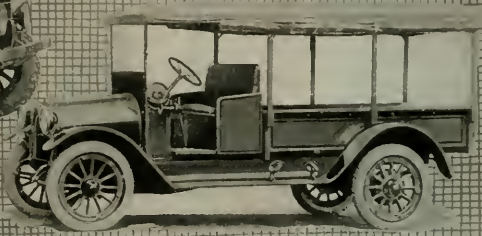


International Harvester Company
Chicago Illinois

International Motor Company
New York City



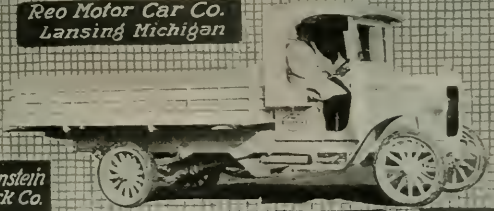
The Garford Motor Car Co.
Lima Ohio.



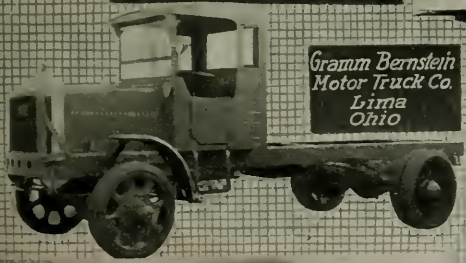
Reo Motor Car Co.
Lansing Michigan



Packard Motor Car Co Detroit Mich



Gramm Bernstein Motor Truck Co.
Lima Ohio



The Nash Motor Co. Kenosha, Wis.

The White Company
Cleveland, O







General Motors Corporation Pontiac Mich.

Republic Motor Truck Co. Alma, Mich.

The NATIONAL AUTOMATIC TOOL CO., Richmond, Ind., U.S.A.

NAMCO



for-

SCREW
SLOTTING

6 SPINDLE
DRILLING

BOLT & STUD
THREADING

CHASER & TOOL
GRINDING

BAR POINTING

THE NATIONAL

NEW ENGLAND PLANT
WINDSOR, VT.

CLEVELAND

BRANCH OFFICES: NEW YORK BOSTON
WAREHOUSES: NEW YORK AN

Makers of Gridley Single and Multiple-Spindle Automatics at Windsor, Vt.; and Ac

AUXILIARY MACHINES

For Secondary Operations—

NAMCO Auxiliary Screw Making Machines were built originally to meet most economically the requirements of our own screw products business. Therefore they represent, both in design and construction, the most efficient method of handling work within their respective uses and capacities as follows:

SEMI-AUTOMATIC SCREW SLOTTERS—

For slotting all kinds of screw heads, regular or irregular, and for milling operations on special parts. Capacity up to ¾".

SEMI-AUTOMATIC M. S. DRILLER—

For drilling holes in screws, bolts and irregular pieces—6 at a time. Feeding, cutting and extracting operations are simultaneous. Capacity up to ¾".

TWO-SPINDLE BOLT THREADER—

For the rapid threading of blanks, milled, upset or forged. Capacity up to ¾".

AUTOMATIC STUD THREADER—

For the automatic threading of studs. Capacity up to 1".

TOOL GRINDER—

For grinding tools in general machine shop practice.

BAR POINTER—

For preparing bar stock for automatic machines.

Our new catalog—A. S. M. M.—gives a detailed description, suitably illustrated, of each machine. Let us furnish you a copy



ACME COMPANY

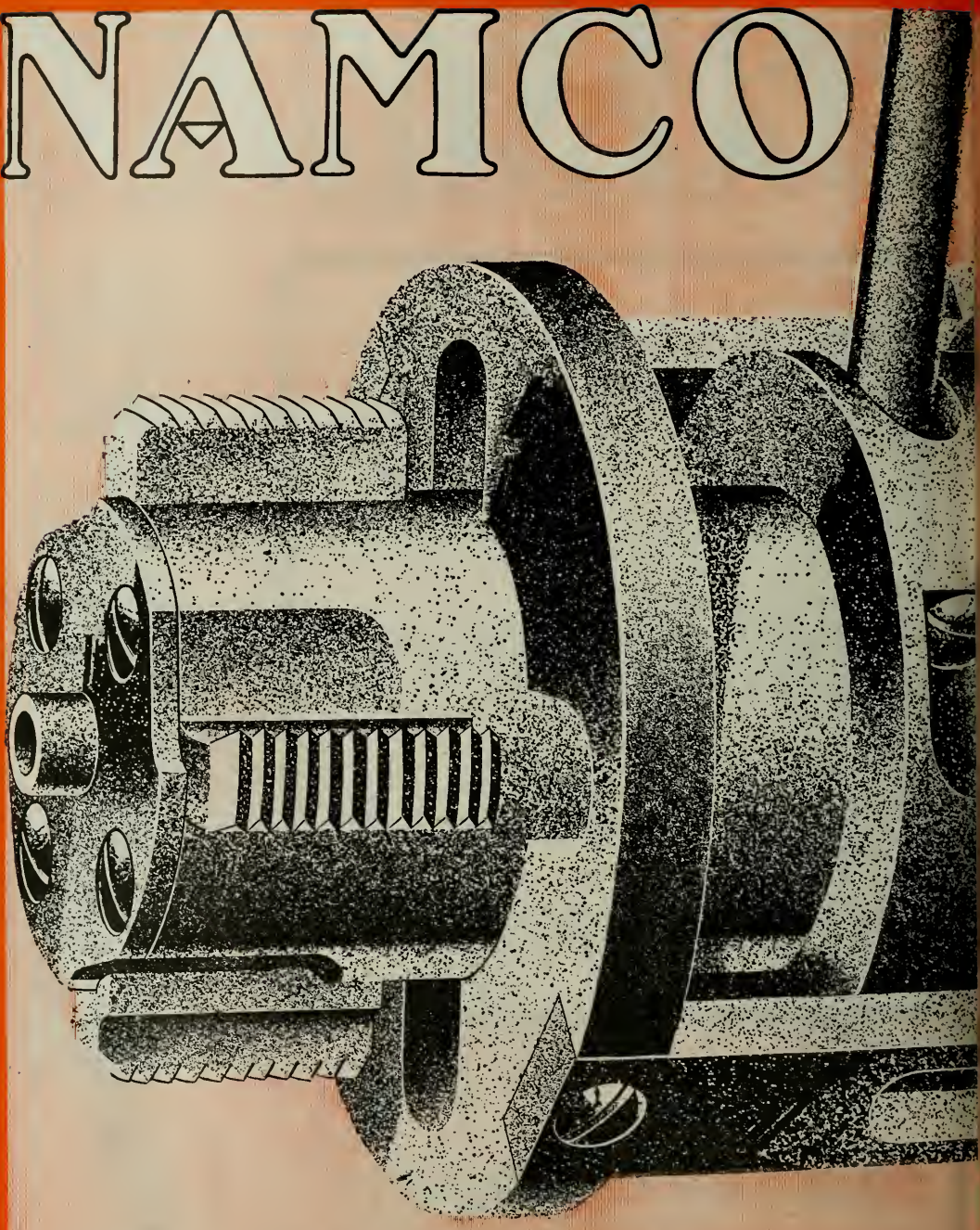
OHIO

CANADIAN SCREW PLANT
MONTREAL, P. Q.

CHICAGO DETROIT BUFFALO
CHICAGO FOREIGN REPRESENTATIVES

Automatic Threading Dies, Collapsing Taps and Screw Machine Products at Cleveland, O.

NAMCO



THE NATIONAL

New York, Boston, Chicago, Detroit, Buffalo **CLEVELAND,**

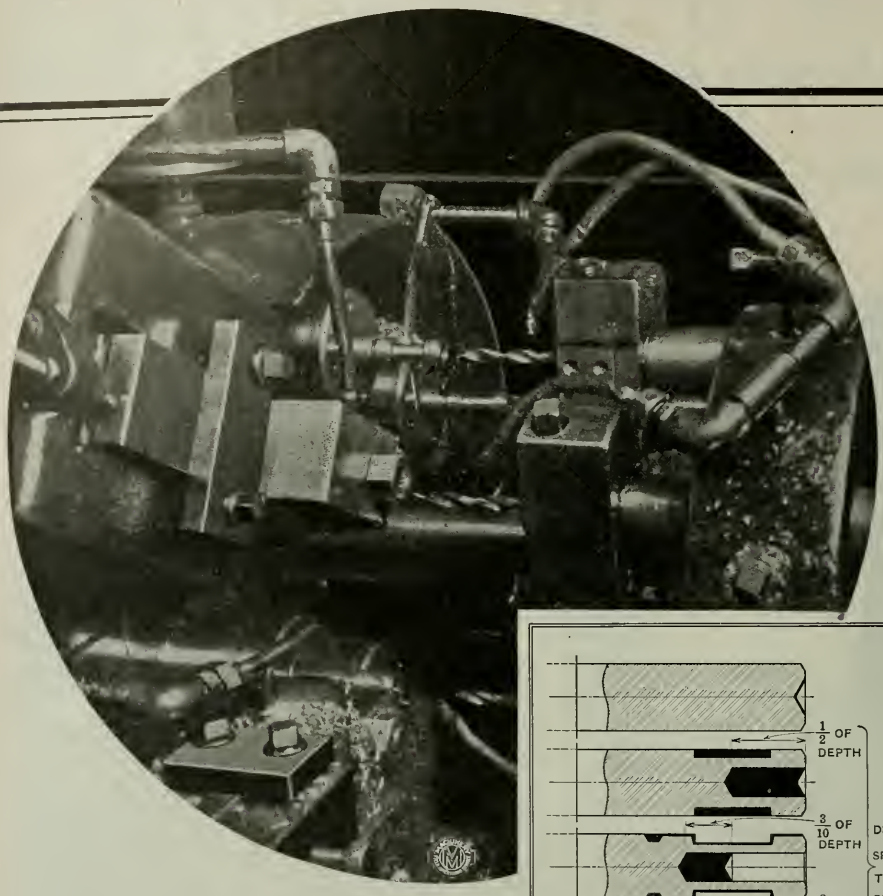
COLLAPSING
— TAPS —

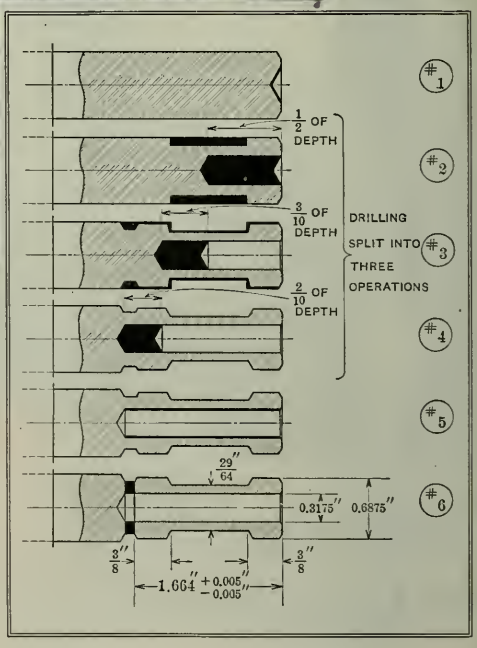


Send for a Catalog

ACME COMPANY

OHIO, Representatives in Principal Foreign Countries





A Part Produced Every Twenty-three Seconds

"NEW BRITAIN" NB NONE BETTER

NEW BRITAIN

Making Steel Gear Blanks on the "NEW BRITAIN" SIX-SPINDLE AUTOMATIC SCREW MACHINE

Two years ago the Up-to-Date Machine Works of Chicago decided that for accuracy, speed and economy in the production of small parts "New Britain" Automatics were unbeatable. Experience has confirmed the decision, and a complete "New Britain" installation is now in operation.

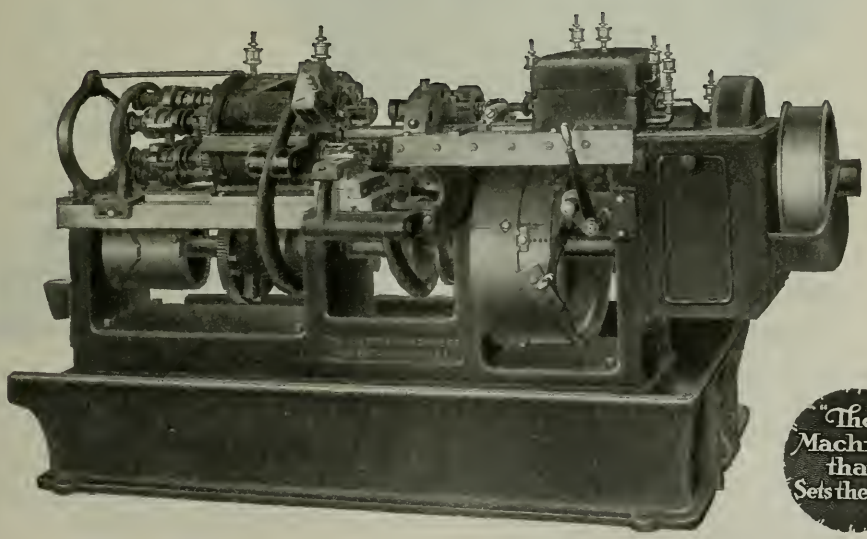
The work recorded by our cameraman was the making of speedometer steel gear blanks, the six operations being as follows: 1st—center; 2d—drill half of the hole and rough form, using side tool; 3d—drill three-tenths of depth of hole and finish form, using side tool; 4th—drill remaining fifth of depth of hole and face; 5th—ream, using accelerating reamer; 6th—cut off.

A finished gear blank is produced every twenty-three seconds.

Let us make a thorough investigation of your screw machine work, submitting estimate of productions to be expected from the "Six-spindle" Automatic.

THE NEW BRITAIN MACHINE COMPANY

New Britain, Conn., U. S. A.

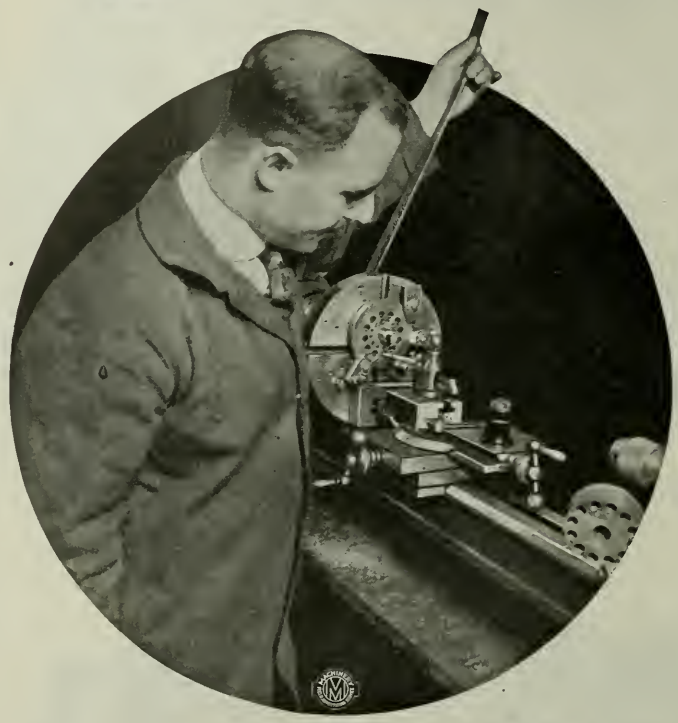


"The Machine that Sets the Pace"

AUTOMATICS

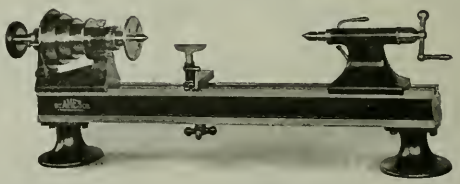
AMES BENCH LATHES

On Interchangeable Dies



Whiting & Comstock of Hartford, Conn., have been using Ames Bench Lathes for the past three years for all kinds of fine tool making, die work, gages, small screw machine work, etc. The machine here shown is a new installation.

Twenty-five Holes—Rough Bored, Bored and Reamed to Close Limits



When photographed, this machine was being used for boring out holes in an interchangeable armature die, one of three which are to duplicate each other so exactly that subsequent punchings will be interchangeable. There are 12 holes each in the outer and inner circles and one large hole in the center, their diameters being 0.390″, 0.203″ and 0.625″ respectively. Limits for spacing and boring are .001″. After boring these holes will be reamed. At the exact moment that the camera registered, one of the outer holes was being rough centered with the pointer. This is a nice piece of toolwork and the operator gives a large share of the credit for its successful performance to the accuracy and convenience of the Ames Bench Lathe.

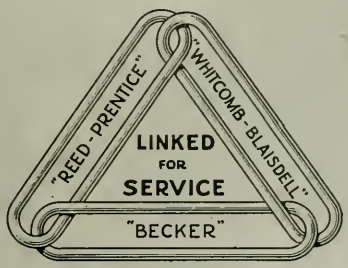
All operations handled on these machines are equally satisfactory and the owners are correspondingly well pleased. Let us send the catalog.

THE B. C. AMES COMPANY

WALTHAM **MASS., U. S. A.**

REED-PRENTICE COMPANY

WORCESTER MASS. U.S.A.



An Announcement

A combination of the Executive-Sales-Purchasing-Auditing Accounting and Advertising Departments of the Reed-Prentice Company, Becker Milling Machine Company and Whitcomb-Blaisdell Machine Tool Company has been made.

These three companies owned and operated by the same financial interests have one main purpose in view—Service. To insure this service the companies have been linked together that their combined products can be marketed by direct factory sales branches located in the principal machine tool centers of the United States.

Your requirements will be handled by salesmen trained in machine tool manufacture and use. This allows your needs to be analyzed intelligently and the maximum results rendered.

You will find us gladly willing to co-operate with you to the end that you may achieve the best production.

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Graydon Stetson, Vice-President.
J. W. Lund, Treasurer.
J. P. Ilsley, General Sales Manager.
F. W. McIntyre, Sales Manager.
V. A. Campbell, Sales Department.
F. E. Rhodes, Sales Department.
G. S. Haven, Sales Department.
F. H. Palmer, Purchasing Agent.
S. L. Crawford, Advertising Manager.

WORCESTER:—Reed-Prentice Company, Cambridge Street.

A. E. Newton, Vice-Pres. and Gen. Mgr.
F. K. Hendrickson, Engineering Dept.
Whitcomb-Blaisdell Machine Tool Company, 134 Gold Street.
Charles Hildreth, Pres. and Gen. Mgr.
F. H. Seng, Sales Department.

NEW YORK:—5th Floor, Grand Central Palace

P. K. Dayton, New York Sales Manager.
P. A. Dyer.

HYDE PARK, BOSTON:—Becker Milling Machine Company.

Scott Taylor, Works Manager.
H. S. Sawyer, Mgr. Cutter Dept.
A. S. Morse, Salesman, Cutter Dept.
A. McDonald, Salesman, Cutter Dept.

CHICAGO:—Temporary Office—621 Washington Blvd., c/o R. E. Ellis Engineering Co. About August 1 or 15th—26 and 28 N. Clinton Street.

W. D. Creider, Chicago Sales Manager.
F. C. Hermann.
J. L. Stone.

DETROIT:—408 Kerr Building, corner Fort and Beaubien Streets.

A. J. Strong, Detroit Sales Manager.
W. B. Ashley.

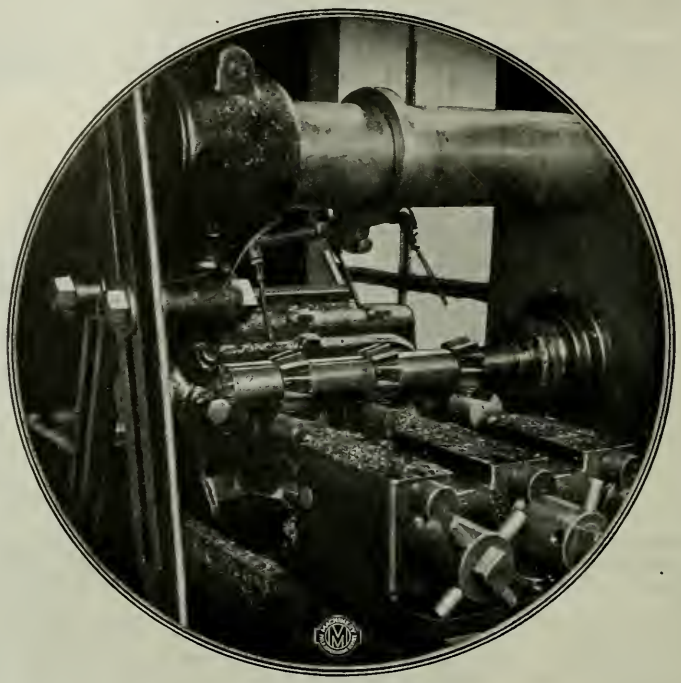
CLEVELAND:—408 Frankfort Avenue.

C. A. Severin, Cleveland Sales Manager.
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T. C. McDonald, Indianapolis Sales Mgr.

GARVIN MACHINE TOOLS



Milling Taps is Speedy Work With GARVIN MILLING MACHINES

Taps and dies on a production basis—all kinds, all sizes; a continuous demand to be met. That's the proposition of the Winter Brothers Company of Wrentham, Mass., and to solve it considerable thought has to be given to the choice of equipment.

Five Garvin Milling Machines help a whole lot in speeding up production while maintaining the concern's reputation for a quality product.

The photograph shows the milling of four flutes on 1½" pipe tap. Three of these parts are milled at once, production being 55 per nine-hour day.

The operator runs four machines.

The Garvin Catalog is both complete and interesting. Send for a copy today

The Garvin Machine Company

Spring and Varick Streets NEW YORK, N. Y.

GARVIN

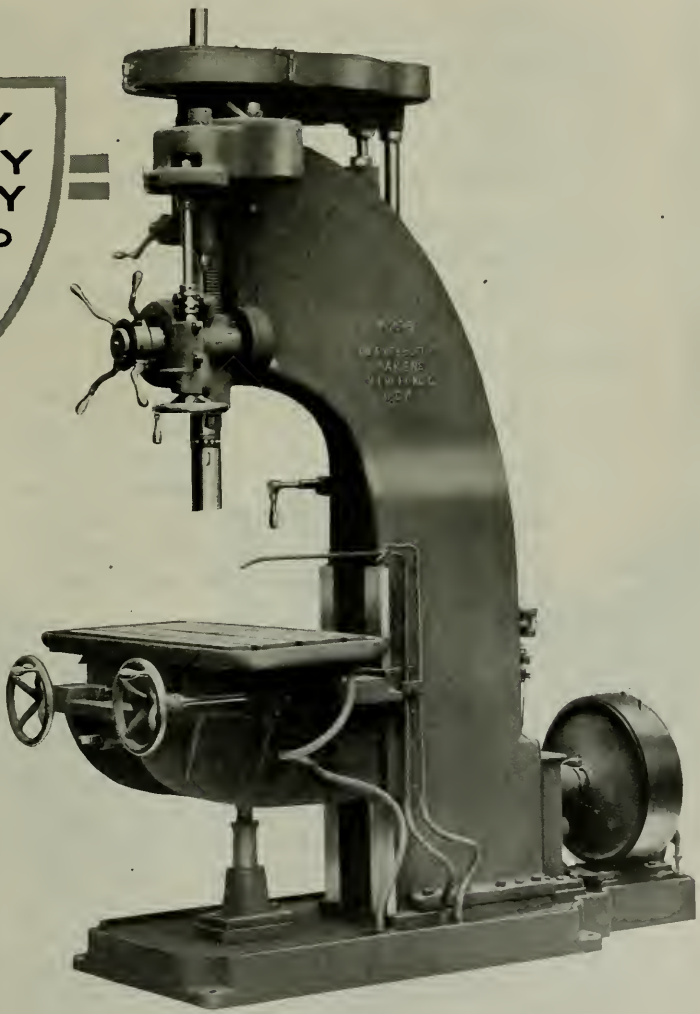
BUILDER OF BETTER MACHINE TOOLS

REMEMBER FOOTE-BURT

When you Want a Drill to Work Hard and Keep at it

When your requirements call for a High Duty Drill to work hard and keep everlastingly at it, then you need a Foote-Burt. The pertinent features are its rigid construction, adaptability to a wide range of work, simplicity of construction and operation, and centralized control.

RIGIDITY
DURABILITY
SIMPLICITY
CENTRALIZED CONTROL



Write us for more particulars or have your purchasing department do so—do it now while you have the matter in mind.

The Foote-Burt Co.
Cleveland Ohio
Milwaukee Office: 633 Wells Bldg.
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FOREIGN AGENTS: Buck & Hickman, Ltd., London, Birmingham, Manchester and Glasgow. Moscow Tool & Engine Co., Moscow. Ing. Ercole Vaghi, Milan. R. S. Stokvis & Zonen, Ltd., Rotterdam. R. S. Stockvis & Fils, Brussels. Glaenzer & Perraud, Paris, agents for France, Switzerland, Spain and Portugal. Mitsui & Co., agents for Japan, Korea and Manchuria.

FOOTE-BURT **HIGH DUTY DRILLS ARE BUILT TO LAST**

WILLIAMS' "AGRIPPA" TOOL HOLDERS

Comparison

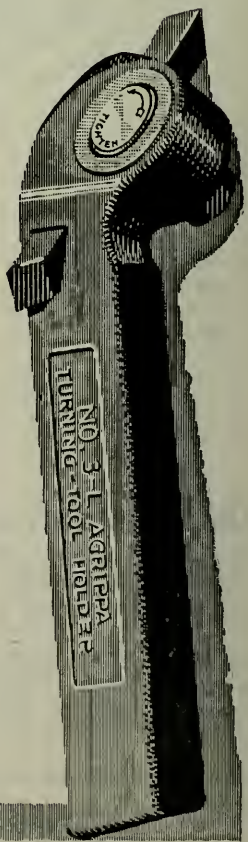
That's a good way to judge men—comparison. When you want a particular job done, you don't select the man indiscriminately; you *compare* the characteristics of Jim and Bill. You know the work each is capable of doing—which is the better qualified for your purposes. And you make your selection accordingly.

It's the same with Tool Holders.

We suggest that you watch the performance of the Tool Holders you use *now*. Watch them closely—note their production—their need of adjustment—the quality of their work. *Then*, on a harder job, with tougher material, heavier cut and faster speed, use a Williams' "Agrippa" Tool Holder.

The result will show that our claim, "Williams' 'Agrippa' Tool Holders, '*The Holders that Hold*,' assure better quality and greater production," is well founded.

In stock for all regular machining operations: Turning, Boring, Planing, Threading, Knurling, Cutting-off and Side Work. Ask for a copy of our new Machinists' Tools Book.



J. H. WILLIAMS & CO.

"The Drop-Forging People"

BROOKLYN, N. Y. 61 Richards Street
BUFFALO, N. Y. 61 Vulcan Street
CHICAGO, ILL. 1061 W. 120th St.

UNIVERSAL
(Horizontal)
BORING MACHINE

Three Years in Service and No Repairs

This is the record that stands to the credit of the Universal Boring Machine which for three years has been in continuous use in the Saginaw plant of the Wilcox Motor & Manufacturing Company.

This machine has been in constant operation, without let up, taking heavy cuts for long periods; but its accuracy has not been impaired in any way.

The photograph shows this "Universal" boring a cylinder for a special machine.

Honest attention to details is a paying investment for us as well as it is for the concern who buys our machine.

"Where Accuracy Counts—We Win"

Let Us Show You.

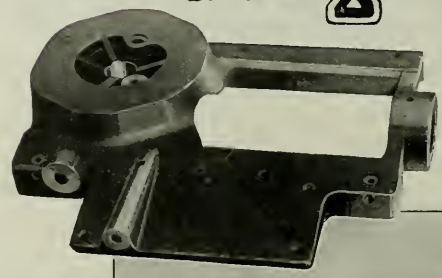
Universal Boring Machine Company

Hudson **Mass., U.S.A.**

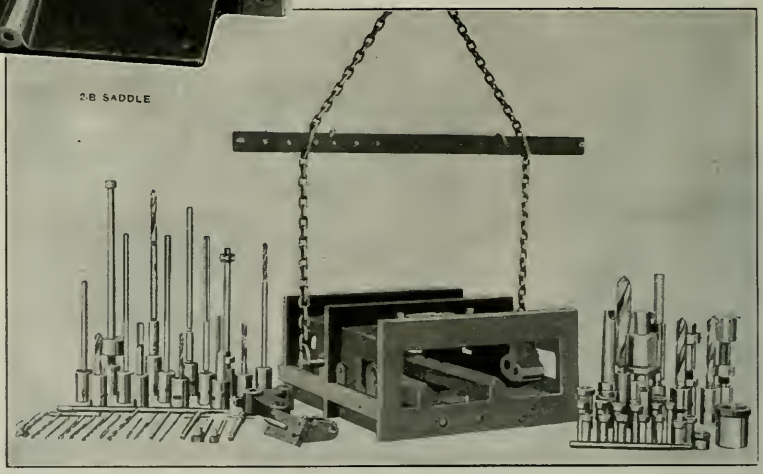


MOD

"Magic" Chucks



As Used By
The Foster Machine Co.,
Elkhart, Ind.



In the Foster Bulletin showing operations which contribute to the high quality of Foster turret lathes, two groups of tools used in Modern "Magic" Chucks are shown. Above is the view showing the gear box. The Foster Concern pays "Modern" a very nice compliment in showing these views and explaining that it is through such operations that Foster Quality is secured. The array of tools used in Modern "Magic" Chucks is surely impressive. For changing small tools quickly there is nothing so efficient as a

Modern "Magic" Chuck

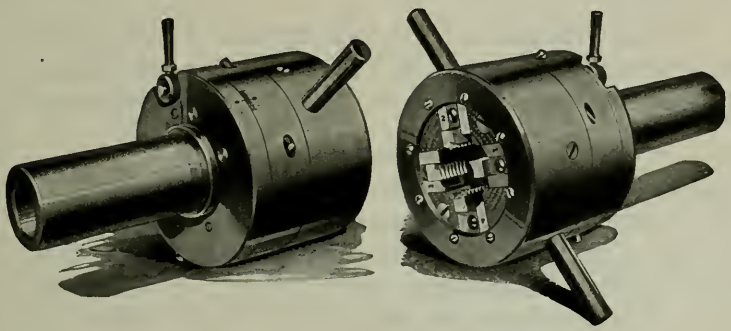
MODERN TOOL COMPANY

BRANCH OFFICES:
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Detroit, Mich., 408 Kerr Bldg. Chicago, Ill., 32 N. Clinton St. Buffalo, N. Y., Associated Service Bldg.,
Export Dept., Bishop Bldg., New York, N. Y.

ERN

Self-Opening Die Heads

17 SIZES



STYLE "H"

Accuracy *Dependability* *Durability*

"Modern" Die Heads are noted for these three qualities. Inquiry of any of the thousands who use them will verify our claims.

The principle of construction, and the careful workmanship insure threads full size, true to lead.

The simplicity of "Moderns" is a real virtue. There is almost nothing to get out of order. They are therefore constantly on the job producing, instead of being frequently in the tool room for adjustment, or repair.

"Modern" Self-opening Die Heads last for many years. They are so rugged in construction that without gross abuse they should last a lifetime.

"Moderns" have an enviable record for volume of production; also for ability to handle difficult work. We should like to tell you about their accomplishments — better still, let us give you details of what they'll do on your own job. Send blueprints and specifications.

Send for complete technical bulletin.

ERIE, PENNSYLVANIA, U. S. A.

MAIN OFFICE AND WORKS: SECOND AND STATE STREETS

Canadian Agents: Rudel-Belnap Machinery Co., Ltd., Toronto and Montreal.
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We Are Old Enough to Know How

FIFTY-FIVE years ago, there was only one Machine Tool Merchant in New England—we were that one—you know how many there are today selling such machinery—but—there's a difference—and that's why we term ourselves MERCHANTS.

Noah Webster in his dictionary doesn't distinguish between the names Merchant, Dealer and Agent, but we must remember that learned gentleman lived many years ago.

Supposing you come in our office or we in yours—you hand us a blueprint or piece of work—you ask us what we recommend to do it—we tell you—you purchase it—and it does everything, if not a little bit more than we claimed—that's what we call being a Merchant.

And it's all because each and every man in our employ is a natural born mechanic—all of them have had practical shop experience—they know what they are selling.

We give service—it doesn't cost a cent—we are just as much interested in what you buy of us, a year or years afterwards, as on the day you put it under the belt.

We really can say—if it's a Machine Tool you want, we've got it.

HILL, CLARKE & COMPANY, Inc.

The Machinery Merchants

— And Young Enough To Do It!

Manufacturers Who Have Confidence In Us.

Badger Tool Co.,
Beloit, Wis.
Disc Grinders.

Carter & Hakes Machine Co.,
Winsted, Conn.
Milling Machines, Bench, Hand and Lincoln Types.

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Dexter, Maine.
Pattern Maker's Lathes.

Warren F. Fraser Co.,
Westboro, Mass.
Grinders, Plain, Universal and Semi-automatic.

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Nashua, N. H.
Lathes, 13″ to 26″ swing.

Geometric Tool Co.,
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G. A. Gray Co.,
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Metal Planers.

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Houston, Stanwood & Gamble Co.,
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Indianapolis, Ind.
"Libby" Heavy Duty Turret Lathes.

Jarecki Mfg. Co.,
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Pipe Machines.

Kearney & Trecker Co.,
Milwaukee, Wis.
Milling Machines, Milwaukee Horizontal and Vertical.

King Machine Tool Co.,
Cincinnati, Ohio.
Vertical Boring Mills.

Knowlton Machine Co.,
Westbrook, Maine.
Cutting-off Machines.

Lees-Bradner Co.,
Cleveland, Ohio.
Thread Millers and Gear Generators.

Liberty Machine Tool Co.,
Hamilton, Ohio.
Open-side Planers.

Oesterlein Machine Co.,
Cincinnati, Ohio.
"OHIO" Milling Machines and Universal Cutter Grinders.

Queen City Machine Tool Co.,
Cincinnati, Ohio.
Plain Grinders, 12″ to 16″ swing.

Rockford Lathe & Drill Co.,
Rockford, Ill.
"Economy" Lathes, 14″, 18″ and 22″ swing.

Sibley Machine Co.,
South Bend, Ind.
Upright Drilling Machines.

Smith & Mills Co.,
Cincinnati, Ohio.
Crank Shapers.

Southworth Machine Co.,
Portland, Maine.
Turret Screw Machines, ⅝″, 1″ and 1½″.

Thompson Grinder Co.,
Springfield, Ohio.
Universal Grinders.

Universal Boring Machine Co.,
Hudson, Mass.
Horizontal Boring Machines.

Western Machine Tool Works.
Holland, Mich.
Radial Drilling Machines, Plain and Universal, 3′ to 8′ arms.

Willard-Middletown Machine Co.,
Cincinnati, Ohio.
Inclinable Power Presses.

BOSTON 9, MASSACHUSETTS, U.S.A.

156 Oliver Street

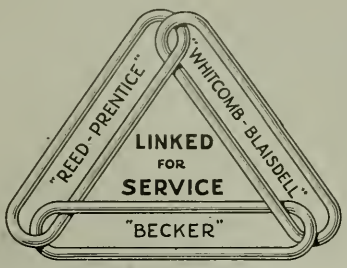
Michigan Tool Co

DETROIT, MICH., U. S. A.

Milling Cutters, Hobs and Special Tools



WHITCOMB-BLAISDELL



An Announcement

A combination of the Executive-Sales-Purchasing-Auditing Accounting and Advertising Departments of the Reed-Prentice Company, Becker Milling Machine Company and Whitcomb-Blaisdell Machine Tool Company has been made.

These three companies owned and operated by the same financial interests have one main purpose in view—Service. To insure this service the companies have been linked together that their combined products can be marketed by direct factory sales branches located in the principal machine tool centers of the United States.

Your requirements will be handled by salesmen trained in machine tool manufacture and use. This allows your needs to be analyzed intelligently and the maximum results rendered.

You will find us gladly willing to co-operate with you to the end that you may achieve the best production.

BOSTON:—53 Franklin Street
A. H. Weed, President.
Graydon Stetson, Vice-President.
J. W. Lund, Treasurer.
J. P. Ilsley, General Sales Manager.
F. W. McIntyre, Sales Manager.
V. A. Campbell, Sales Department.
F. E. Rhodes, Sales Department.
G. S. Haven, Sales Department.
F. H. Palmer, Purchasing Agent.
S. L. Crawford, Advertising Manager.

WORCESTER:—Reed-Prentice Company, Cambridge Street.
A. E. Newton, Vice-Pres. and Gen. Mgr.
F. K. Hendrickson, Engineering Dept.
Whitcomb-Blaisdell Machine Tool Company, 134 Gold Street.
Charles Hildreth, Pres. and Gen. Mgr.
F. H. Seng, Sales Department.

NEW YORK:—5th Floor, Grand Central Palace
P. K. Dayton, New York Sales Manager.
P. A. Dyer.

HYDE PARK, BOSTON:—Becker Milling Machine Company.
Scott Taylor, Works Manager.
H. S. Sawyer, Mgr. Cutter Dept.
A. S. Morse, Salesman, Cutter Dept.
A. McDonald, Salesman, Cutter Dept.

CHICAGO:—Temporary Office—621 Washington Blvd., c/o R. E. Ellis Engineering Co. About August 1 or 15th—26 and 28 N. Clinton Street.
W. D. Creider, Chicago Sales Manager.
F. C. Hermann.
J. L. Stone.

DETROIT:—408 Kerr Building, corner Fort and Beaubien Streets.
A. J. Strong, Detroit Sales Manager.
W. B. Ashley.

CLEVELAND:—408 Frankfort Avenue.
C. A. Severin, Cleveland Sales Manager.
Charles Brandhill.

INDIANAPOLIS:—940 Lemcke Annex Bldg.
T. C. McDonald, Indianapolis Sales Mgr.





They Cut the Heaviest Steel Forgings

The heaviest steel forgings present no difficulties to the Disston Inserted Tooth Saws with which the plant of the Horsburgh Forge Company, Cleveland, Ohio, is well equipped. The photograph shows a Disston Inserted Tooth Saw, 48″ diameter, which, running at 3½ R.P.M. and carrying a heavy feed, rapidly cuts through a section 10¾″ x 31″. There's a Disston Saw for every metal cutting operation. You can't forget the name.

HENRY DISSTON & SONS, Inc.

PHILADELPHIA, U. S. A.

Chicago
New Orleans
Seattle
Sydney, Australia
New York City
Boston
Memphis
Cincinnati
Bangor
San Francisco
Portland, Oregon
Vancouver, B. C.

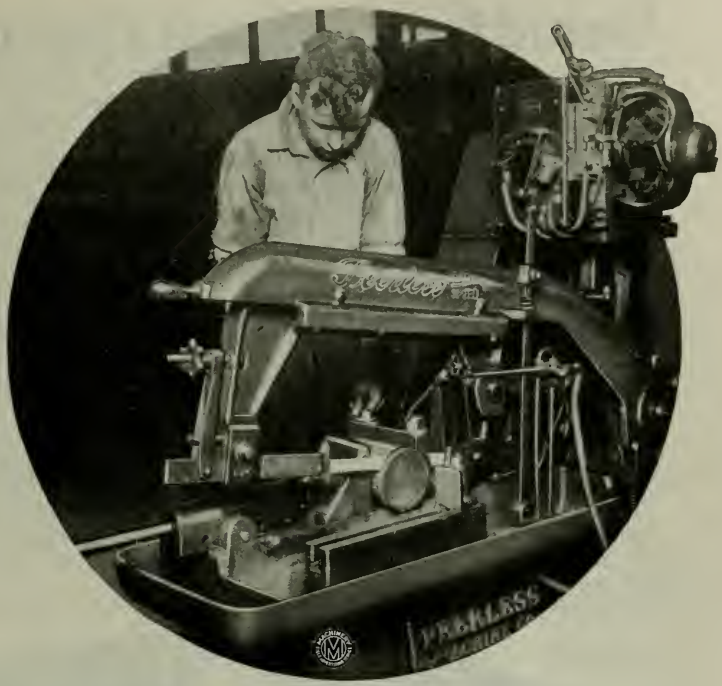
CANADIAN WORKS: TORONTO, CANADA.

DISSTON

METAL CUTTING SAWS

WHEN THE DISC SAW FAILED

Another Triumph for the **Peerless** HIGH SPEED *Metal Cutting Machine*





You also will discard other methods when you see the money making possibilities of the "Peerless" which we will be glad to show you at any time. Write us.

Metal cutting in the Gardner Machine Co.'s plant, Beloit, Wis., is exacting work and the disc saw installed for the purpose failed to make good—so the Company replaced it with this Peerless High Speed Metal Cutting Machine and found the problem of cutting up stock solved once and for all.

"We find the 'Peerless' handy and convenient," said a member of the firm. "We like its durable construction and use it for work that a regular disc saw was bought to do and failed. The 'Peerless' costs little to run."

PEERLESS MACHINE COMPANY

1611 RACINE STREET, RACINE, WISCONSIN, U. S. A.

Use Peerless HIGH SPEED Tungsten Power Blades for Heavy Duty

LANDIS CRANK GR

Grind Crank Shaft Pins to Close Limits Here

These photographs taken at the Mitchell Motors Company, Inc., Racine, (Wis.) plant show one of the Landis Crankshaft Grinders in use here. Especially designed for grinding and finishing both single and multiple throw crankshafts, and especially valuable in the manufacture of motors and gas engines for automobiles and launches, they have found special favor here.

Landis Crankshaft Grinders grind with accuracy and finish practically unobtainable by other methods; this with an increased output that tremendously reduces production costs.

The cranks are driven from both ends, as the head and footstocks are geared together; the throws are set for by a sliding adjustment of the work-carrying heads on the face-plates, and for multiple throw shafts the pins are ground in their exact relative position with each other. The work is easily and accurately held by quickly operated clamping holders at both ends—no offset centers are required.

Compare the operation and production given on the opposite page with work of the same class done by any other method; judge for yourself the reasons for the popularity of these machines.

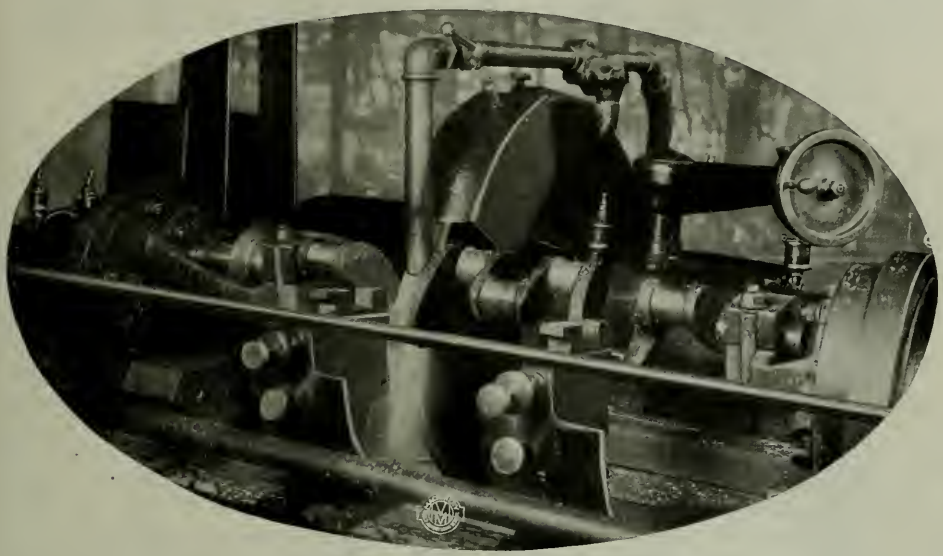


LANDIS TOOL COMPANY,

New York Office:

DOMESTIC AGENTS: Dewstoe Machine Tool Co., Birmingham; Elliott & Stephens Machinery Co., St. Louis; F. C. Richmond Ma- Hendrie & Bolthoff Mfg. & Supply Co., Denver; Seeger Machine Tool Co., Atlanta; Sheehan-North Co., El Paso.

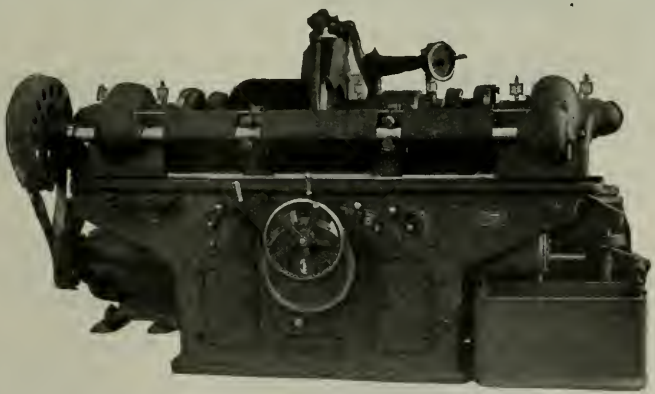
INDING MACHINES



"Landis Grinders are Fine Machines for Accurate Finishing" Says the Foreman

Mitchell crankshafts are of drop forged steel, S A E specification No. 1045, scleroscope hardness 38 to 48. They come to the Landis Grinders with the six pins turned within 0.050″ of the finished dimensions. The finished diameter is 2.000″ with limits of plus or minus 0.001″; the finished width is 2.250″ with limits of plus or minus 0.0025″; from 0.035″ to 0.038″ is removed in rough grinding and from 0.012″ to 0.015″ is removed in the finish grinding operation; production is 25 finished crankshafts per ten-hour day on each machine.

Send for the complete catalog of Landis Grinding Machines. See pages 44 to 53 for the details of the machine shown here.



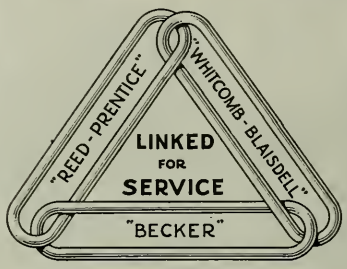
LANDIS

WAYNESBORO, PA., U. S. A.

50 Church Street

chinery Co., Salt Lake City; Hallidie Machinery Company, Seattle; Harron, Rickard & McCone, San Francisco and Los Angeles;

BECKER



An Announcement

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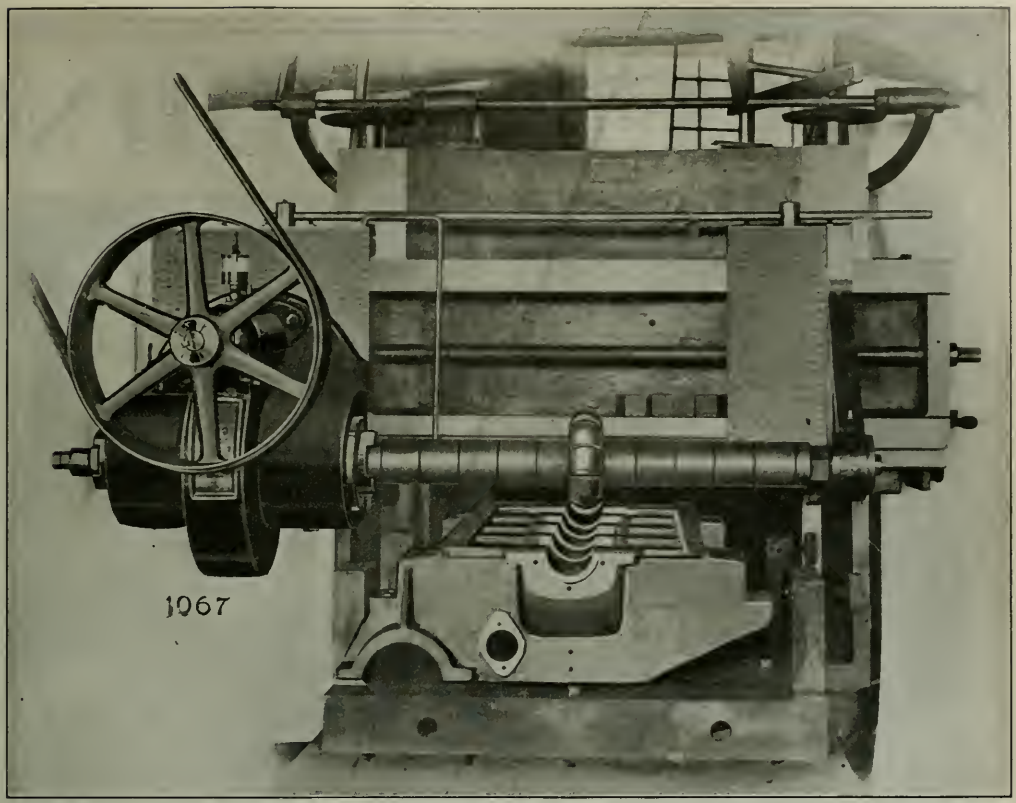
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Charles Brandhill.

INDIANAPOLIS:—940 Lemcke Annex Bldg.
T. C. McDonald, Indianapolis Sales Mgr.



FARWELL MILLING MACHINE FOR PLANERS

The above illustration shows a No.3 Farwell Milling Machine milling crank cases for 5½ x 7 inch engine, in the plant of the Pittsburgh Model Engine Co., Peru, Indiana. This crank case has five main bearings, four of which are 3½ inches in length, the other one being 5 inches long. A 10-tooth high speed radius cutter, 8 inches in diameter, 1 3/16 inches radius, is used, and milling is done at a speed of 42 feet per minute, with a feed of .020 per revolution. The cutting time on this job is 35 minutes, with about 10 minutes consumed in loading the jig ready for milling.

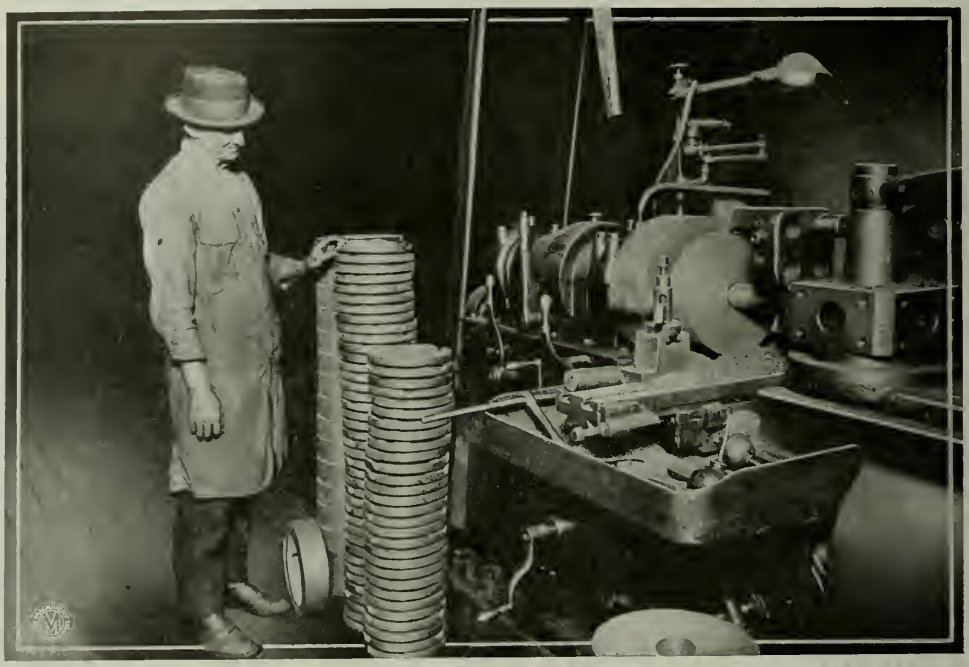
If you have difficult jobs in milling to handle, do not go to the expense of purchasing a large and expensive machine. Utilize your planer for this purpose, by installing a Farwell Milling Machine on the rail. This sturdy machine will make your planer capable of turning out the work of a big powerful vertical and horizontal milling machine, boring mill and planer. This machine interferes in no way with the operation of the planer, as it may be slid to the overhang of the planer rail when not in use.

Write for a copy of our catalog No. 58, in which are illustrated many of the unusual operations this equipment is capable of performing.

THE ADAMS COMPANY, 1908 Market Street Dubuque, Iowa, U.S.A.

ESTABLISHED 1883

POTTER & JOHNS



Piling Up Production With Potter & Johnston Automatics

High cost of production, expensive raw material, keen competition! What is the best way to synchronize production with this situation? Automatic machinery? Obviously!

Production by a series of operations on many machines, means wasted time and effort, frequent failures to make deliveries on schedule, the possible paying of a forfeit.

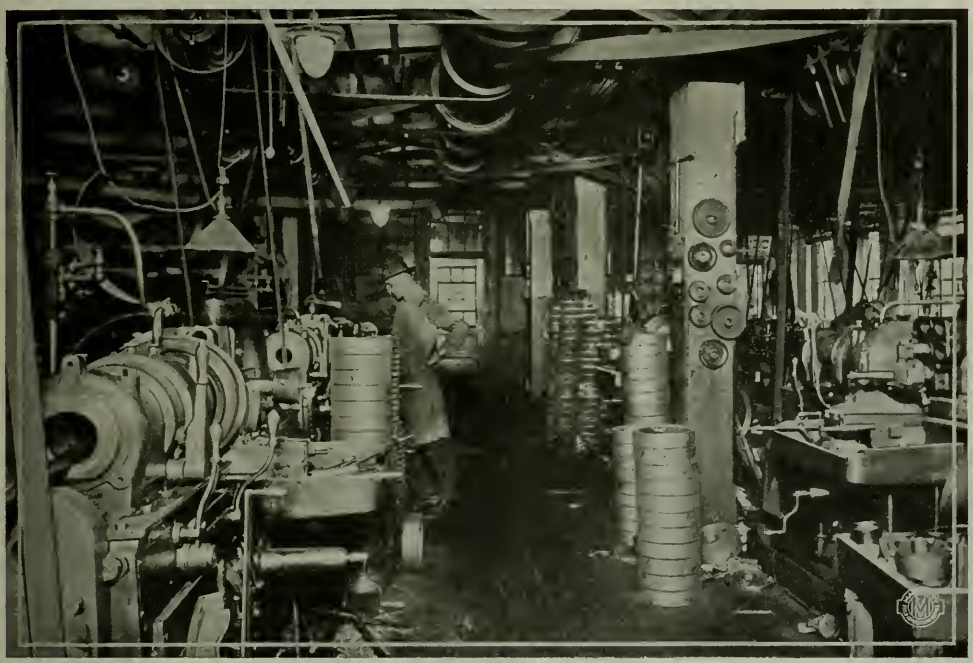
All this is changed when you install Potter & Johnston Automatics —you chuck another piece when one is completed, that's all. Then with a P. & J. installation, you can lay your work out far in advance—each day's production is pre-determined.

P. & J. Production Figures on your work are always available. Mail blueprints.

Potter & Johnston,

OFFICES AND REPRESENTATIVES: Great Britain, France, Italy, Belgium, Switzerland, Spain and Portugal; 68 Avenue de la Grand Armee, Paris, J. Ryan, Manager. New York Office, Fulton Bldg., 50 Church St., Walter H. Foster Co., Managers. Detroit Office: Modern Machinery & Engineering Co., 1514 Ford Bldg. Chicago Office: 1001 McCormick Bldg., Chas. H. Shaw,

TON AUTOMATICS



An Installation of P. & J. Automatics in the Terkelsen & Wennberg Company's Factory, Boston, Mass.

You can figure your quotations closer than your unequipped competitor because fluctuations in costs have little effect on your production.

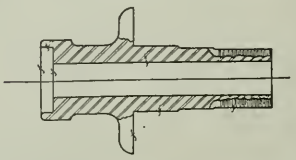
With Potter & Johnston Automatics you know exactly where you are at today, where you will be at tomorrow—or three months hence. What wonder that the call for Potter & Johnston Automatics from many widely varying industries grows greater every day!

Let us make an estimate of P. & J. equipment which would best solve your present problems.

Pawtucket, R. I., U. S. A.

Manager. Toronto Office: 1501 Royal Bank Bldg., E. C. Roelofson, Manager. FOREIGN AGENTS: Chas. Churchill & Co., Ltd., London, Birmingham, Manchester and Newcastle-on-Tyne, England and Glasgow, Scotland. Ercole Vaghi, Corso Porta, Nouva 34, Milan, Italy.

They do This "*Stunt*" Every Eight Minutes



"It's quite a stunt," said the visitor as he was shown a part which the production manager told him had been turned in eight minutes. "Don't you wish you could get that speed in regular production?" It was quite a shock when the visitor learned that eight minutes *was* average production, and that the lathe responsible for the work was a "Libby".

First operation: to chuck casting by large flange, bore, turn and thread and face the flange. Second operation (casting held by threaded portion, pulling finished face of flange back against plate), face end and recess. Time to complete, eight minutes.

We estimate on all kinds of unusual lathe work. How about yours?

INTERNATIONAL MACHINE TOOL CO.

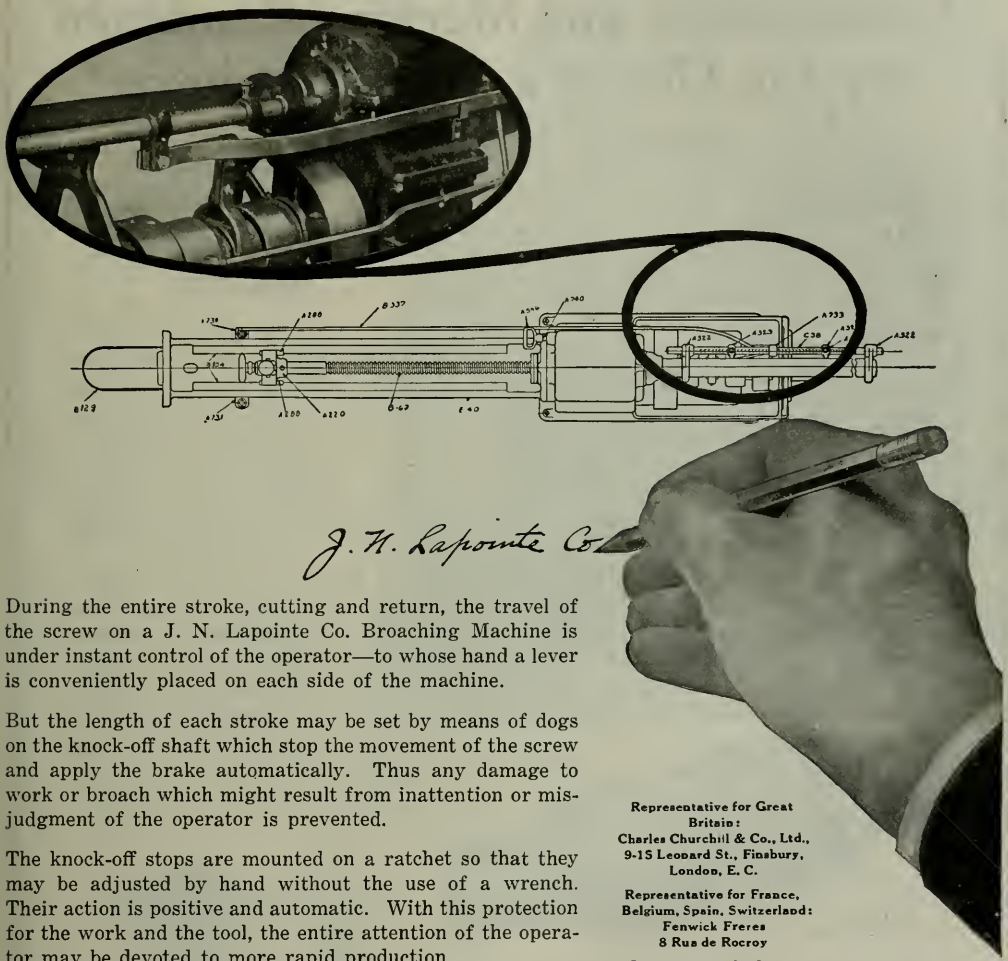
INDIANAPOLIS, INDIANA, U. S. A.

DOMESTIC AGENTS: Blackman-Hill-McKee Machinery Co., St. Louis, Mo. Brown & Zortman Machinery Co., Pittsburgh, Pa. Eccles & Smith Co., San Francisco, Cal., Los Angeles, Cal., Portland, Ore. E. L. Essley Machinery Co., Chicago, Ill., Milwaukee, Wis., and Moline, Ill. Strong, Carlisle & Hammond Co., Detroit, Mich., and Cleveland, Ohio. Vandyck-Churchill Co., New York, N. Y., New Haven, Conn., and Philadelphia, Pa. Syracuse Supply Co., Syracuse, N. Y., and Buffalo, N. Y. Aumen Machinery Co., Baltimore, Md. Northern Machinery Co., Minneapolis, Minn. Seifreat-Woodruff Co., Cincinnati and Dayton, Ohio. FOREIGN AGENTS: Coats Machine Tool Co., Ltd., London, Eng. Iznosskoff & Co., Petrograd, Moscow and Ekaterinburg, Russia. Hijo De Miguel Mateu, Barcelona, Spain. Isbecque & Company, Belgium. Moerch & Reumet, Paris, France. V. Lowener, Copenhagen, Denmark; Chrisiania, Norway; Stockholm, Sweden.



Photograph by courtesy of St. Louis Malleable Casting Company.

"Speed with the Work and the Tool Protected"



During the entire stroke, cutting and return, the travel of the screw on a J. N. Lapointe Co. Broaching Machine is under instant control of the operator—to whose hand a lever is conveniently placed on each side of the machine.

But the length of each stroke may be set by means of dogs on the knock-off shaft which stop the movement of the screw and apply the brake automatically. Thus any damage to work or broach which might result from inattention or misjudgment of the operator is prevented.

The knock-off stops are mounted on a ratchet so that they may be adjusted by hand without the use of a wrench. Their action is positive and automatic. With this protection for the work and the tool, the entire attention of the operator may be devoted to more rapid production.

Safe speed—dependable accuracy—these are salient advantages in broaching machines made by the

Representative for Great Britain:
Charles Churchill & Co., Ltd.,
9-15 Leonard St., Finsbury,
London, E. C.

Representative for France, Belgium, Spain, Switzerland:
Fenwick Freres
8 Rue de Rocroy

Representative for Japan:
Commercial Co. of Tokio,
Tokio

J.N. LAPOINTE CO.
of NEW LONDON, CONN.

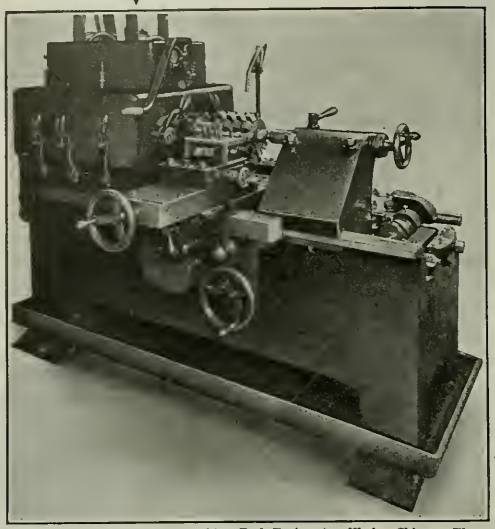
DETROIT OFFICE: 31 HARPER AVENUE

Makers of Broaching Machines and Broaches.

2066-L

THE JOHNSON FRICTION CLUTCH

Countershaft and Machine Combined by the Use of a Johnson Clutch

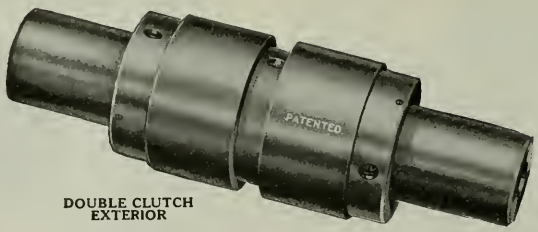


Courtesy of the American Machine Tool Engineering Works, Chicago, Ill.

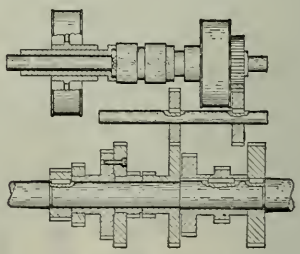
Self-contained Unit Construction on the Hack Relieving Machine

By mounting a compact Johnson Double Clutch on the drive shaft, the Hack High Power Universal Relieving Machine obtains a complete countershaft—with stopping, starting and reversing functions—built right into the headstock of the machine itself.

The neatness of this construction, its saving of space and equipment, deserve the attention of every machine builder. Johnson Clutches offer many other ways of simplifying power control—always supplying a smooth-running, durable mechanism adapted to any form required.



DOUBLE CLUTCH EXTERIOR



Johnson Clutch Installation on the Hack Relieving Machine

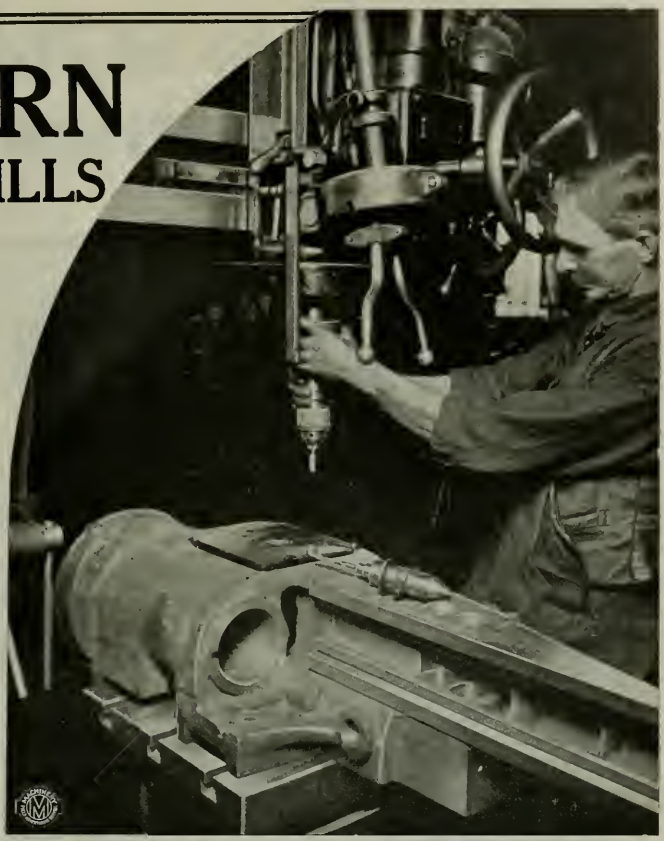
Send for our booklet "Clutches As Applied to Machine Building." Also our "Catalog A."

FOREIGN AGENTS

CANADA: Williams & Wilson, Ltd., 84 Inspector St., Montreal. The Canadian Fairbanks-Morse Co., Ltd., Montreal and branches. ENGLAND: The Efandem Co., Ltd., 22 Newman St., Oxford St., London, W. 1. AUSTRALIA: Edwin Wood, Pty., Ltd., 231 Elizabeth St., Melbourne, Victoria. FRANCE: Anciens Etab. Glaenzer & Perreaud, 18 Faubourg du Temple, Paris. SPAIN: R. D'Aulignac, Cortes 559, Barcelona. BELGIUM: Louis Reyners, Rue de la Buanderie 71, Brussels. HOLLAND: Louis Reijners, Kloveniersburgwal, 101, Amsterdam. DENMARK and SWEDEN: Wilh. Sonesson & Co., Copenhagen and Malmo. NORWAY: Oscar C. M. Knudsen, Odinsgate 4, Christiania. ARGENTINA: Pedro Merlini, Calle Defensa 124, Buenos Aires. INDIA: J. D. Jones & Co., 56 Esplanade Road, Fort, Bombay.

THE CARLYLE JOHNSON MACHINE CO. MANCHESTER CONN.

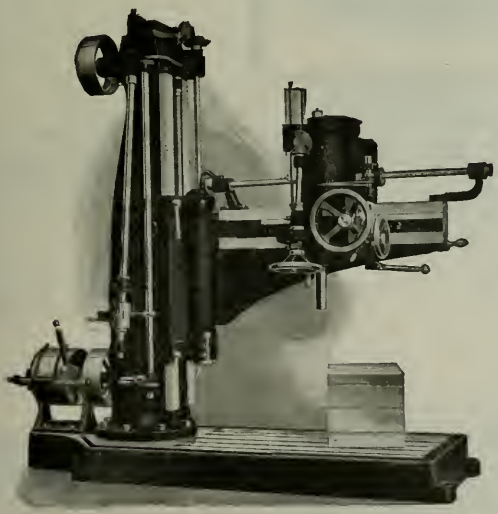
WESTERN
RADIAL DRILLS



This photograph of a Western Radial Drill in the shops of the Universal Boring Machine Co., Hudson, Mass., shows this versatile machine in operation on an unwieldy piece of work—a boring head for the Universal Boring Machine to be drilled and tapped with 144 holes in sizes ranging 3/16″ to 5/8″ in diameter.

A good test for the accuracy of the Western Radial—an apt illustration of its versatility and convenience.

We Say They are Versatile Machines—Here's a Job That Proves It



Accuracy, versatility, range and convenience are machine tool characteristics almost equally important to economical production.

Western Radial Drills have all these things—that is why their popularity is constant and ever growing, why they are used by so many builders of well known machines.

Send for the details of Western Radial Drills. A post card will bring our circular.

WESTERN MACHINE TOOL WORKS

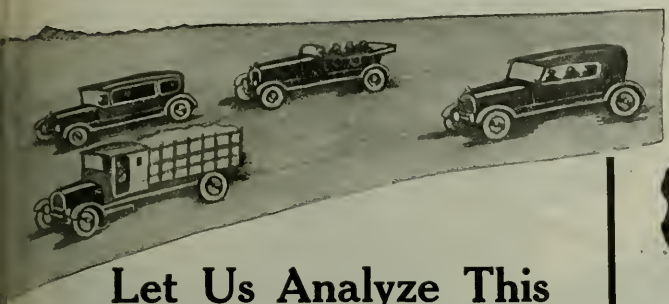
HOLLAND MICHIGAN, U. S. A.

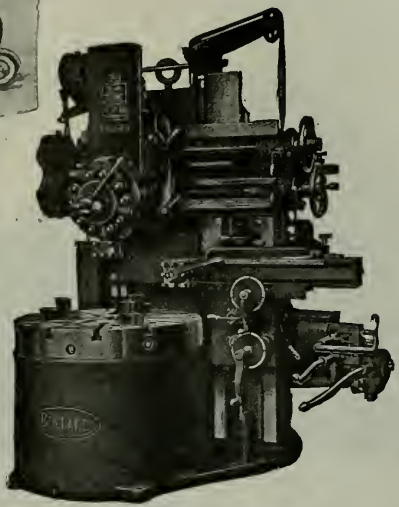
90 Per Cent of *All* Fly Wheels Made in America are Being



TO BULLARDIZE is to secure the greatest profit per man, per machine, per minute, per inch of floor space.

f *All* Trucks and Cars urned out on BULLARDS





Let Us Analyze This

"90% Story of Bullardization"

Any machine or any method (Bullard machines are both) that can supersede former methods ninety per cent must have phenomenal production-boosting and cost-cutting features. Bullards have.

Every Bullard Mult-Au-Matic or Vertical Turret Lathe sold had to prove its right to installation. This leads us to the question of what earns this installation right. And the answer is "greatest profit per man, per machine, per minute, per inch of floor space." The answer is the definition of a term that is heard everywhere in these days of intensive production—BULLARDIZE.

Sixty to eighty per cent savings in time over former methods is the record of every BULLARD in operation not only in machining flywheels but pistons, gear blanks, sprockets, differential cases, truck wheels and dozens of motor parts as well.

Not only is this work being done much quicker, but it is being accomplished with fewer men, releasing valuable operators for other important work and saving floor space, which today is an item of great importance.

Bullardization of production on the machining of castings, forgings or bar stock cut in sections should command first place in your fight for greater production.

VERTICAL TURRET LATHE

Cuts Time Between Cuts

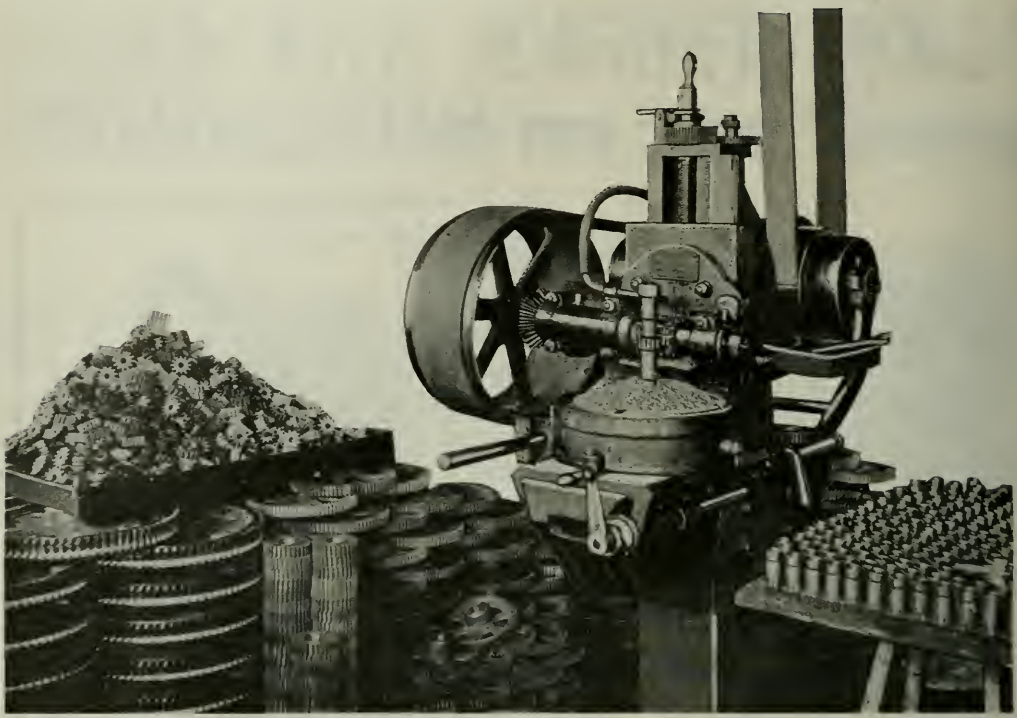
Let Bullard Engineers assist you. Send blue print or sample piece. Literature on request.

BULLARD MACHINE TOOL COMPANY

BRIDGEPORT **CONNECTICUT, U. S. A.**

Also Builders of the Production-famous Maxi-Mill

BULLARDIZE
YOUR PRODUCTION



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"We beg to advise that the following gears were cut in fifty-four hours, including setting up the machine six times:

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400—12 tooth, 10 pitch, ½" face, 7/16" bore, steel pinions.
92—30 tooth, 10 pitch, 11/16" face, ¾" bore, cast iron pinions.
60—60 tooth, 10 pitch, 11/16" face, ¾" bore, cast iron gears (with hub).
60—80 tooth, 10 pitch, 11/16" face, 1" bore, cast iron gears (with hub).
24—80 tooth, ½" pitch, 1¼" face bronze worm gears.

"The operator was able to spend a large portion of his time on other machines, except while cutting the steel pinions with shank, which were cut one at a time, as the shank is larger than the bottom diameter of the gear."

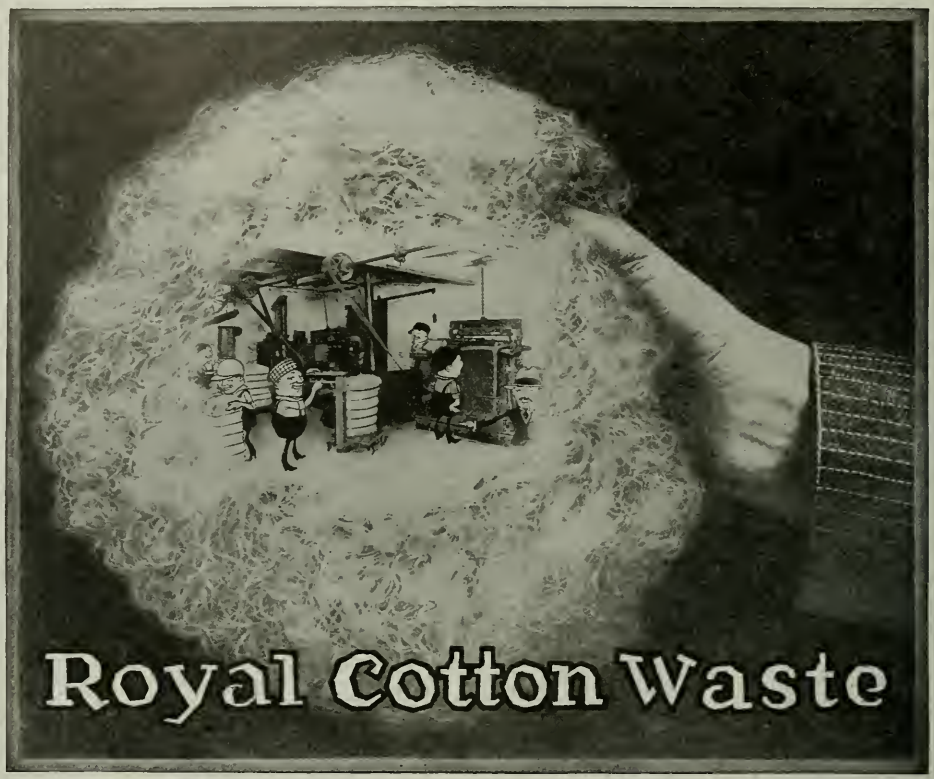
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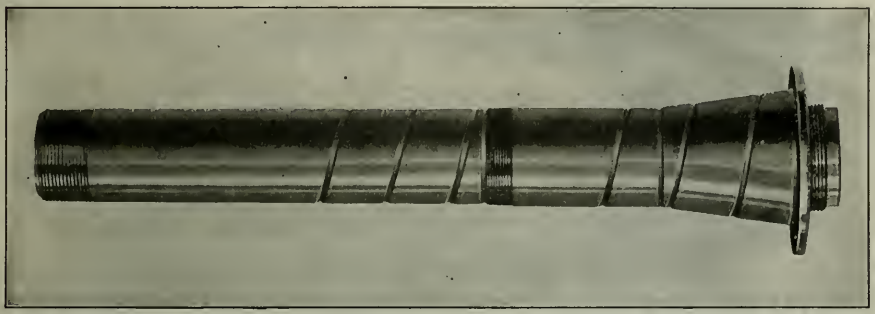
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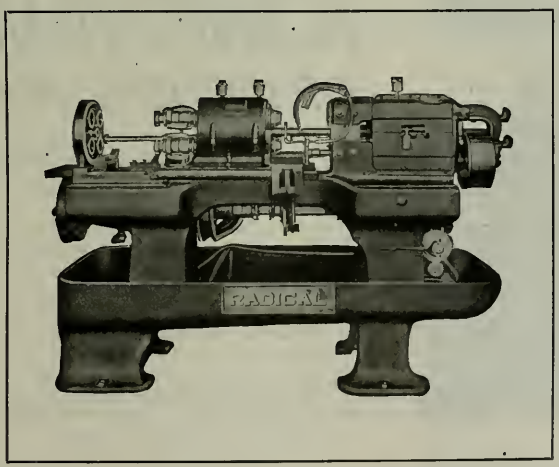


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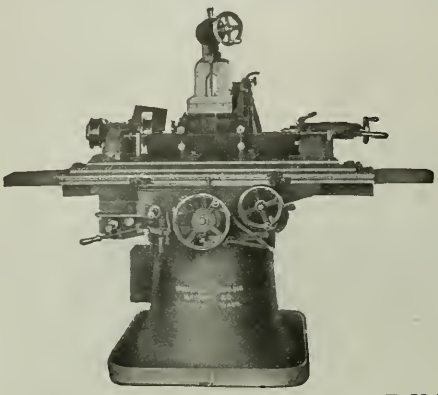
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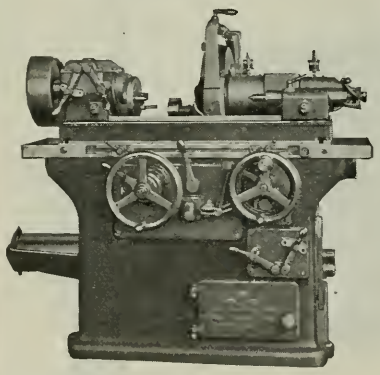
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Specifications

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Work centers, No. 4 Morse Taper	1¼" dia.
Grinding wheel spindle front bearing	3" dia. 7⅝" long.
Grinding wheel spindle rear bearing	2½" dia. 6½" long.
Grinding wheel spindle pulley	6" dia. 4⅜" face
Size of grinding wheel	16" dia. 1" to 3" face 5" hole
Number of grinding wheel speeds 2	1400 to 1640 R.P.M.
Number of work speeds 6	64 to 340 R.P.M.
Number of table speeds 6	28 to 150 per min.
Tight & Loose pulley on countershaft	10" dia. 4¼" face
Speed of ball bearing countershaft	700 R.P.M.
Floor space at right angles to spindle	52"
Floor space parallel to spindle	83"
Net weight, about	4100 lbs.
Gross weight, crated	4800 lbs.

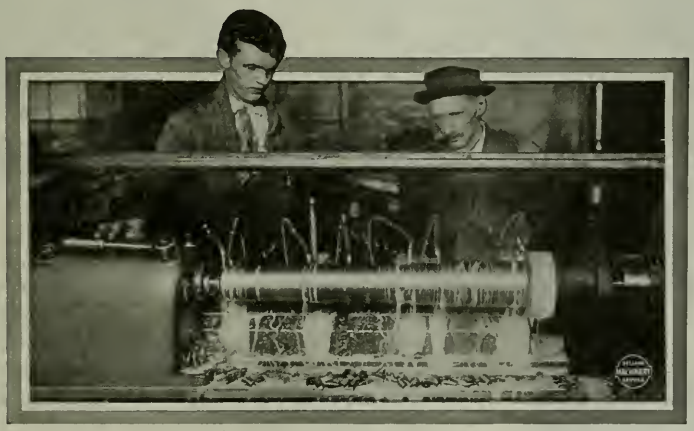
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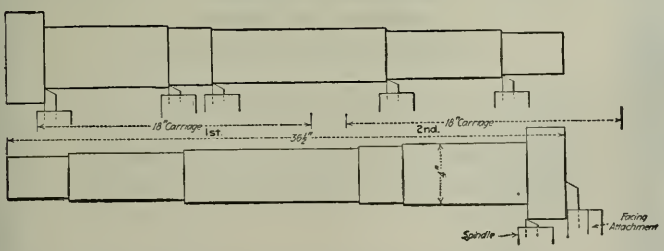
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PW-504

Manufacturing Three-area Contact Ball Bearings



A Detailed Description of the Manufacturing, Inspection, and Assembling Methods Used in the Shops of the Federal Bearings Co., Inc., Poughkeepsie, N. Y., in Producing Three-area Ball Bearings First of Two Articles

By FRED R. DANIELS

THE development of the three-area contact annular ball bearing is in no sense an attempt to change established practice in ball-bearing design, but rather to augment the efficiency and adaptability of the ball bearing to meet present-day requirements. It is claimed by the manufacturers of this type of bearing, the Federal Bearings Co., Inc., Poughkeepsie, N. Y., that in this product there are incorporated features of construction and design which make for severe service, increased efficiency, and high thrust capacity; in fact, a thrust capacity, in either direction, of 50 per cent of the rated radial capacity is claimed, due mainly to the three-area contact feature of the bearing.

In order that this characteristic may be thoroughly understood at the outset, so that it will not become confused with the three-point cup-and-cone design which is fast being superseded by annular bearings, attention is directed to the sectional view of the bearing, Fig. 1, in which the relation of the contact areas is indicated. It will be seen that the bearing consists of an inner race ring *A* having a rather deep annular groove in which a single row of balls is arranged. The balls contact in two outer race rings *B*, the included angle being 28 degrees as indicated in the illustration. The curvature of the three contact surfaces, in both inner and outer race rings is 4 per cent greater than that of the balls. A cage or ball separator consisting of two interlocking retainers, as shown at *C*, partially encloses the balls, the whole being contained in an outer case *D*.

The very term "three-point contact," or more properly "three-area contact" makes it difficult for the engineers of the Federal Bearings Co. to convince the users of ball bearings as to the claims which are made for this design, for, in general, the use of three-point bearings is not popular. This is no doubt due to the tendency, in the original three-point design, of the balls to wear down the cone, particularly under thrust load, causing them to bind and cease to function properly. In the bearing here described, however, the three contacts are obtained in an annular bearing, using but one line of balls, and consequently the objectionable feature of the cup-and-cone type of bearing as just cited, cannot obtain. While it is claimed by some that a four-area contact bearing is the ideal arrangement for ball bearing design, the expense which has always attended the manufacture of bearings of this type, as well as the unsatisfactory results obtained by their use in the past, has resulted in the commercial use of these bearings being superseded by bearings of more simple design and greater manufacturing facility. The three-contact design is of standardized specifications, meeting the requirements established for ball bearings by the Society of Automotive Engineers.

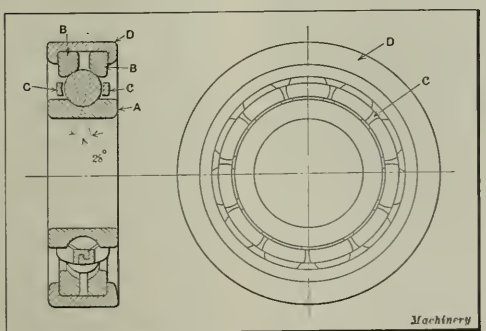


Fig. 1. Sectional View of Three-area Contact Ball Bearing, showing Relation of Parts

Making the Ball Bearing Case

The bearing case or jacket in which the various parts of the bearing are enclosed is made of open-hearth cold-rolled steel, and is blanked cold from sheet stock on a power press equipped with standard construction blanking dies. The second operation consists of drawing to the proper depth, and the third operation is that of punching out the center of the shell. The inside diameter of the case is next sized, this work also being done on a power press equipped with a plain cylindrical punch. The cases are next slightly chamfered on both outer edges and both sides of the pierced hole, as shown in the sectional view in Fig. 1. Except for the final truing up and grinding operations, and the operation of closing the case and removing burrs resulting from this operation, all of which is done after the hearing has been fully assembled, this concludes the machine work on the case. In the manufacture of smaller sizes of bearings which may

be used as rollers, it is necessary to harden the case, but otherwise this treatment is not required.

Operations on the Race Rings Prior to Heat-treatment

The inner race ring *A*, Fig. 1, is roughed out from solid bar stock or sometimes from heavy steel tubing, on Cleveland or National Acme automatic screw machines. The stock from which the rings are made is a high-carbon chromium steel having the following special analysis: Carbon, 1.15 to 1.30 per cent; phosphorus and sulphur, less than 0.02 per cent each; manganese, 0.30 to 0.45 per cent; chromium, 1.15 to 1.30 per cent; and a trace of vanadium. Following the roughing out operation on the automatic in which the ball race or groove is also rough-turned, both sides of the ring are chamfered inside and out, after which the parts are ready for heat-treatment.

The outer race rings are made from a special chrome-vanadium alloy steel of the following composition: Carbon, 0.95 to 1.10 per cent; phosphorus and sulphur, less than 0.2 per cent each; manganese, 0.45 to 0.60 per cent; silicon, 0.10 to 0.20 per cent; chromium, 1.00 to 1.10 per cent; and vanadium, 1.15 to 1.20 per cent. The rings are not made from solid stock, but are blanked out cold from sheet metal, and after being subjected to two press operations are forged to the approximate section shown in Fig. 1 at *B*. The second press operation consists of cupping or drawing the blank, a production rate of from 10,000 to 12,000 pieces per day being maintained on the average size blanks. The center holes are next punched out, leaving a flange at the bottom of the shell, after which the parts pass to a gas furnace where they are heated from 1450 to 1475 degrees F., and they are then forged to shape. This is evidently the most satisfactory method of producing the rings, eliminating many machine operations and much wastage of stock which would be required to produce the parts from bar or tube stock on the automatics. The rings are next annealed and then pickled to remove the oxide scale and dirt, after which they are ready to be shaved on the inside diameter. This operation removes surface defects such as might be produced in forging, and is performed on a turret lathe or hand screw machine, the rings being held in a suitable chuck while the operation is being performed.

Heat-treating the Rings and Testing for Hardness

Both the inner and outer rings are subjected to essentially the same heat-treatment, which is carefully performed in the heat-treating department, a view of which is shown in Fig. 2. On the right-hand side of the room will be seen a battery of Frankfort oil-burning furnaces, manufactured by the Strong, Carlisle & Hammond Co., while at the left of the room may be seen a hardening furnace, also one water and one oil quenching tank. The heat-treatment consists of normalizing the parts at a temperature of from 1450 to 1475 degrees F. in the heat-treating furnaces shown in the illustration, the heat being regulated by individual pyrometer control. After cooling, the rings are reheated to the decalescence point (1450 to 1475 degrees F.) in the hardening furnace and quenched.

Fig. 4 shows a view of the water quenching tank to which attention has been called in connection with the reference to Fig. 2. A special quenching device is shown, which is used in hardening the outer race rings only. They are placed in this holding arrangement *A*, which is conveniently attached to the side of the tank and quickly immersed in the water. This special provision in connection with the even temperature of about 65 degrees F. maintained by circulating the water, prevents the rather slender rings from warping and assures an even hardness. The holding device is attached to the side of the tank in such a way as to permit a stirring movement when immersing it, and a weighted arm prevents it from dipping into the bath while the handle is being operated, during the operation of putting the hot rings in place. The inner race rings are quenched in oil instead of in water, and the tank in which they are quenched is provided with coils for the purpose of circulating the oil and maintaining an even temperature throughout the bath. This oil quenching tank may also be seen in Fig. 2.

After hardening, all rings are tempered in oil at 350 degrees F., and then subjected to a file hardness test. It has been the experience of the engineers of the company, that more satisfactory results can be obtained by using the file test than by either the Brinell or scleroscope methods. The testing department in which the rings are tested is situated at the farther end of the hardening room, which enables the heat-treating and testing departments to work in close co-



Fig. 2. View of the Hardening Department, showing Battery of Heat-treating Furnaces and Quenching Tanks

operation. Warpage defects are here also carefully looked for, the rings being tested on a surface plate.

Finishing Operations on the Inner Ring prior to Assembling the Bearing

In the manufacture of high-grade ball bearings many types of grinding machines are used. Besides employing grinders of standard construction, satisfactory results are obtained by using a special radial grinder designed by the company, a sectional view of which is shown in Fig. 3. It will be seen that the design of the machine is simple, consisting of a grinder-head *A* and a work-head *B*, both of which are driven independently. The work-head is capable of swinging on post *C* and is provided with suitable means for regulating the length of radius when setting up the machine.

The first operation on the inner race ring after heat-treatment is performed on a Blanchard grinder, both sides being ground to very close limits. The rings are next ground on the bore, an operation which requires very accurate workmanship, the tolerance on certain sizes being as close as plus 0.0002 inch and minus 0.0003 inch. This operation is performed on Heald, Bryant, and Van Norman internal grinders. After being ground the work is carefully inspected, and no rings are permitted to be passed along if they are bell-mouthed, tapered, or not within the tolerance limits.

In grinding the raceway in the inner ring, a radius 4 per cent greater than that of the balls which are to be assembled in this groove, is produced. This operation is shown in Fig. 6, the machine employed being of the special design previously mentioned and shown in Fig. 3. It is equipped with an arrangement for testing the diameter of the groove and also the running truth of the grinding machine arbor. This is accomplished by means of suitable lever arms *A* and *B* in which diamond points are carried, which are brought in contact with the work from time to time as the rings are being ground. The very accurate limits to which the raceway is held are determined by an Ames indicator, which is plainly shown in the illustration. The indicator is graduated to read to 0.001 inch, and the lever arm ratio is 10 to 1, so that each 0.001 inch on the dial will indicate a change of 0.0001 inch in diameter or in running truth, according to which diamond point is in contact with the work.

During the final operation on the inner rings before assembly, the raceways are lapped, the work being done on a speed lathe as illustrated in Fig. 5. A lapping compound consisting of wax, tallow, and flour emery is used, and a special lead lap employed which is secured in tong-like holders as shown. The illustration also shows a number of rings mounted on an arbor, and the lapping operation being performed. The rings are then cleaned in soda and sent to the inspection department.

Finishing Operations on the Outer Race

After being subjected to the hardness test in the heat-treating department, the outer race rings are ground on the side, the parts being held on the magnetic chuck of a Blanchard grinder, equipped with a measuring arm and an Ames dial indicator, as clearly shown in Fig. 7. By this means the limits to which the work is held may be quickly and accurately obtained. After grinding, the rings are cleaned by compressed air at 80 pounds pressure. It will be apparent, as the chips adhere to the rings due to the magnetism produced in the grinding operation, that the only satisfactory way to clean the rings is with compressed air.

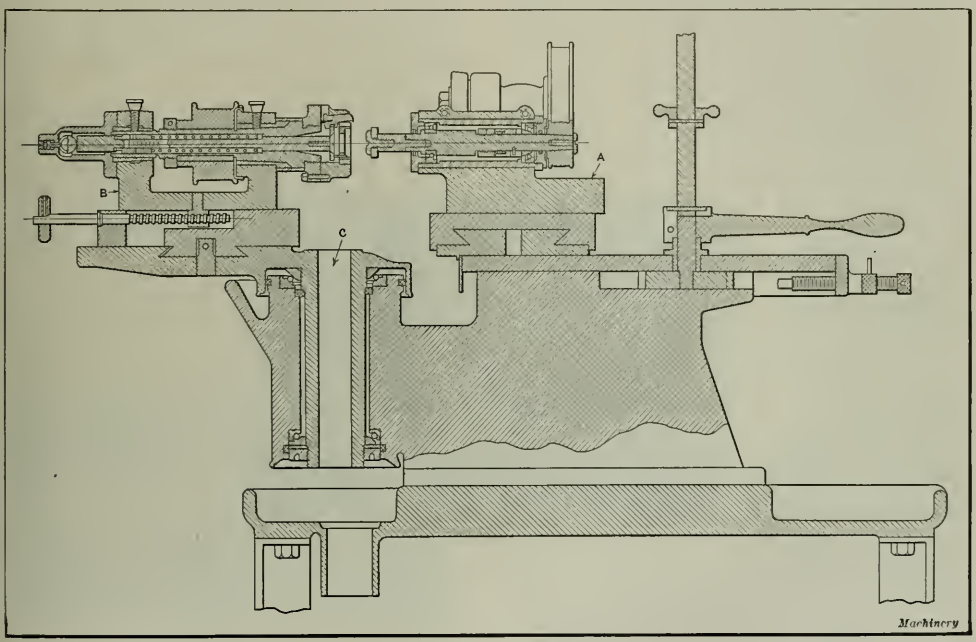


Fig. 3. Sectional View of Specially Designed Radial Grinding Machine used in grinding the Race Rings

The parts are next demagnetized on a Walker demagnetizing machine, after which they are ground on the outside diameter. During this operation the rings are mounted on an arbor in either an Ott or a Norton cylindrical grinder provided with a dial indicator and measuring arm as shown in Fig. 8. This illustration shows the operation very clearly, although the diamond point which is kept constantly in contact with the surface being ground, and which is held in the opposite end of the measuring arm, cannot be seen. The leverage of the measuring arm has a ratio of 10 to 1 so that readings within 0.0001 inch are obtainable.

The radial grinder shown in Fig. 9 is fitted with an automatic calibrating device, which gages the accuracy of the ball track location during the process of grinding the contact surface in the outer race ring. This calibrating device is similar to those employed on previous grinding operations,

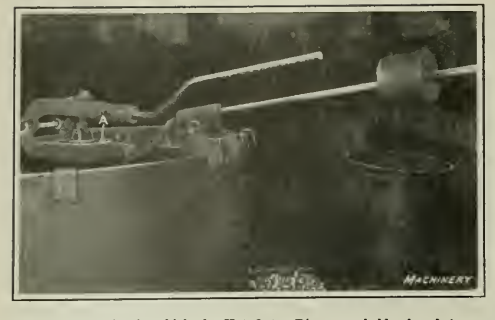


Fig. 4. Device in which the Hot Outer Rings are held when being quenched as a Means of preventing Warpage

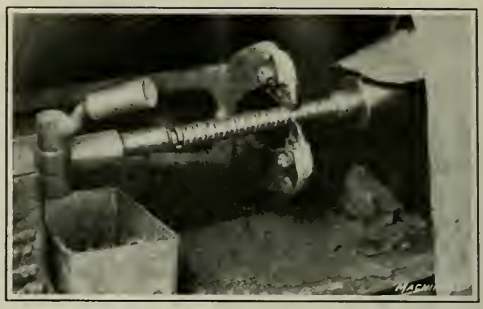


Fig. 5. Lapping the Raceways in the Inner Rings on a Speed Lathe, the Laps being held in a Special Holder

and consists of a lever-arm arrangement with a dial indicator on one end and a diamond point which is held in a suitable pivoted arm and which is brought in contact with the race ring from time to time during the process of grinding. This is accomplished by the thumb-lever arrangement shown. As in other grinding operations performed on both the outer and inner race rings, the established limits of accuracy are maintained. It has already been mentioned that much of the radial grinding work performed on these parts is done on machines of special design, although the great amount of grinding necessary on these ball bearing parts has resulted in the use of a large number of machines of various standard types. The raceways are next lapped, using a lead lap and a lapping compound composed of wax, tallow, and flour emery, the operation being similar to that employed in lapping the raceway of the inner ring. Before passing to the inspection bench, the outer rings are cleaned in the same manner as the inner rings.

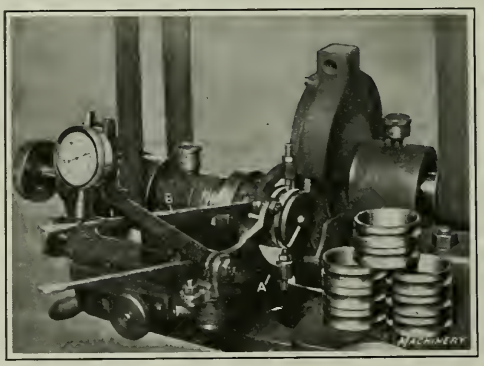


Fig. 6. Grinding the Raceway of the Inner Ring. A Special Calibrating Device is used to obtain the Required Accuracy

The cage or separator which encloses the balls in the bearing is shown at *C*, Fig. 1, from which an idea of the relation which it bears to the ball in the assembly may be had. However, the construction of the cage can more clearly be seen by referring to Fig. 10, which also shows the various stages of manufacture required in producing the two members or retainers of which the cage is composed. At *D* in this illustration the cage is shown assembled, that is, locked together. This arrangement is a distinctive feature of the cage, and as a result no rivets or similar means of holding the two parts together are required. The lugs on the mating members are so shaped that they will interlock. The advantage derived from this arrangement will be more fully apparent by a description of the assembling process.

The retainers are made from ordinary sheet metal and are blanked out and formed during a series of punch press operations. No heat-treatment or finishing operations are required, as the purpose of the cage is simply to provide a sufficiently flexible arrangement to accommodate the variations in load and changes in the axes of rotation in the balls when thrust loads are applied, and at the same time, by means of the interlocking lugs, to do away with the separate distance pieces between the balls, sometimes employed in ball bearing construction.

The first press operation on the outer retainer ring, that is, the ring in which the lugs are formed on the outside, consists of perforating and blanking, the work being done in one operation. The appearance of the stock after this operation is shown at *A*, while the shape of the part after the next operation is shown at *B*. It will be seen that in producing this shape a simple blanking operation was performed on the stock shown at *A*. The third operation is that of bending the outer lugs at right angles to the face of the ring as shown at *C*, and the final press operation produces the finished retainer. This is a forming operation in which the spaces between the lugs are shaped to the required curvature, and at the same time the lugs are given the final

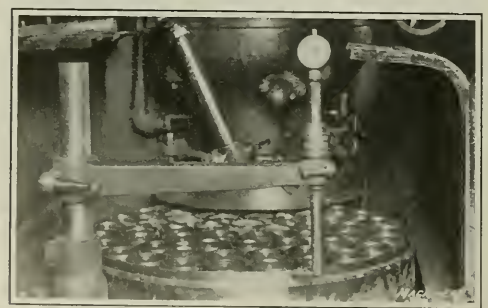


Fig. 7. Grinding the Sides of the Outer Race Rings on a Blanchard Grinding Machine

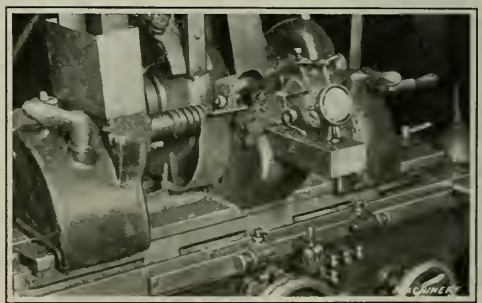


Fig. 8. Grinding Outside Diameter of Outer Race Rings on an Ott Cylindrical Grinding Machine

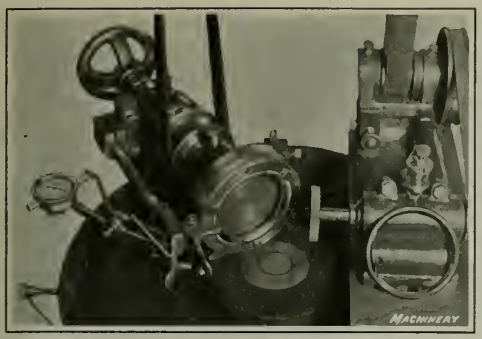


Fig. 9. During the Grinding Operation on the Outer Ring Track a Gaging Device is employed in which a Diamond Point is held in Contact with the Work

90-degree bend toward the center. In producing the inner member of the cage the work is first blanked, and then perforated, which gives it the appearance shown at *F*. The center is next punched out as at *G*, after which the internal lugs are formed at right angles to the face, as indicated at *H*. The final forming operation is similar to that employed on the outer member of the cage, and produces a retainer having internal rather than external interlocking ledges.

Owing to the large variety of bearing sizes which are in commercial use, the making of these retainers requires an elaborate outlay of dies in order that these conditions may be met. This means, of course, the employment of a great number of power presses and an extensive tooling equipment for each. The collection of parts shown in Fig. 10 constitutes a set of samples, and similar sets of every bearing manufactured are kept on file in suitable cabinet compartments,

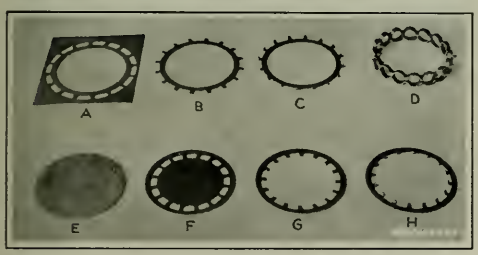


Fig. 10. Various Stages in manufacturing the Mating Retainers of the Ball Cage

together with the punches and dies employed for each individual size. For instance, the samples shown in the illustration are complete for bearing No. 212.

The second article, which will be published in the September number of MACHINERY, will deal with the inspection methods used in the plant of the Federal Bearings Co., and will describe the assembling process, as well as the final testing and truing operations.

* * *

The Ordnance Department has established a staff of trained engineers whose function it will be to study the technical problems of the Ordnance Department that seem worthy of development. Doubtless such a staff will be able to advise upon many problems where the individual engineer in charge of certain work would be unable to arrive at accurate conclusions, due to the limited time that he will have for considering all the problems encountered in his daily work.

HINGED JIG FOR DRILLING AND TAPPING

By F. SERVER

An iron casting of rather frail construction on which there are no finished surfaces is shown in Fig. 1. The only machine work required on this part is the drilling and tapping of two holes as indicated at *X*. The jig employed to hold these parts is illustrated in Fig. 2. This jig is of rather simple construction; it is of the hinged-cover type, provided with suitable means for clamping the work. On the cast-iron base *A* are two lugs by means of which the cover *B* is hinged. The cover is made from a steel forging and contains two drill bushings *C* and *D* of suitable size for guiding the tap drills. When the jig is opened, the cover may be swung back until the lug *E* comes in contact with stop *P*,

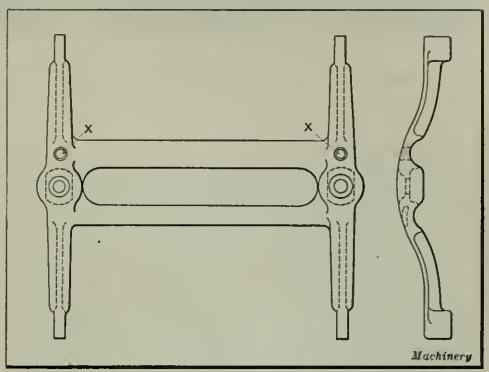


Fig. 1. Iron Casting of Frail Construction which is drilled and tapped in the Jig shown in Fig. 2

so as to prevent it from dropping back more than 30 degrees from the vertical. When the cover is closed, it rests against the studs *M* and *L*. Stud *L* also serves as a stop against which the work is abutted and secured by means of the eccentric cam *J*, located at the opposite end of the jig and operated by the pin *K*. The partial view illustrates the arrangement very clearly, from which it will be seen that the saw teeth in stud *L* prevent the work from lifting from its seat after the cam *J* has been operated to bind it in place.

It will be apparent that the casting rests on the lugs or seats *F*, *G*, and *H* and that these seats are formed on the base of the jig to conform to the shape of the casting. Studs *M* and *L* are a drive fit in the base, while the eccentric cam *J* is held in place by means of a screw and washer *N*. After the holes have been drilled, the cover is swung back and the holes are tapped without disturbing the work. It is in this connection that the rather novel method of clamping the work in place becomes of special value. The jig may be quickly loaded, and for the class of work for which it is used, the results are sufficiently accurate.

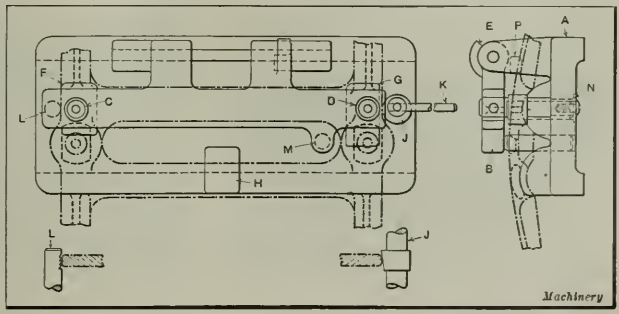
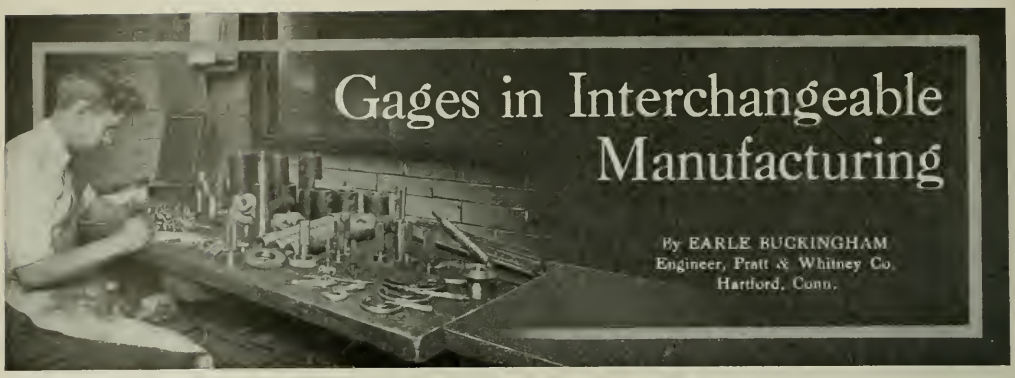


Fig. 2. Hinged-cover Drilling and Tapping Jig with Eccentric Cam Clamping Arrangement



Gages in Interchangeable Manufacturing

By EARLE BUCKINGHAM
Engineer, Pratt & Whitney Co.
Hartford, Conn.

Second of Two Articles Describing Various Types of Gages and Gaging Devices Employed in Manufacturing Interchangeable Parts

IN the first article dealing with gages in interchangeable manufacturing, which appeared in the July number of MACHINERY, attention was called to the necessity for gages in economical interchangeable manufacturing, a classification was given of gages according to their use, the required accuracy of gages and the desired relation between working and inspection gages were dealt with, and in addition, snap gages, ring gages, plug gages, contour or profile gages, flush-pin gages, and sliding-bar gages were described. In the present article it is proposed to deal with flat depth and length gages, hole gages, thread gages, wing gages, indicator gages, functional gages, and gear gages, and to present a general discussion on the subject of master gages and reference gages.

Flat Depth and Length Gages

A simple type of templet gage to measure the depth of a counterbored hole is shown in Fig. 21. One step is used as a "Go" gage, while the other is used as a "Not Go" gage. A similar gage can be used for measuring the length of a shoulder. Fig. 23 illustrates a length gage, on which the limits are indicated by scribed lines. This type is really a special scale for measuring certain fixed dimensions.

Hole Gages

A "hole gage" is a gage for testing the location of holes relative to each other or to a specified register point. The gages measure the distances between the outer and inner points of the peripheries of the holes. They are, in effect, functional gages. While the gage does not actually measure the center distances, it will insure that the accepted parts may be assembled properly. When designing such gages, the functional conditions of the mating parts must be carefully checked and analyzed to insure that the results desired will be secured without imposing unnecessary hardships on the manufacturing departments. Attention is called to the previous discussion of these conditions under the sub-head "Dimensioning of Holes" in the article on component drawings, published in the December number of MACHINERY.

This type of gage comprises an almost infinite number of designs. Some may be simple templets with studs or bushings and plugs, while others may be almost duplicates of the drill jigs used in producing the holes, using plugs through the bushings instead of drills and reamers. In fact, if the drill jig is not in constant use, and is kept properly checked, the addition of suitable plugs will make it an extremely effective gage. A few examples of gages of this type will be illustrated to indicate their wide variety. In Fig. 22 are shown two hole gages with their plugs. These are used for testing the locations of the holes in the end of the transmission case dealt with in the articles on interchangeable manufacturing equipment published in the May and June numbers of MACHINERY. They are examples of the simplest type of hole gages.

A more elaborate gage for the same transmission case is shown in Fig. 24. The holes in the shifter cover face of the work are tested with this gage for their relation to each other and to the main shaft. The transmission case is centered on the arbor and clamped by the hollow plug *A*. The stud *B* locates the case radially. The plate *C* is placed on the shifter cover face, and is located from the central arbor by forks *D* on the plate fitting in the grooves *E* on the arbor. The small plug *F* is then used to test the locations of the six small holes in the shifter cover face. At the left in Fig. 25 is shown a hole gage unloaded, and at the right, the same gage is shown with the work in the gaging position. This gage is a duplicate, in its general design, of the jig that is used when drilling the holes in the shifter cover face.



Fig. 21. Simple Type of Templet Gage employed to measure the Depth of a Counterbored Hole

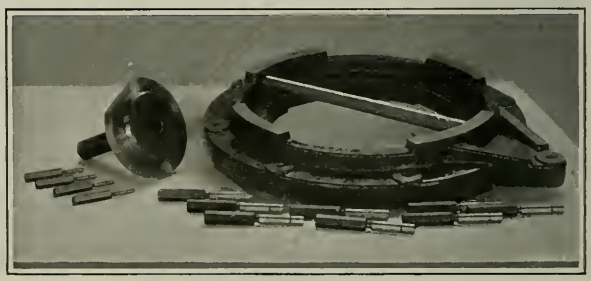


Fig. 22. Hole Gages and Plugs used in testing the Locations of Holes in an Automobile Transmission Case



Fig. 23. Gage used for measuring Lengths, the Limits of the Work being indicated by Scribed Lines at the Right-hand End

Discussion of the Factors Involved in Gaging Threads

At the present time, a wide difference of opinion exists as to the proper method of testing threads. Owing to the fact that a thread is a complicated composite surface, and that any composite surface is difficult to measure readily, and also because threads are employed in so many places for a wide variety of purposes, this condition is one to be expected. There are three main elements in a threaded surface: The form of the thread, the lead or pitch of the thread, and its diameter. The form of the thread itself is composed of several surfaces. The form of a sharp V-thread is composed of two angular flanks, but this form is theoretical only. A certain amount of rounding or flattening is inevitable at the crest and root. The form of most other standard threads is composed of four surfaces—the crest, the root, and the two flanks. Thus a thread is a composite surface, the accuracy of which depends upon the interrelation of the following: The diameters and form of the crest and root, the form of the two flanks, and the lead.

There is a broad general principle in regard to limit gages which should always be kept in mind. Where compound tolerances are not involved, a "Go" gage with fixed measuring surfaces may check as many dimensions at one time as desired, and effective inspection will be secured. On the other hand, an effective "Not Go" gage can check only one dimension. By effective inspection is meant assurance that specified requirements in regard to size are not exceeded. The above principle must be applied with common sense, as there are a great many requirements that drawings fail to express clearly. This is especially true in the case of surfaces that are threaded.

The gaging of an externally threaded component will now be considered. A diagram of such a surface, illustrating the terms that will be used in the discussion, is shown in Fig. 26. The outside, or largest diameter, will be called the "major diameter." The smallest diameter will be called the "minor diameter." The top of the thread will be called the "crest," and the bottom, the "root." The sides of the thread will be called the "flanks." The dimension taken square with the axis of the thread from flank to flank at any point, will be called the "effective diameter." The "included angle" is the angle between the flanks of two threads, and the "lead" is the distance from a certain point on one thread to a similar point on the next thread.

Method of Expressing Tolerances on Threaded Parts

The correct method of gaging this thread consistently depends on the manner in which the tolerances are expressed.

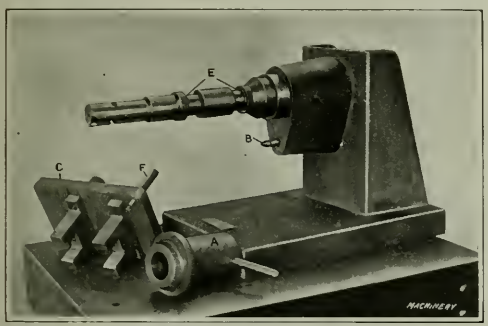


Fig. 24. Gage used in testing Holes in a Transmission Case, the Work being mounted on the Arbor for the Purpose

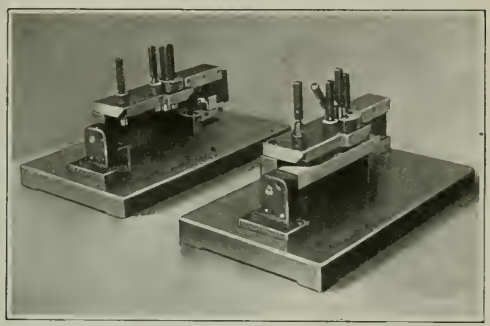


Fig. 25. Another Type of Hole Gage which is a Duplicate of the Drill Jig used in machining the Holes in the Work

In any event, the major and minor diameters should be treated as independent elementary surfaces. They may be gaged, when necessary, either independently or in conjunction with the other elements on the "Go" gage. The tolerances on the other elements may be expressed in one of two ways—either as a total cumulative error expressed in terms of the effective diameter, which will eliminate compound tolerances, or as individual tolerances on each element, which will introduce compound tolerances with all their resulting annoyances and inconsistencies.

If the tolerances are expressed in the second manner, the only consistent method of gaging would be to provide suitable gages for each element and to test each of them independently. Any gage to test all of the elements at one time would need to be a functional gage and its design would involve a careful study of each set of companion threads to establish the proper dimensions. If the tolerances are expressed in the first manner, the gaging problem is simpler. The "Go" gage may be a ring thread gage checking the "Go" dimensions of all elements. As a matter of economy, in making the gages, it is necessary to provide clearance at that part of the ring gage which

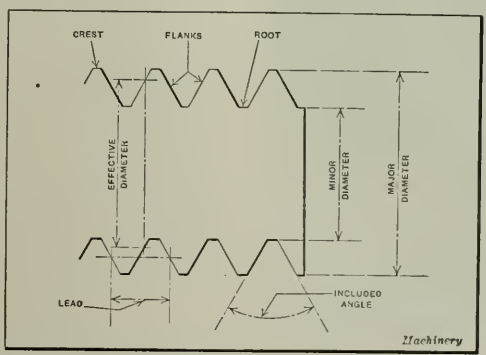


Fig. 26. Diagram illustrating the Meaning of the Terms used in the Discussion on Thread Gages

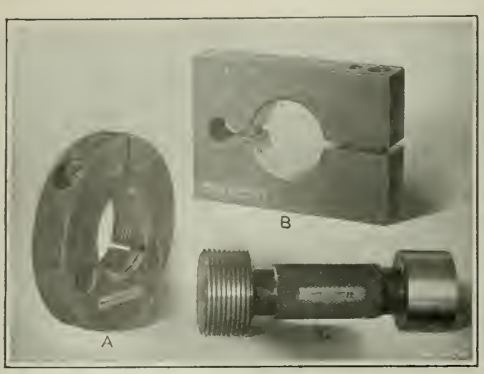


Fig. 27. Standard Ring Thread Gages and a Standard Plug Thread Gage

would check the major diameter, so as to facilitate lapping or grinding. This dimension on the part may readily be checked, when desired, by a simple snap or ring gage.

A decided difference of opinion exists as to the proper length of engagement for thread gages. From an academic viewpoint, the gage should be as long as the effective length of the thread on the component. The effect of the use of longer or shorter gages is to hold the error in the lead of the thread to a lesser or greater amount. Many conditions exist where a relatively large error in lead is not important. In such cases, a shorter gage will make the manufacturing conditions much easier, and at the same time pass only satisfactory parts to meet such conditions. For example, if the length of a gage is reduced to one-half the effective length of the thread on the component, it will permit an error in lead of double the amount which would be allowed by a gage which is as long as the full effective length of the thread on the component.

Theoretically, individual "Not Go" gages should be provided for the major diameter, minor diameter, and effective diameter. Practically, the most severe requirements will usually be met by providing a "Not Go" gage for the effective diameter only. This would be a ring thread gage, made to clear both the major and minor diameters of the component. Its length must be such that it will not engage over one or two turns on the component. As a matter of fact, the strength of the engagement of a screw and nut depends primarily on the amount of the engagement area between the threads.

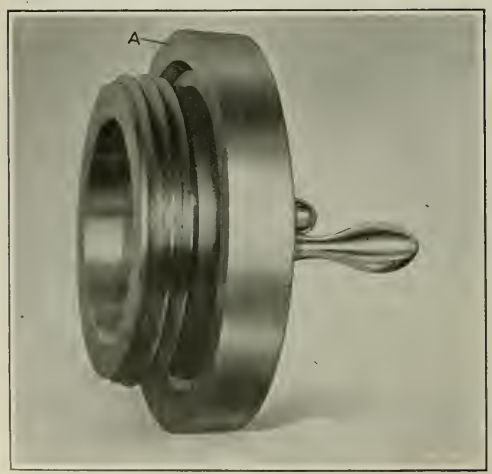


Fig. 28. Qualifying Gage for inspecting the Breech Mechanism of a Large Gun

In many cases suitable inspection will be secured by the use of a "Go" ring thread gage which has clearance at the major diameter of the component, and a "Not Go" ring or snap gage for the major diameters of the component. At *A* in Fig. 27 is shown a standard ring thread gage. The gaging of internally threaded components involves the same problem as the gaging of those threaded externally. A standard plug thread gage for this purpose is shown at *C*. In this case the "Go" gages are made to clear the minor diameter of the component, while the "Not Go" gages are made to clear both the major and minor diameters.

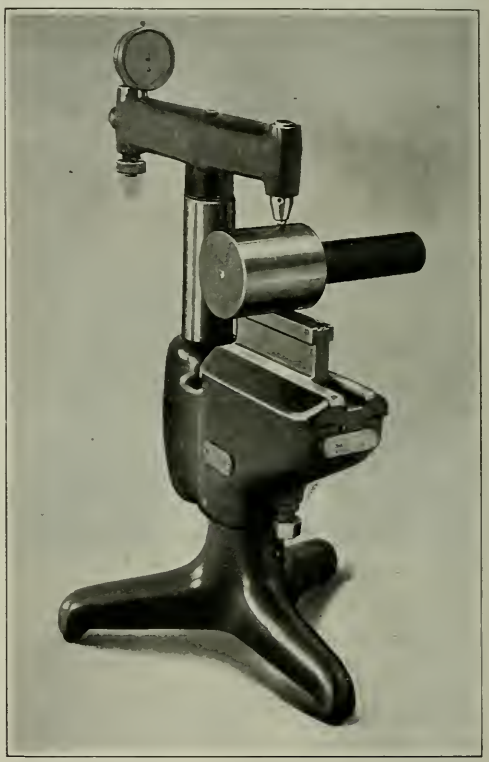


Fig. 29. Amplifying Gage which permits the Rapid Inspection of a Large Variety of Surfaces

Types of Thread Gages

Standard plug and ring pipe thread gages are tapered, and on this account one gage acts both as a "Go" and as a "Not Go" gage. A notch on the gage must be flush with the end of the part within a specified number of turns. These gages are made to clear both the major and minor diameters. In Fig. 28 is shown a "qualifying" gage for the breech mechanism of a large gun. This is a case where the thread must start in a certain specified position. A line is graved on the flange of this gage which must coincide within specified limits, when the gage is screwed home, with another line on the work. The gage measures the relationship between flanks on the work and surface *A* on the gage. This gage is cleared at all points except at surface *A* and on the thread flanks, the angle of the threads being sufficient to center the gage when it is screwed home.

Wing and Indicator Gages

Wing gages are used in some instances where snap gages cannot be conveniently employed. These gages are of the limit type and have two projections or wings. The principle

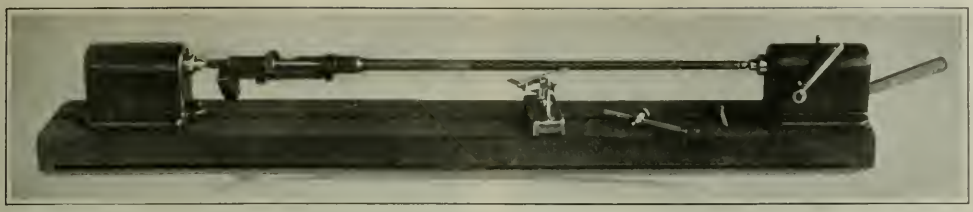


Fig. 30. Indicator set on Bench Centers for testing the Concentricity of a Rifle Barrel

is that one wing must pass the surface of the work to be gaged, while the other must not. This construction permits work to be rapidly and accurately gaged.

Many effective gages can be made simply by providing suitable stands or holding blocks for dial indicators. In one of the prominent watch factories, a large percentage of the gaging equipment is constructed in this manner. These indicators can be set up not only to measure lengths, diameters, etc., but also profiles and locations. Several standard indicating gages are now on the market which require very little in the way of holding blocks, etc., to adapt them to measure a great variety of surfaces. In Fig. 29 is shown an amplifying gage, which is very rapid in operation. In the illustration Fig. 30 is shown an indicator used in connection with bench centers for the purpose of testing the concentricity of a rifle barrel that is assembled with a receiver.

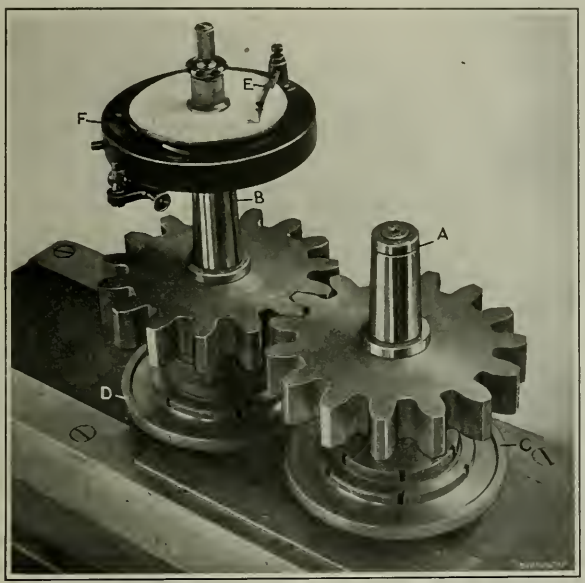


Fig. 31. Machine for testing the Uniformity of Motion between Two Gears, which indicates and records the Amount of Error

Functional Gages

A functional gage is one that tests the functional operation of a component without strict adherence to its exact physical dimensions. Thus, when a repair part is made for a mechanism and fitted to the machine, the machine itself becomes a functional gage for that part. In manufacturing, there are often parts or surfaces on some components which cannot be checked satisfactorily by a series of individual measurements. As a final test for these parts, functional gages are of great value. In some cases, it is possible to eliminate several individual gages, at least for inspection purposes, by the use of suitable functional gages. These duplicate as far as possible the functional conditions required by the mechanism. In fact, in many cases they are almost duplicates of the mechanism itself.

For large work and relatively small rates of production where ordinary gages would be heavy and cumbersome and the number required for effective inspection would be large, the functional gage offers a satisfactory means of gaging. Sometimes, of course, modifications of the design of the mechanism must be made in the functional gages to permit them to be assembled and disassembled readily. In general, they duplicate as far as possible the functional conditions required by the mechanism.

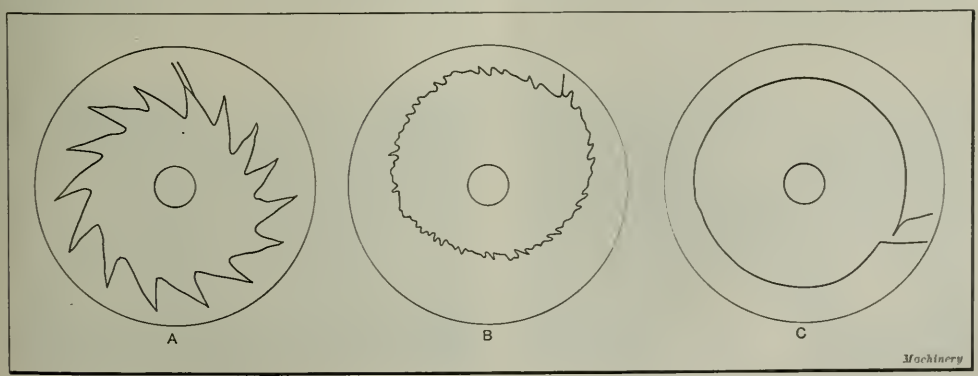


Fig. 32. (A) Chart obtained on Machine illustrated in Fig. 31 from Two Gears cut with Form Milling Cutters. (B) Chart obtained from Two Gears cut on a Gear Generating Machine with a Straight-sided Rack Cutter. (C) Chart secured from Two Gears hardened and then ground in a Grinding Machine of the Molding-generating Type



Fig. 33. Size Blocks being used to check the Distance between the Gaging Surfaces of a Snap Gage

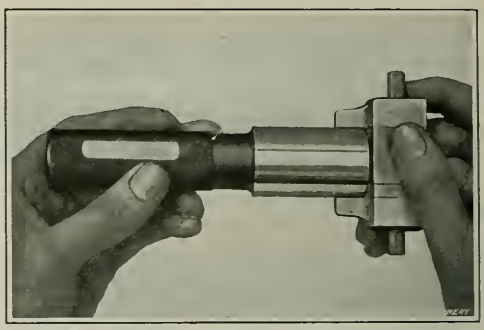


Fig. 34. Application of Size Blocks and End Measuring Attachments for checking the Diameter of a Plug Gage

Functional Gaging of Gears

The satisfactory gaging of gear teeth is a complicated and difficult problem, if each element is tested independently, because of the many factors involved. If the testing is reduced to a functional inspection, however, the problem becomes simpler. The prime object of gears is to transmit a uniform motion, and if this result is accomplished it does not matter what the exact contour or dimension of any of the operating surfaces may be. On the other hand, if the gears do not accomplish this result, the only good that knowledge of the various discrepancies does, is to indicate the possible causes for the error. This is useful information in the making of the gears, but has little value to the inspector who must decide whether or not the gears are acceptable.

There are several important factors governing the functioning of the gears: First, the tooth profile; second, the spacing of the teeth; third, the concentricity of the teeth; fourth, the radial position of the tooth profile; and fifth, the relative thickness of the teeth and spaces or the amount of backlash. Errors in any one of the first four factors will cause an error in the uniform transmission of motion. If one of these factors is to be checked to test for this condition, all four should be checked. The simplest method of testing the backlash is to set the gears in mesh at their proper center distances and actually measure the backlash. Often this can be accurately measured with feeler gages. Another method is to place a piece of soft lead wire between two teeth, run these teeth past the center line, and measure the thickness of the deformed wire.

Description of Gear Gaging Machine

The principal operating parts of a machine for testing the uniformity of motion between two gears are shown in Fig. 31. This fixture not only indicates the amount of error, but also records it on a chart when desired. Its principle is as follows: The gears are mounted on arbors *A* and *B*, which are spaced to the proper center distance. Under each gear is a plain disk the periphery of which is ground to the pitch diameter of the gear. On arbor *A* both the gear and disk *C* are mounted on the same sleeve; but on arbor *B*, which carries the indicating device, the gear is mounted on one sleeve while disk *D* is mounted on another. Indicator *E* is mounted on the sleeve which carries disk *D*, while an arm which engages with the indicator is attached to the sleeve carrying the gear. Plate *F* which carries the chart is mounted on the fixed arbor *B*.

It will be seen that as the two gears are revolved, the two disks will also revolve, while any differences in the angular position of the gear on arbor *B* and disk *D* will be recorded by the indicator. If the gears are correct, the disks of proper diameter, and there is no slipping between them, a perfect circle will be developed on the chart. An error in the diameters of the disks or slipping between them will develop a spiral on the chart. This makes it easy to detect the errors due to the testing machine. An error of thirty seconds in the angular position of the two gears results in a departure from a smooth line of about 1/16 inch on the chart. The indicator will read errors of ten seconds.

At *A* in Fig. 32 is a chart obtained from two fifteen-tooth gears cut with form milling cutters. These are the two gears shown in Fig. 31. At *B* is a chart resulting from two fifteen-tooth gears cut on a gear generating machine with a straight-sided rack cutter. A chart from two twenty-seven-tooth gears, hardened and then ground in a grinding machine of the molding-generating type is shown at *C*.

Special Gages for Rapid Inspection

Whenever an extremely large quantity of duplicate parts must be continuously inspected, special gaging devices and machines are often designed. Many ingenious indicating devices are used for this purpose. Often a large number of flush pins are operated at one time, and their position is indicated by colored lights, electrical contact being made ac-



Fig. 35. Checking the Hole of a Ring Gage by Means of Size Blocks and Internal Measuring Ends

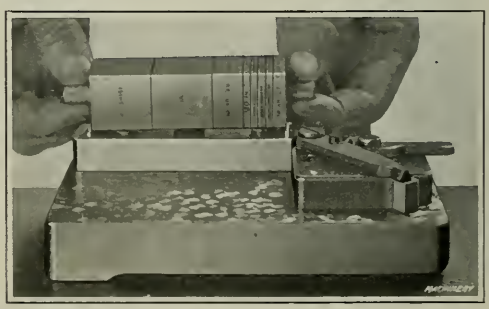


Fig. 36. Employing Size Blocks to test the Distance between Two Pins of a Gage



Fig. 37. Use of Size Blocks in Conjunction with a Sine Square for testing the Accuracy of an Angular Surface

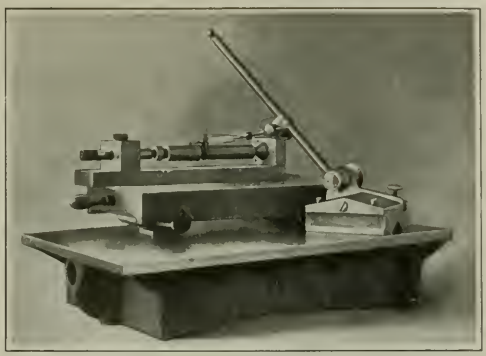


Fig. 38. Illuatration showing the Use of a Size Block and Sine Surface Plate in testing a Tapered Part

cording to the location of the end of the flush pin. At other times, several gaging devices are built on a surface plate, while the work is moved readily from position to position. Again, in the case of the inspection of cartridges for small arms, special automatic machines are sometimes built for this purpose—machines which require only the services of an operator to feed the work, while the machine automatically gages and sorts the parts. After all, gaging is one of the important operations required in interchangeable manufacturing, and gaging equipment should be designed to meet the particular needs of each component, due attention being paid to the same factors as govern the design of the other manufacturing equipment.

Master Gages and Reference Gages

It is evident that some means of testing gages for their accuracy must be provided. The extent of this testing equipment depends on the ultimate accuracy required. Gages for forgings or other semi-finished parts can be effectively checked with standard measuring instruments, such as micrometers, scales, height gages, protractors, etc. On the other hand, gages for intricate interchangeable parts must be checked with far greater care and require much better measuring facilities. Devices for checking elementary dimensions, such as length, diameter, thickness, etc., will be considered first. Measuring machines are on the market for establishing such dimensions within very small limits of error.

Accurate size blocks in sets which can be built up to any desired dimension are also on the market. With such equipment, it is seldom necessary to make special master or reference gages for special dimensions. The older practice was to make up special size blocks for every important gage—a practice which was very expensive. A set of size blocks, with a few attachments, will cover a wide field of checking and eliminate the need of the great majority of special reference gages. For example, in Fig. 33, several blocks are being used to check a snap gage. In Fig. 34, with the use of end measuring attachments, several others are used to check a plug gage. Again, in Fig. 35, size blocks are being used with internal measuring ends to check a ring gage. Fig. 36 illustrates their use in testing the location of two pins in a gage. A more elaborate set-up is shown in Fig. 37. Here a sine square and size blocks are employed for testing the accuracy of an angular surface. Fig. 38 shows their use with a sine surface plate to test a taper.

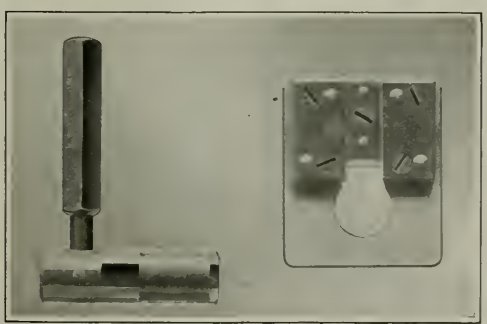


Fig. 39. Gage for testing a Composite Surface, and Reference Gage employed in its checking

In each of the above cases, every surface has been treated as an elementary surface for the purpose of testing. For the rapid testing of composite surfaces, however, special master or reference gages are required. Sometimes these masters are tried directly on the gage. Such is the case with the master shown to the right in Fig. 39. In other cases, the master is a duplicate of the gage itself, and the gage is tested by comparative measurements from the master. This is common practice with plug thread gages. A measurement is taken with thread micrometers or over wires on the master gage, and a similar measurement is taken on the gage itself. The comparison between the two measurements determines the conditions of the gage.

* * *

BUSINESS COURSE FOR WORKMEN

A workman's forum is being organized this summer in a number of plants under the auspices of the Business Training Corporation, 185 Madison Ave., New York City, for the purpose of giving employes a sounder knowledge of the economics of business and an appreciation of the problems of management. The need for such education is apparent, as many industrial misunderstandings can be traced to wrong thinking and misinformation along these lines.

The forum will include plant managers, foremen, and selected workmen, and will cover five consecutive weeks. At each meeting a lecture will be given by a speaker supplied by the Business Training Corporation, and text pamphlets which have been read by the forum members during the week will be discussed. The subjects of the five lectures and texts are: "The Three Partners in Industry"; "Cheaper Goods with Higher Pay"; "Production Made Easy"; "Bigger Men in Better Jobs"; and "Making a Better Living." Such a course should give the worker an idea of the part that management plays in helping him earn his living; point out opportunities for bettering himself through serving the company; remove tendencies toward distrust; build up plant morale; and encourage teamwork. The forums are under the direction of John Calder, manager of the industrial relations department of Swift & Co., and Meyer Bloomfield who organized the industrial activities in the shipbuilding field during the war.

Dies for Seamless Water Pails

By J. BINGHAM, President, The B. J. Stamping Co., Toledo, Ohio

THE seven punch press operations required in the manufacture of a seamless water pail and the dies used in the performance of each operation are described in this article. The first of these operations is a blanking operation; the next four are drawing operations in which the pail or shell is drawn to the desired shape; the sixth operation consists of trimming a flange formed on the open end of the shell; and the final operation consists of bending this flange around a wire to form the rim of the pail. In order to permit the construction and operation of the drawing dies and curling or wiring die to be thoroughly understood, illustrations of these dies are presented. A dimensioned drawing of the work as it appears after each drawing operation, is shown beneath the die. The blanking and trimming dies employed in the production of this part are of standard construction and for this reason are not illustrated. The metal from which the shell is produced is sheet steel, 0.028 inch thick, of a deep drawing quality, the blank being cut to a diameter of 18¼ inches in the blanking operation.

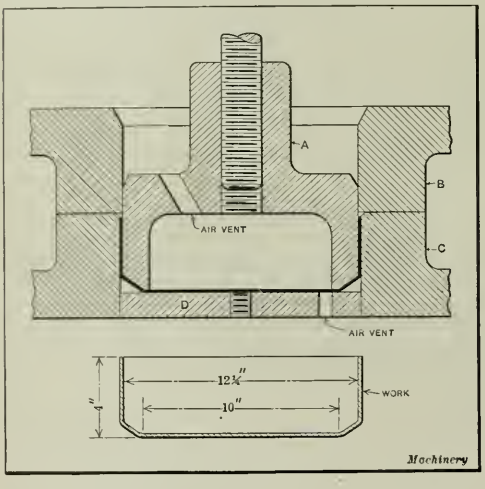


Fig. 1. Double-action Drawing Die employed in First Shaping Operation on Shell

First Drawing Operation on the Shell

The die used in the first drawing operation on the shell is illustrated in Fig. 1. This is a double-action die which is used in connection with a double-action press and consists essentially of punch *A*, blank-holder *B*, die-block *C*, and knock-out pad *D*, all of these parts being made of cast iron. Prior to an operation with this die, a blank is placed on the upper surface of die-block *C*. Then on the downward movement of the press ram, blank-holder *B* descends slightly in advance of punch *A* until it exerts a certain pressure on the blank, at which time its descent is stopped by means of the operating mechanism of the press. The blank is drawn to the desired cup shape by punch *A* as it continues to descend after the blank-holder has been stopped, drawing the blank from between the blank-holder and die-block into the opening in the die-block. On the return stroke of the ram, the shell is forced from the punch by coming in contact with the bottom surface of the blank-holder which overhangs the die opening. Knock-out pad *D* is provided for ejecting the shell from die-block *C*.

It will be noted that punch *A* is cored out for the purpose of lightening it. An air vent is provided in both the punch and knock-out pad to permit the ready escape of air when the punch and shell descend into the die. This is an important requisite on dies of this type. Mention has already been made of the fact that the various parts are made of cast iron, it having been the experience of the writer that this material is a very good drawing medium for producing light metal parts of comparatively large dimensions.

Successive Reducing Operations Performed with Double-action Dies

The double-action die used in the second drawing operation in which the diameter of the shell is reduced, consequently increasing its length, is shown in Fig. 2. Punch-holder *A*, blank-holder *B*, die-block *C* and knock-out pad *D*

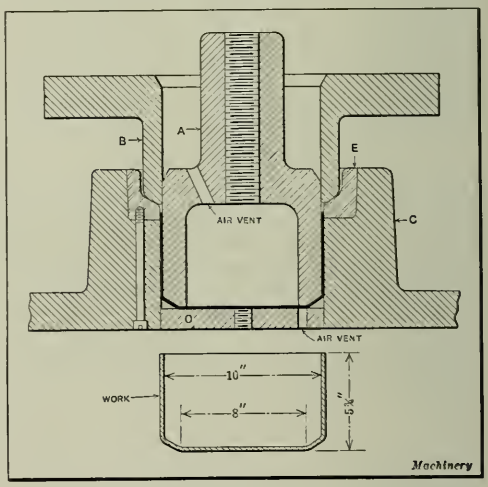


Fig. 2. Drawing Die used to reduce the Shell Diameter and increase the Length

are all made of cast iron. The die-block, however, is provided with an inserted ring *E* made of chilled cast iron. In the operation of this die the shell is seated on the tapered surface of the die ring *E*, which is ground to suit the bottom of the shell as formed in the preceding operation. On the downward movement of the press, blank-holder *B* descends into the shell and exerts a pressure on the inside of the taper surface on the bottom of the shell, at which point its downward movement is ended. The shell is then drawn to the dimensions shown by punch *A* as it continues to descend, drawing the shell from between the blank-holder and the die ring. The means provided for the escape of air and for the removal of the shell from the punch and die are similar to those on the die previously described.

Fig. 3 shows the die employed for the performance of the next operation, which consists of making another reduction in the shell diameter and at the same time increasing its length. The open end of the shell is bell-mouthed in this operation to facilitate the forming of a flange in the succeeding operation. This die is also of the double-action type, and as its construction and operation are very similar to

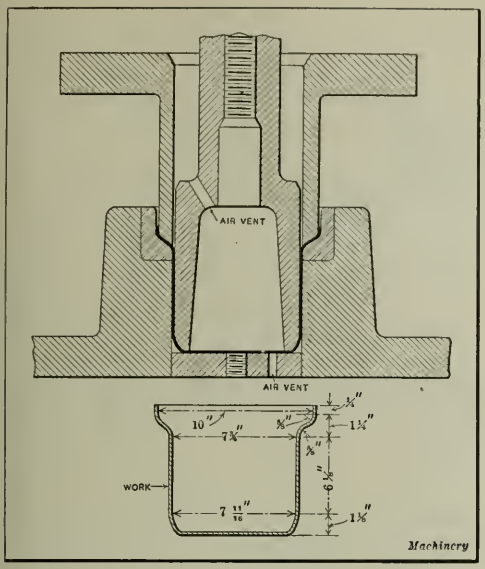


Fig. 3. Operation in which the Shell Diameter is further reduced while the Open End is Bell-mouthed

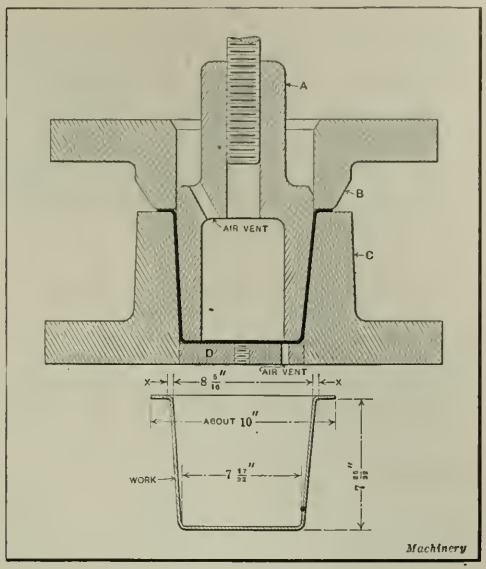


Fig. 4. Final Drawing Operation in which the Body of the Shell is tapered and a Flange is formed on the Open End

that of the die shown in Fig. 2, a more detailed description is unnecessary.

The double-action die illustrated in Fig. 4 is used for the fourth drawing operation in which the body of the shell is drawn to a taper while the bell-mouthed opening is flattened to form a flange. As in the dies previously described, punch *A*, blank-holder *B*, die-block *C* and knock-out pad *D* are made of cast iron. In preparing for this operation, the outside surface of the bell-mouthed portion of the shell formed in the preceding operation is seated on the top surface of die-block *C*, the body of the shell projecting into the die opening. It will be noted that the end of blank-holder *B* is beveled to permit its ready entry into the shell opening when the blank-holder descends on the downward stroke of the press. The shell is pressed firmly on die-block *C* by blank-holder *B*, while the punch *A* descends and draws the shell to shape, the flange being formed by means of the flat bottom surface of the blank-holder. The removal of the work from the punch and die, after the completion of the operation, is effected in the same manner as on the dies previously described. The sixth operation consists of trimming the flange of the shell close up to the rounded corner at the open end as indicated by lines *X* in the detail drawing of the work shown in Fig. 4. The construction of the trimming die used in this operation is not illustrated.

Die Employed in Wiring Operation on Pail

The final press operation on the pail consists of forming a depression in the bottom surface and curling the edge of the open end over a wire placed around the outside of the pail. The die used for accomplishing these results is shown in Fig. 5. It will be noted that the punch is built up of a number of parts consisting mainly of punch-holder *A*, curling ring *B*, nose-piece *C*, disk *D*, rubber buffer *E*, and fillister-head screw *F*. When the punch is lifted from the die there is a clearance between curling ring *B* and the upper surface of nose-piece *C* equal to the clearance shown between the head of screw *F* and disk *D*. Die-block *G* is provided with die ring *H* which is in a raised position prior to the descent of the punch, the purpose being to hold up the wire, around which the edge of the pail is to be curled, when ring *B* is engaged in this curling process. Die ring *H* is raised to this position by means of several coil springs placed between the die-block and the die ring, the height of the position being determined by the head of screw *I* coming in contact with the die-block.

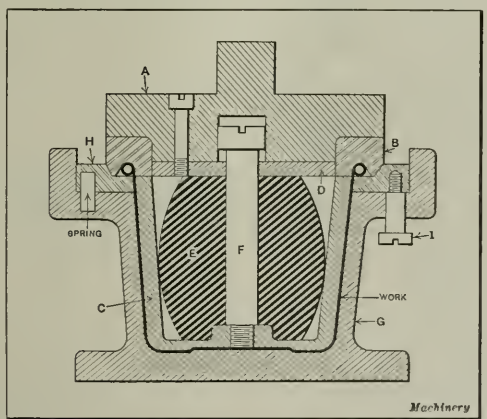


Fig. 5. Die used to curl the Edge of the Shell at the Open End around a Wire

Prior to the performance of an operation in this die, the wire around which the edge of the bucket is to be curled, is laid upon the die ring *H*, and the shell is inserted through the wire into the die. On the downward movement of the press ram, nose-piece *C* enters the die, and the pressure exerted by the rubber buffer *E* between the nose-piece and disk *D*, causes a depression in the bottom of the bucket. The pressure is exerted on all surfaces of the shell during the curling portion of the operation. There is sufficient clearance allowed between nose-piece *C* and wire ring *B* to permit the nose-piece to hold the shell firmly before the curling process commences. The edge of the shell is curled around the wire by ring *B* as the punch-holder descends, and at the same time die ring *H* is forced down on die-block *G*.

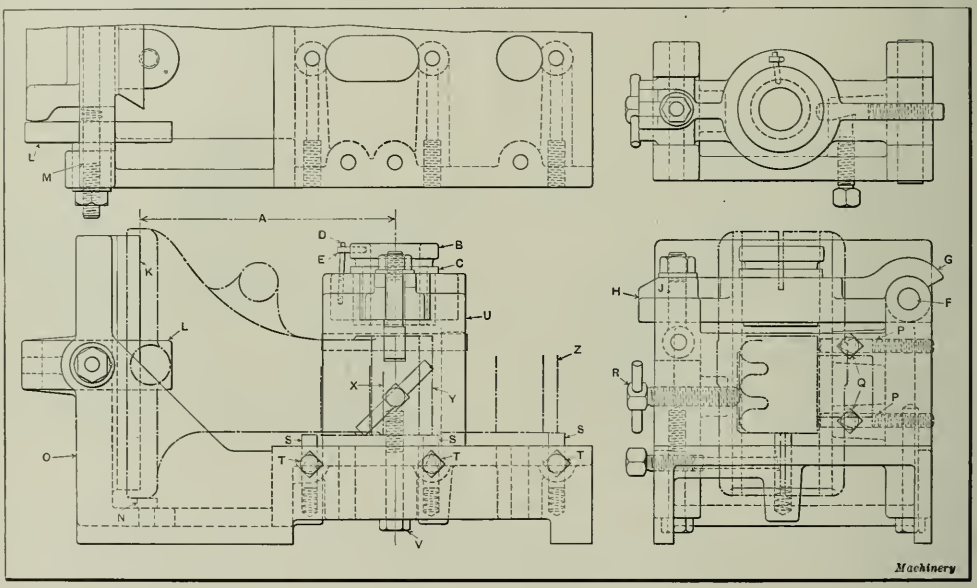
On the return stroke of the punch, the rubber buffer holds the nose-piece and the work in the die until the head of screw *F* comes in contact with disk *D*, after which the

nose-piece and the buffer are also withdrawn as the punch continues to ascend. The shell is raised from the die by die ring *H* as this ring returns to its original position due to the pressure exerted by the coil springs previously referred to. It is always essential to provide a nose-piece and a rubber buffer or other similar means of exerting pressure on the various surfaces of the work during a curling operation, in order to insure that the form of the body of the shell will remain unchanged by this operation. The dies described in the foregoing were developed by the writer while superintendent of the Toledo Machine & Tool Co.

* * *

DRILL JIG FOR BRACKETS OF DIFFERENT LENGTHS

A jig designed for use in drilling and reaming the hole through the boss of a bracket that is made in three different lengths is shown in the illustration. The work is illustrated by heavy dot-and-dash lines, the dimension that varies on the different brackets being indicated at *A*. The location of



Drill Jig having Movable Member to adapt it for machining Brackets of Similar Design but of Different Lengths

passes through both clamps. The swinging leaf is then lowered and locked in place by the eye-bolt *J*. The boss end of the bracket rests upon one of the pins *S*, each of which is provided with a spring that raises the pin until it comes in contact with the bottom surface of the boss. The pin is then clamped in this position by means of screw *T* which has a taper surface at the end corresponding to the taper surface on the pin. This arrangement prevents the pin from altering its position during the operation and offers a firm support to this end of the bracket. Originally, ordinary pins were used instead of spring pins, but the vertical height between the rough surface of the bracket resting upon pin *N* and the finished surface of the boss which rests on pin *S*, was often so great that the boss did not rest upon the pin. The result was that the casting sprung during the operation on account of the leverage caused by the distance of the boss from the dovetail groove.

Spring pins *P* and the binding screw *R* are used to prevent sidewise movement of the bracket during the operation. After the bracket is placed in the jig and pins *P* are in contact with the side of the boss, the screws *Q* are tightened, thus clamping the pins in place. The binding screw *R* is then also tightened so that the boss is held firmly between it and pins *P*. The construction of pins *P* and screws *Q* is similar to that of pins *S* and screws *T*, respectively.

the bosses of the various lengths of brackets which can be accommodated in the jig is indicated by the reference letters *X*, *Y*, and *Z*, the jig as illustrated being set for machining the hole in a bracket having the boss at location *Y*. The principal parts of the jig consist of the base *O*, the movable block *U*, and the swinging leaf *H* which contains the slip bushing *B* and which hinges on pin *F*. The movable block can be placed in three different positions to suit the length of the bracket being machined, and is secured to the base by two bolts *V*, holes being drilled in the base at the different positions to suit these bolts. The movable block is located in the exact position on the base by means of two dowel-pins which are not illustrated.

After the movable block has been secured in the proper position for machining a bracket, the swinging leaf *H* is raised until lug *G* comes in contact with the movable block. Then the work, which has a dovetail groove at the large end, is placed on tongue *K* on base *O*, the bottom end resting upon pin *N*. The work is then clamped to the base by means of two clamps *L*, one of which can be seen in the partial plan view of the base. These clamps are tightened on the work simultaneously by turning the nut on bolt *M* which

It will be noted that the slip bushing *B* is held in a permanent bushing *C* and is prevented from turning by means of the locking pins *D* and *E*. Lug *G* is provided on the swinging leaf to prevent it from being thrown back so far that it would be liable to become damaged. Care must be exercised in changing the movable block *U* from one position to another, to see that no chips or other foreign matter is on either of the contact surfaces of the block and base *O*. Such an occurrence might destroy the alignment of the drill bushing with the work, and it is well to test the first piece machined after the position of block *U* has been changed, to see whether it is within the requirements. In using this jig, a comparatively large number of brackets of one length were usually machined together so that the movable slide did not need to be changed frequently. Jigs designed on the principle outlined will be found of considerable value, not only because of their convenience, but also because of their time-saving features. H. M.

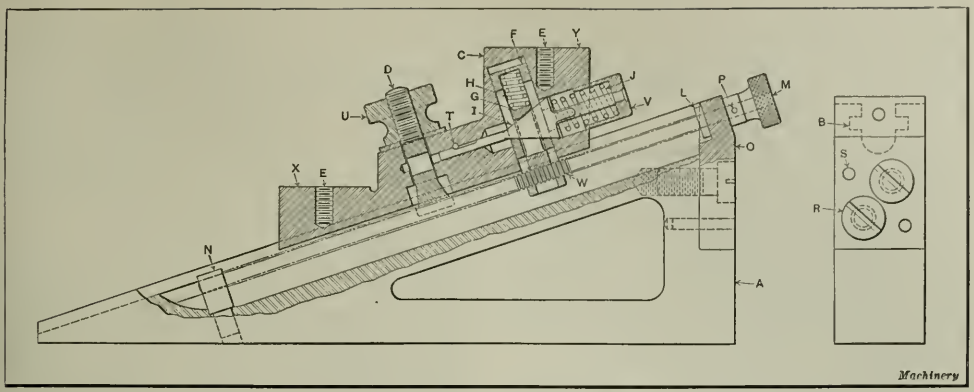


Fig. 1. Planer Tool-setting Gage with a Vernier for obtaining Direct Readings and Means of securing Quick or Accurate Adjustments

Precision Type of Planer Tool-setting Gage

A Tool-setting Gage Provided with a Vernier for Obtaining Direct Readings and with Means for Securing Quick and Accurate Adjustments

By GUSTAVE YOUNGQUIST

A GAGE that is frequently used for setting a planer tool to the proper height for taking a cut on a piece of work, consists essentially of a base having an inclined surface on which is mounted a sliding member. This sliding member has two upper surfaces that are always parallel with the bottom of the base. By this arrangement the sliding member can be set so that a measurement taken from the bottom of the base to one of the upper surfaces of the sliding member will equal the height to which a planer tool is to be set. The planer tool is then set for taking the desired depth of cut by placing the gage on the planer table or on some convenient surface of the work, and then lowering the planer head until the tool rests upon the proper tool-setting surface of the gage. Planer gages of this type are no doubt familiar to most shop men, as they are manufactured by a leading small tool concern. In the illustration Fig. 1 is shown a tool-setting gage, the design of which is based on the same principle as the commercial product, but this gage is so constructed as to provide means for obtaining either a quick or an accurate adjustment, and it is also provided with a vernier that permits the reading of the setting to be taken direct in thousandths of an inch. The provision of the vernier eliminates the necessity of using a micrometer or other measuring means that must be employed on the commercial type of gage to ascertain to what height the sliding member of the gage should be set.

Construction of the Gage and Methods of Obtaining Accurate or Quick Adjustments

The angle between the inclined and the bottom surfaces of base *A* is 18 degrees 30 minutes. The smaller this angle, the finer the adjustments that can be obtained with the gage, but the range of heights is at the same time decreased. It has been found that an angle of the magnitude given is well suited for most shops in which such a gage is used. Base *A* is provided with a T-slot *B* in which a tongue on the bottom of slide *C* and the head of the clamping screw *D* slide. Slide *C* is machined in the customary manner with two tool-setting surfaces *X* and *Y*, which are parallel with each other and with the bottom surface of base *A*. The difference in height between these two gaging surfaces is one inch. The tapped holes *E* are provided so that attachments can be mounted on these surfaces to permit planer tools to be set to heights ordinarily beyond the capacity of the gage. Both the base and slide are made of low-carbon steel and are hardened and ground on their wearing surfaces. In addition to this, the sides of the tongue on slide *C* and the corresponding wearing surfaces of the T-slot in base *A* are lapped. Fig. 2 shows details of slide *C* and some of the other gage parts, the construction of which might not be readily understood by referring only to Fig. 1. The reference letters of these details are identical with the letters used in referring to the same parts in the illustration Fig. 1.

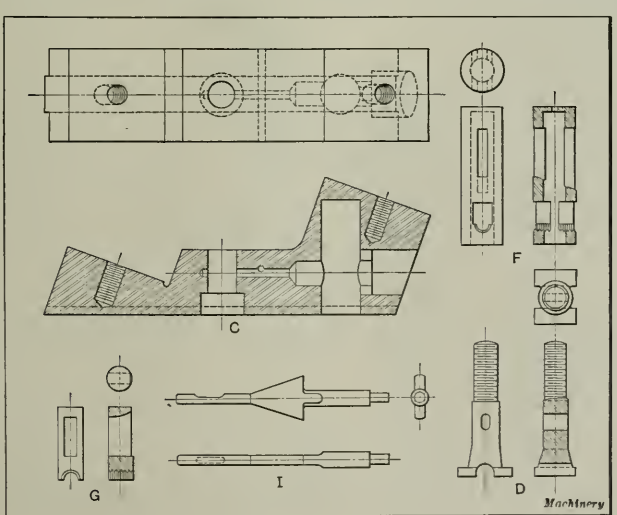


Fig. 2. Details of Tool-setting Gage illustrated in Fig. 1

The fine adjustment of the gage is obtained by means of a fine-pitch screw *W* which has a bearing at one end in bracket *O* and at the other end in stud *N*. Bracket *O* is also made of low-carbon steel and is hardened and ground. It is secured to base *A* by two fillister-head machine screws *R* and two dowel-pins *S*. The upper portion of the bracket is machined so as to form bearing surfaces for the knurled head *M*, which takes the end thrust of screw *W* in one direction, and for washer *L* which takes the thrust in the opposite direction. Head *M* is secured to screw *W* by means of pin *P*. Stud *N* is driven into a reamed hole which extends to the bottom surface of the base so as to permit the stud to be readily removed if this should prove necessary.

Nut parts *F* and *G* are used in conjunction with screw *W* when obtaining accurate adjustment of the gage. Reference should be made to Fig. 2 in order to understand the construction of these parts. It will be noted that part *F* is cylindrical and contains a hole in which plunger *G* operates. A hole in the lower part of *F* is threaded to fit the bottom half of screw *W*, while part *G* is threaded to fit the upper half. These two parts are tightened on the screw by means of the expansion coil spring *H*, which exerts pressure on both members. When these nut parts are in engagement with the screw, the slide can be accurately raised or lowered by turning head *M* in the proper direction, provided clamping screw *D* is previously loosened by turning knurled nut *U*. Part *F* is properly machined to clear screw *W* when obtaining quick adjustment by the method to be described later. Parts *F* and *G* are made of tool steel and are hardened and ground, the threaded portion of these parts being lapped to insure a smooth working action with the screw.

When desiring to obtain a quick adjustment of the slide, clamping screw *D* is first loosened. Nut parts *F* and *G* are then released from contact with screw *W* by pressing on knob *V* by hand, which compresses the expansion coil spring *J* and forces the wedge-shaped push-pin *I* forward. The upper taper surface of the push-pin engages with a slot similarly machined in part *G*, while the lower taper surface of the push-pin engages with a similar inclined surface on part *F*. Thus, as push-pin *I* is forced forward, the movement causes part *G* to be lifted and part *F* to be lowered out of contact with the adjusting screw. The slide may then be moved by hand to any desired position. As soon as the pressure is relieved on knob *V*, spring *J* forces pin *I* back to the position illustrated, while spring *H* again forces parts *F* and *G* in contact with screw *W* for obtaining accurate adjustments. Push-pin *I* is also made of tool steel, and is hardened and ground.

By referring to the detail of slide *C*, it will be noted that the hole in which knob *V* operates is counterbored, the resulting wall providing a contact surface for spring *J*. A slot is machined through this wall to accommodate push-pin *I*. The push-pin is prevented from being forced out of the slide by pin *T*, which fits into a hole drilled through the slide, and contacts with a flat surface on the upper side of the push-pin. Clamping screw *D* is provided with a slot into which the end of the push-pin extends when it is forced forward in order to permit a quick adjustment of the sliding member to be obtained.

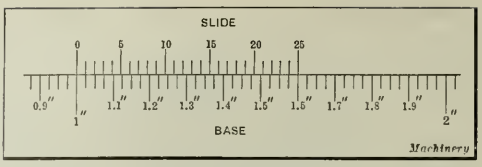


Fig. 3. Vernier Scale provided on Base and Slide to permit Easy Reading of the Setting

Description of the Vernier Scale

The vernier scale provided on this gage to permit direct readings of the tool settings, is graduated on adjacent sides of base *A* and slide *C*. The base is graduated in such a manner that when slide *C* is moved a distance of one graduation along the base, the vertical height between the bottom surface of the base and surfaces *X* and *Y* is increased 0.025 inch. The vernier gives the direct reading of the measurement between surface *X* of the slide and the bottom of the base. In order to obtain the height of surface *Y* at any setting, it is necessary to add one inch—the vertical distance between surfaces *X* and *Y*—to the reading of the vernier. The vernier scale provided on the gage is shown in Fig. 3. As the movement of the slide past one graduated space on the base raises it a distance of 0.025 inch, it is obvious that it is necessary to move the slide a distance of forty spaces in order to raise it one inch vertically.

The scale on the slide has twenty-five graduated spaces, the total distance between the extreme graduations being the same as the length of twenty-four spaces on the base. Thus it is evident that the vertical distance corresponding to each graduation on the slide is equal to $24/25 \times 0.025 = 0.024$ inch. The difference in height represented by the spaces on the base and those on the slide is therefore 0.001 inch, so that the taking of readings in thousandths of an inch is possible. Preparatory to graduating the base and slide, it was necessary to first determine the actual distance between each graduation on these parts. As previously stated, a movement past forty spaces on the base effects a vertical rise of one inch of the slide. The actual distance on the base between the inch graduations was then readily determined by multiplying one inch by the cosecant of 18 degrees 30 minutes, the angle elevation of the base. Thus, $3.1515 \times 1 = 3.1515$ inches, or the distance between the inch graduations. The distance between each 0.025-inch graduation, therefore, equals $3.1515 \div 40 = 0.0788$ inch. As the total length of the scale on the slide is equal to twenty-four spaces on the base, the total length of the slide scale is equal to $24/40 \times 3.1515 = 1.8909$ inches. The length of each space on the slide therefore, equals $1.8909 \div 25 = 0.0756$ inch.

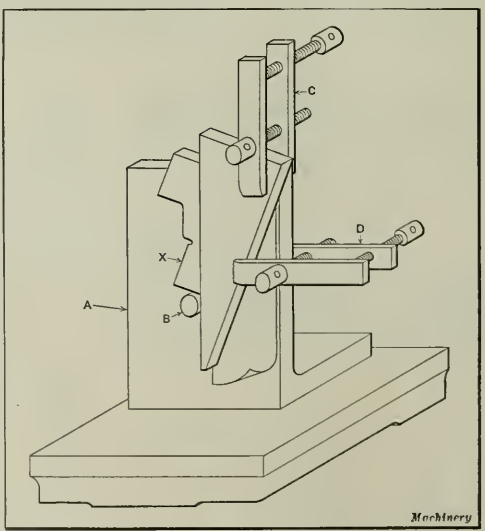


Fig. 4. Method of locating and securing Slide and Base on an Angle-plate for the Graduating Operation

Graduating the Vernier Scales on the Base and Slide

In placing the graduations on the parts, the slide was set on the base in such a position that a micrometer reading gave the distance between the bottom surface of the base and surface *X* of the slide as one inch. The surface to be graduated was then covered with a thin film of beeswax, although any other acid-resisting substance could be used. The gage was

mounted on an angle-plate, a piece of paper being placed under the base as shown in Fig. 4. The angle-plate *A* was provided with a removable plug *B* against which the lower end of the slide was placed, this end having been previously ground. The inclined surface of the base was placed in a vertical position, and the base was secured in this position by means of parallel clamps *C* and *D*. After arranging the gage on the angle-plate in this manner, the next step was to locate and scribe the one-inch graduation on the base and the zero graduation on the slide.

The length of the inclined surface or base of the slide is 2¼ inches, and as the scale is located centrally along this surface, it was necessary to calculate the distance from the lower end of this surface to the zero graduation. This distance is equal to 1.125 — (1.8909 ÷ 2) or 0.180 inch. A line of suitable length was then scribed on both the slide and base perpendicular to their inclined surfaces, the correct location of the line being obtained by means of a set of precision gage-blocks, although a height gage or another planer gage set to the proper height could have been employed to accomplish the same purpose.

After this first line had been located and scribed, the slide and plug *B* were removed from the plate, the base, however, remaining clamped in the same position. The inclined surface of the base and the T-slot in the base were given a coating of beeswax so that these surfaces would not become harmed by the application of the acid used in etching the graduation lines and figures on the part. The scribing of the remaining graduations was then accomplished by the aid of gage-blocks, the number of graduations on the base beneath the one-inch graduation being determined by measuring the distance from this graduation to the bottom end of the inclined surface and dividing this measurement by 0.0788 inch, the actual distance between each graduation. There proved to be sufficient space for fifteen graduations, and after the lowest one was located and scribed, the remaining graduations were scribed in order along the inclined surface. When the lines had all been laid out carefully, the base was removed from the angle-plate and etching acid applied. The figures on the scale were etched later.

After the graduating of the base had been completed, the slide, having also been coated with beeswax, was replaced on the angle-plate in the same position as when the zero graduation was scribed, but with a straight block occupying the position previously occupied by the base. The twenty-five graduations of this scale were then scribed and etched on the slide by using the same methods employed in graduating the base. In shops where the dimensions to which work must be machined are given in millimeters, a vernier scale could also be placed on the opposite sides of the slide and base to permit planer tools to be set according to this system of measuring. It is evident that in such a scale the length of the space between the graduations would differ from that between the spaces in the inch vernier scale.

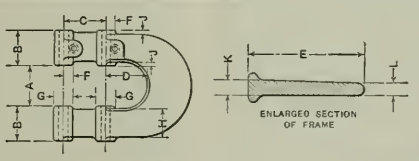
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DIMENSIONS FOR SNAP GAGE FRAMES

By J. B. CONWAY

The accompanying table gives all the dimensions necessary for proportioning a set of snap gages for handling work up to and including 17 inches in length. Although the illustration shows the adjustable measuring point type of gage, equipped with screws for securing the adjustment after it has been obtained, such features are arbitrary and can be disregarded when designing the frame. The material used may be either cast or malleable iron, and both the interior and exterior surfaces surrounding the holes should be finish-ground parallel and perpendicular to the center lines of the adjusting points.

PROPORTIONS FOR SNAP GAGE FRAMES



Frame No.	Range, Inches	Dimensions of Frame, Inches										
		A	B	C	D	E	F	G	H	J	K	L
1	0-1¼	½	⅞	5/8	9/16	1 5/16	0.220	½	¾	1/16	5/32	⅛
2	¼-1½	¾	15/16	5/8	11/16	1⅜	0.220	½	13/16	1/16	5/32	⅛
3	½-1¾	15/16	1	⅝	13/16	1 7/16	0.220	½	⅞	1/16	5/32	⅛
4	¾-1	1 3/16	1 1/16	¾	1	1½	0.220	½	15/16	1/16	5/32	⅛
5	1-1¼	1 7/16	1⅛	¾	1⅛	1 9/16	0.250	5/8	1	1/16	3/16	5/32
6	1¼-1½	1 11/16	1 3/16	¾	1¼	1⅝	0.250	5/8	1 1/16	1/16	3/16	5/32
7	1½-1¾	1 15/16	1¼	¾	1½	1¾	0.250	5/8	1⅛	1/16	3/16	5/32
8	1¾-2	2 3/16	1 5/16	¾	1⅝	1⅞	0.250	5/8	1 3/16	1/16	3/16	5/32
9	2-2½	2 11/16	1⅜	⅞	1⅞	2	0.312	¾	1¼	1/16	¼	3/16
10	2½-3	3 3/16	1 7/16	⅞	2¼	2¼	0.312	¾	1 5/16	1/16	¼	3/16
11	3-3½	3 11/16	1½	⅞	2½	2½	0.312	¾	1⅜	1/16	¼	3/16
12	3½-4	4 3/16	1 9/16	1	2¾	2¾	0.312	¾	1 7/16	1/16	¼	3/16
13	4-4½	4¾	1⅝	1	3¼	3	0.343	⅞	1 7/16	3/32	5/16	¼
14	4½-5	5¼	1 11/16	1⅛	3½	3¼	0.343	⅞	1½	3/32	5/16	¼
15	5-5½	5¾	1¾	1⅛	3¾	3½	0.343	⅞	1 9/16	3/32	5/16	¼
16	5½-6	6¼	1⅞	1¼	4⅛	3¾	0.343	⅞	1 11/16	3/32	5/16	¼
17	6-7	7¼	2	1¼	4⅝	4	0.410	15/16	1 13/16	3/32	⅜	¼
18	7-8	8¼	2⅛	1½	5⅛	4¼	0.410	15/16	1 15/16	3/32	⅜	¼
19	8-9	9¼	2⅛	1½	5¾	4½	0.440	1	1 15/16	3/32	⅜	¼
20	9-10	10¼	2¼	1½	6¼	4½	0.440	1	2 1/16	3/32	⅜	¼
21	10-11	11¼	2¼	1½	6¾	4¾	0.470	1⅛	2 1/16	⅛	⅜	¼
22	11-12	12¼	2½	1¾	7⅜	4¾	0.470	1⅛	2¼	⅛	⅜	¼
23	12-13	13¼	2½	1¾	7⅞	5	0.470	1⅛	2¼	⅛	7/16	5/16
24	13-14	14¼	2¾	1¾	8⅜	5	0.570	1¼	2½	⅛	7/16	5/16
25	14-15	15⅜	2¾	1¾	9	5½	0.570	1¼	2½	⅛	7/16	5/16
26	15-16	16⅜	3	1¾	9½	5½	0.570	1¼	2¾	⅛	7/16	5/16
27	16-17	17⅜	3	1¾	10	5½	0.570	1¼	2¾	⅛	7/16	5/16

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THE METRIC SYSTEM AND THE ENGINEERING PRESS

This number of MACHINERY contains an article dealing with the adoption and use of the metric system in a large American machine-building plant. The article is written by the man who had entire charge of the mechanical operations during the period in which this system was being installed, and therefore constitutes a record which should be of interest to American manufacturers at a time when the question of legislative action with regard to the metric system is before us.

In presenting this unusual record of actual performance, MACHINERY does so in the belief that the duty of engineering journals, no matter what their own opinion on a subject may be, is to present to their readers and to the industry that they serve, the actual facts, irrespective of whether these facts appear to prove or disprove the majority opinion among the leading men in the industry.

At the same time MACHINERY wishes to reiterate its opinions expressed in the editorial on the metric system in the April number—"Inches versus Millimeters." Congress should not by compulsory legislation force the metric system—or any system of measurements—upon the industries of the country. The manufacturers should be permitted to decide for themselves upon the system of measurements to be used in the industries they have built up; and until such time as a majority of the manufacturing and engineering associations definitely express themselves in favor of a change, Congress should take no action. If individual manufacturers wish to change from one system to another, they should be at liberty to do so. It is safe to say that if the advantages of a change in the system of measurements can be clearly shown, American manufacturers will not hesitate to change. If the advantages cannot be proved to the satisfaction of the individual manufacturer, his judgment will dictate against the adoption of a new system. As far as MACHINERY knows, all manufacturers in the machine tool field are opposed to a change. In their judgment it would be very harmful to the best interests of the industries. But it is nevertheless the duty of the engineering press to give a fair hearing to facts that are presented on either side of this or any other engineering controversy.

* * *

THE TREACHEROUS SHARP CORNER

Why should it be necessary to repeatedly urge machine designers to avoid sharp corners in machine parts where strength is required? Every good machine designer knows that liberal fillets should be provided; yet they are often omitted, indicating that many designers cannot be placed in the class defined by the word "good." Recently a workman was killed by an accident due to a sharp corner in the bridle of a derrick. A new bridle had been made of heavier dimensions than the original one in order to obtain increased strength; but in making the drawing the designer showed sharp inside corners, and the blacksmith who forged the bridle of course followed the drawing. As a result the new and heavier bridle was not as strong as the old one; for the old bridle, although made to less heavy dimensions, was properly designed with well rounded corners. A crack started at the sharp corner of the new bridle, and when the load came on it, breakage occurred.

The principle in machine design that the sharp corner is treacherous and should be avoided is so well known that it should not be necessary to mention it editorially, or to have it emphasized by a fatal accident. But it seems to be the very familiarity of machine designers with this principle that makes them sometimes forget its application when it would be most important to remember it.

* * *

STANDARDIZING LOCOMOTIVE REPAIR PARTS

The railroads are so absolutely essential to modern social and commercial life that there is widespread interest in ideas for their general improvement. Many different plans have been proposed for securing more economical maintenance and operation, and a recent suggestion intended to effect greater economy in locomotive repair work, reducing the non-productive periods due to disabled equipment, seems worthy of general adoption. The plan, in brief, is first to standardize parts—especially those which often need to be replaced—and then produce these interchangeable parts in a well equipped plant, distributing them, as needed, to different terminal points or wherever broken or worn parts can be replaced.

While finished parts are sent out from the main shops of some railroads, trouble has been experienced in many instances due to lack of adequate standardization. It is necessary to first adopt tolerances based on the functions of the different parts, and then adhere to them strictly, by employing good gaging and inspection methods.

One advantage of the plan referred to is that parts can be produced economically on a large scale in one plant equipped with modern machines and fixtures that would be too expensive for small production. Another great saving would be effected by reducing the time required for repairs, especially when the replacement of one or more parts is all that is necessary. Any plan that facilitates the making of repairs automatically reduces the number of repairs necessary, because the old adage that "a stitch in time saves nine" applies with double force to locomotives.

The Government is to advance $125,000,000 out of the revolving fund of $300,000,000 provided by the Transportation Act for the use of the railways for purchasing rolling stock, and of this amount $50,000,000 is for new locomotives. This new equipment is greatly needed; but there is also need for more modern practice in the maintenance of equipment, particularly the locomotives which are such an important factor in the transportation problem.

Progress or Retrogression?

THE industries of the United States have developed to a greater degree than those of any other country, due chiefly to two things: Our unparalleled natural resources and the reward to individual initiative and industry possible under our institutions. Here any man of energy and capacity may become a captain of industry. As a result, the production of all things necessary to present-day civilization has been greater in the United States, in proportion to population, than anywhere else, and the comforts of life enjoyed by all classes of our people have excelled those of all other countries. We have, and have had, a greater abundance of food, clothing, houses, and luxuries than the great mass of the people in other countries, because our production has been higher per worker than elsewhere; hence, the return to each producer—whether working with brain or with hand—has also been greater.

Unfortunately, this basic reason for the prosperity of our whole nation is not generally understood, and there are powerful forces at work resisting the progress we could still make toward even better conditions. Organized efforts are made to discourage production and limit output. Union labor, in opposing scientific management, bonus and piece-work systems, is trying to limit production in a manner that will ultimately prove harmful to all. Our greatest need is increased production. But the leaders of union labor preach limitation of production, with the result that prices already high mount still higher. The higher wages buy no more goods today than the lower wages of ten years ago bought then; nor will they ever buy more, no matter to what figure they may rise in dollars and cents, unless production is increased so that there is a surplus rather than a scarcity of the goods needed for the comfort and well-being of all.

No greater fallacy has ever been taught labor by their leaders than the doctrine that by limiting production, the union man performs a service to himself. Labor has been led to believe that wages are paid out of an inexhaustible fund and that there is hardly any economic limit to the height to which wages can go, provided the unions are able to make their demands effective. The leaders of labor have never understood—nor been willing to understand—that wages are created out of the products of labor, and that if the product be artificially curtailed, the fund available for wages is thereby decreased. Labor can buy and enjoy only the commodities produced by labor. If there is less of those commodities because of curtailed production, labor's share must be less.

The reason offered by labor leaders for curtailing production is that more opportunities are thus created for the employment of labor—there are more jobs. Temporarily, this may be true, but adjustment to the inexorable operation of economic law is absolutely certain. For a brief period the industries may continue to hire more men to perform the work of a smaller number, but the returns to each worker measured by what he can buy with his wages will be less. Ultimately, the unsound doctrine of curtailed production leads to higher prices, industrial depression and unemployment, and instead of having achieved employment for more men, the result will be unemployment for the great masses of the people.

On the other hand, when production is increased to its highest point, the wages of labor can be raised without any danger to the economic industrial structure, and these wages will buy the maximum of goods, because with greater production, prices fall. The returns to the industries will also be larger, and as the greater part of these returns is reinvested in enlargements to plants and the starting and developing of new ones, employment is provided for all willing to work. As this employment is provided in a natural way, it remains permanent, while the artificial employment produced by curtailing production ultimately leads to the destruction of the industries.

No intelligent employer today objects to high wages, provided they are based upon production. In the modern industrial plant production is the essential thing, and under a bonus or piece-work system the man receiving the highest wages is the most valuable man to the employer.

Union labor must learn to realize this. If not, by its mistaken efforts it will plunge the country into a condition of industrial chaos, and a period of depression during which the workers themselves and their families will be the keenest sufferers. If the labor union leaders, instead of devoting all their efforts to limiting production, creating strife, and hampering the industries, would aid in educating their membership in sound economic doctrines, they would really be working for the welfare of the men and women whom they profess to benefit. Their efforts might then be enlisted for progress instead of retrogression. It is not probable that the present leadership of labor unions is able to do this, and ultimately the rank and file of labor must select new leaders—enlightened men able to comprehend twentieth century methods of economic production. The present leadership of the unions must ultimately pass, for no combination of men can permanently survive if they block our advancing civilization.

Possibilities for Machine Tools in China

By F. A. FOSTER, Peking, China

The author of this article, who is at present on a visit to the United States, has lived in China for the last ten years, and has been engaged in engineering and industrial education in that country during this time. Mr. Foster is a graduate of the Worcester Polytechnic Institute, and a member of the American Society of Mechanical Engineers, as well as a member of the American Chamber of Commerce at Shanghai, China. He is therefore well qualified to speak authoritatively on the subject with which he deals in this article, and his opinions and advice are worthy of receiving most thorough and earnest consideration by American machinery builders.

HAVING returned to the United States for a brief visit after ten years spent in technical educational work in China, I would like to impress upon manufacturers of machinery in general, and upon those making machine tools in particular, that China offers one of the greatest potential markets in the world for machinery of all classes, provided an effort is made to teach Chinese the use and application of machines in the industries and the advantages to be obtained by the employment of modern machines, tools, and methods. Here we have 400,000,000 people, one-quarter of the world's population, highly intelligent, for centuries trained in mechanical arts developed along lines unique to Chinese civilization, eager to learn, and ready to accept the industrial methods and processes of the white race. Further, we deal with a country having unparalleled natural resources—in fact, the time is not far off when some of the important minerals and supplies of the world markets will have to come from China because of the exhaustion of these raw materials elsewhere. Hence, China affords a tremendous market to the machine builders of the world and especially to those of America, because it may be said without question or hesitancy that the Americans have gained the friendship and confidence of the Chinese as has no other foreign nation, and a special opportunity therefore awaits the progressive American manufacturer; but it is necessary for him to take active steps for promoting this trade, for it must be remembered that this potential market is not to be had merely for the asking. Intelligent preparatory work has to precede the actual sales, and some money must be spent along the lines explained in the following, before the full opportunity due to Chinese industrial development can be realized in the trade intercourse between this country and China.

The Fundamental Needs of China

In order to develop the Chinese industries, there are two matters which are of prime importance: One is more adequate means of transportation—that is, more railroads—and the other is technical and engineering education. Little need be said in this article relating to the further needs for railroad communication, because this is a matter which doubtless will be taken care of by the great financial interests and banking circles of this country and Europe. But more needs to be said about providing facilities for technical and engineering education in China, because it is here that the American manufacturer must step in, in order to prepare the market that ultimately will be his if he intelligently cultivates it.

More railroads will, of course, automatically promote other industries in China, but if there is a lack of technically trained men to act as executives and leaders in the industries, progress will be slow. On the other hand, if American manufacturers, through a cooperative movement, would establish engineering schools in China, equipping their laboratories and work-shops with American machinery, the time would not be far off when the results would show in a greatly increased trade in machinery of all classes with China. From the intimate knowledge that I have of Chinese conditions, the general spirit of the times in that country, and the characteristics of the Chinese people, I consider it safe to predict that if a movement of this kind were started now, the results would show themselves appreciably within ten years, and become greater as time passes. Some American machine tool builders have already donated machine tools to Chinese industrial schools, and as a result of these donations orders have already been placed in America for machine tools of similar types for other uses in China. The trade with China in machine tools so far is not great, but it is increasing, and during the month of May over $36,000 worth of machine tools and about an equal amount of other metal-working machinery were imported into China from the United States.

Present Industrial Activities in China

The present industrial activities in China that are of particular interest to the manufacturers of machine tools are the railroad shops and the repair shops in connection with some of the larger industries in other fields. Among the railroad shops one of the larger, if not the largest, is located at Tangshan. This shop employs 5000 men and builds locomotives and cars, as well as doing the repair work for one of the most important of the Chinese railroads. There are many textile mills in China, some of them very large, and these mills must have extensive repair shops, because if anything breaks, there is no opportunity to send to the makers for repair parts because they are thousands of miles away, either in America or in England. The same is the case in the steel mills and at the mines. Chinese industrial undertakings must be prepared to handle all the repair work necessary in connection with their plants while the industries are in their present state of development.

As is well known, Chinese agricultural methods are crude, and few modern implements are employed. There is a tremendous opportunity for the use of agricultural machinery in China, and it is likely that much of this machinery, as well as agricultural implements in general, will be made in China, just as soon as industrial activities along these lines develop. This, in turn, will require large numbers of machine tools. It must be remembered that China is preeminently an agricultural country and that it feeds its 400,000,000 people from its own soil. What the possibilities are in the development of agricultural tools and implements under these conditions is evident even to a superficial observer. The millions of dollars worth of machine tools that will be required in the not very distant future for the factories that will make agricultural machinery and implements is an item not to be passed over without consideration.

In addition to an industrious people and abundant resources in practically every direction, China also has practically limitless supplies of coal, making it possible to develop great industrial enterprises.

The Educational Aspect

If America is to gain the potential machinery trade of China, it is necessary that educational facilities be provided for young Chinese men whereby they may learn to operate

American machinery and to gain an engineering training so that they may become leaders in the industries of their country. Any nation that undertakes this educational work will get a large share of the future trade. France is endeavoring to bring young Chinese men to France in order to train them in the industries, so that when they return to China they will retain friendly trade relations with France. It is proposed to have 6000 young Chinese go to France within the next two years. They will be given an opportunity to learn industrial trades in the factories of France and will then be given a technical education enabling them to return to China equipped to develop her industries.

A plan that has been considered for furthering American interests in China, and that will be helpful to the Chinese, is to establish an American school of mechanical engineering with American capital, equipment, and control, in which Chinese students could get a thorough training in the use of American machinery and methods of manufacture, and, at the same time, have developed in them that power of initiative and self-reliance so necessary to make development work successful. In such a school, particular stress should be put on the practical side of the work.



Fig. 2. Part of Machine Shop in the Chihli Provincial Technical School, Paotingfu, China

Peking University—An American Educational Institution

Peking University, an American institution in Peking, China, has been considering the matter of undertaking some such work, and has worked out some very good plans for such a technical education as will best serve the needs of the country and utilize its various resources. The university has already established a fine school of agriculture as the first and most needed work. A notable feature of this first work is that the Chinese, realizing from their own experience the need of such a school, have donated half a million dollars in financial support, and 1200 acres of land.

Along mechanical engineering lines, the Chinese have not so much experience as in agriculture on which to base similar development work, and will need some American assistance to start them off. Once a good demonstrating start is made by the Americans, there is good reason to believe that the Chinese will come forward with substantial encouragement and financial backing.

In addition to the engineering course, an industrial bureau is proposed, which will study the resources and needs of China and work for the development of new industries. This bureau will work in close cooperation with the engineering department, so that young men will be suitably educated to fill industrial positions in the particular developments under way at any one time.

This, however, is only a beginning. Engineering education on a much broader scope should be planned for under American auspices. The machine building industries in the United States should, under the auspices of some of the leading manufacturers' associations, endeavor to endow complete technical schools in China, in which the instruction would be along American lines, thereby bringing to life the great potential market that exists in China.

Some Pointers on the Machine Tool Trade in China

In the small Chinese machine shop today one seldom finds anything but simple lathes and drilling machines, often driven by hand; four men work at a large flywheel provided with handles and thereby supply the motive power. In order to create a large general trade in machine tools in China the Chinese must be shown what the modern machine tools can do for them, and that is exactly what the industrial education proposed in this article would do.

In selling machine tools in China, all dealings should be directly between American dealers and Chinese customers, and all shipments, if possible, should be made directly to a Chinese port, preferably Shanghai, which may be termed the New York of China. This is the best place for the location of agencies and a port where simpler lines of machine tools should be kept in stock, as it takes too long a time to order and ship the tools from the United States for each individual sale. Tientsin is also an important port and is destined to become more so in the future. A good deal of American machinery has arrived in China in poor condition because of faulty boxing. It is necessary to box export shipments to China in the most substantial manner.

American machine tool builders have already driven an entering wedge into China by the gifts of machine tools that some of them have made to Chinese industrial and engineering schools. The National Machine Tool Builders' Association has been active in this movement through a committee of which Mr. Broxterman of the John Steptoe Co. in Cincinnati is chairman. Some sales have already resulted from the fact that these machines have been presented to China, because the schools where they are used are really exhibition places where Chinese men of business can see and learn to understand the value of these machines.

It is to be hoped that American machine tool builders will, in the future, equip more of the trade schools in China with modern American machine tools. To the extent that this is done, American manufacturers will insure for themselves a larger share in the great future trade that unquestionably will open up with China in machine tools.



Fig. 1. Small Machine Shop in China, showing Lathes driven by Hand-power. Note Big Flywheels with Handles

The Metric System in an American Shop

By THEODORE H. MILLER, Works Manager, DeLaval Separator Co., Poughkeepsie, N. Y.

HAVING been at the head of a manufacturing establishment for the past eighteen years in which, during that time, the change has been made from the English to the metric system, I believe that an account of how this was done in an American factory, and what the results have been, might be of interest to many of my fellow shop men who may be seeking light upon the subject and endeavoring, meanwhile, to keep an open mind regarding it. It is a question, which, like others combining mechanical and business or commercial aspects, should be considered with coolness and impartiality; and, above all, both sides of the matter should be examined.

Reasons why DeLaval Separator Co. Changed to Metric System

In our case there were special reasons for looking into this question—reasons that would not apply in all cases. Our intimate connection with a manufacturing establishment in Sweden, making a similar machine there for the European market, made it important for us to be able to visualize measurements and quantities stated in metric terms and to be able to readily read and thoroughly comprehend drawings made to the metric system. In other words, it became almost imperative that the two establishments, the one in Sweden and the other here, should use—in their correspondence and on their drawings—the same system of weights, measurements, and capacities. For reasons not necessary to go into here, it would have been unthinkable for us to have asked our Swedish friends to change to our system, and so we considered whether we ought not to change to theirs, and finally did so, without any of the tremendous difficulties and enormous expenses that we hear so much about.

How the Change was Accomplished

Our machines are manufactured in very large numbers in a thoroughly organized factory, equipped to a rather unusual extent, I think, with expensive and highly refined special tools and machines. If our change to the metric system had meant throwing these away and making new ones having integral metric measurements, the task would have been practically impossible; but we did not need to do this. We simply adopted metric measurements for the machines we were already manufacturing; we put metric dimensions on the drawings for these machines and for the tools used in manufacturing them, as fast as circumstances called for it to be done, and commenced to talk millimeters and hundredths of a millimeter, instead of inches, eighths, sixteenths, thirty-seconds, sixty-fourths and thousandths of an inch. We did the same with units of weight and capacity. It was all very simple, and after a short time almost everyone about the place was using the new terms with the greatest ease and familiarity.

Whether the change from one system to the other can be made quickly or not, depends upon what we mean by the change. I claim that when we quit talking about our machines and tools in English terms and commenced to talk of them in metric terms, our factory had made the change. It removed all the difficulties mentioned at the beginning of this article and it introduced no new ones not easily overcome. The expense was slight and never showed itself to any appreciable extent in the factory cost of our machines; and we think we know costs about as accurately as anyone does. This change took place twelve years ago and we have seen no reason whatever to regret having made it. On the contrary, it has been advantageous to us in every way.

When we design a new model of our line of machines or a new size we shall probably make some, and perhaps all, of the dimensions, to what may be called integral metric sizes, that is, even millimeters so far as possible; but, regardless of how far our judgment may lead us to go in that direction, we shall certainly define all dimensions in metric terms. It is my belief that others who follow that plan will find the change very easy and the results favorable.

This experience has been all the more interesting to me, as I was brought up and educated in the English system and spent fifteen years, previous to becoming engaged in executive work, as an apprentice, toolmaker, gage-maker, and shop foreman, working exclusively to the English system of measurement, except for a period of six months spent in Mexico.

The Changing of Drawings

When the change was made at the plant of the De Laval Separator Co., a carefully planned course was pursued, and no confusion resulted. Dimensions in millimeters were placed on the old drawings directly under the inch dimensions. On new drawings the inch dimensions were omitted, all dimensions being in millimeters, so that gradually the inch measurements disappeared from all drawings. No difficulty has been experienced by inability of the men to work to the metric units, except in case of a man who may have so thoroughly absorbed the English units and become so mentally inelastic, that he is unable to read a drawing or take a measurement except in terms of English units of length; but this is a rare case, especially among young or middle-aged men. As soon as the men are able to forget the existence of the inch and its fractions, the metric system becomes extremely simple. It is only when a needless attempt is made to translate one system into another that confusion arises, and the workman's inclination to do this should be discouraged.

In a large industrial plant working under the metric system in America, some difficulty is, of course, experienced in the purchasing department, owing to the fact that it is impossible to buy certain materials, such as square, round, or flat bar stock, for example, in other than inch measurements and sizes. This difficulty is also encountered in other cases during the process of manufacturing, owing to the use of English units of measure outside of the plant.

The Likelihood of Making Errors

It has been said that the use of the decimal point increases the possibility of error. I firmly believe that errors caused by the omission or transposition of decimal points are not so frequent as those caused by changing fractions of an inch into decimals. If the use of decimals were objectionable or likely to cause errors, they would be particularly objectionable in high-grade gage and tool work. But, even in the English system, limits are always expressed in decimals of an inch in work of that kind, often to four, or even five, places; yet errors due to that source rarely occur. These errors are still further reduced when the metric system is used, because the same degree of accuracy is expressed with fewer figures. From an experience of twelve years, I can say without hesitation that the change from the English to the metric system of measurement has, in the case of the De Laval Separator Co., proved an economical measure, for after once being established, fewer errors have been made in interpreting drawings and making calculations.

The Question of Patterns, Gages, and Tools

The adoption of the metric system will not necessitate the wholesale scrapping of patterns, gages, or machine tools. Any practical mechanic, after a little reflection, should, I think, understand this. The experience of the De Laval Separator Co., in changing from the English to the metric system bears this out, for in the shop today many of the machines and much of the equipment are still the same as when the English system was in use, and no machines have been discarded on account of the change. It is not the dimensions of the work that are changed at first, but simply the nomenclature pertaining to the sizes. It is of little importance to the workman, especially when engaged in production work, whether a gage is dimensioned in thousandths of an inch or in hundredths of a millimeter, for he need not often refer to the drawing, but is interested mainly in whether or not the work comes within the limits of the gage. When gages, tools, and fixtures are to be replaced because of wear or from other causes, the new equipment is made to the new system of measurement. By following this gradual transformation practice, no extra expense has resulted from the introduction of the metric system in our factory.

Patterns are foundrymen's tools, and the system of measurement to which they are made is of minor importance. There has never been a case where it has been necessary to discard one of our patterns because it was made to the English system, even though the machined surfaces later were machined to metric measurements; nor has there been any difficulty in the use of the machine tools made to the English system, as they are employed equally well for finishing machine parts dimensioned in the new system; and no gages have been thrown away at any time because of the change from one system to another. The men have been found to read metric scales and micrometers more easily than those made to the inch system. In the case of scales and micrometers, of course, there is an initial added expense, as in this case the old tools must be replaced with new. This has been done gradually, so that at the present time in the De Laval plant all micrometers, scales and other graduated instruments read in the metric system.

The Author's Conclusions

Through the actual use of the metric system in a large manufacturing plant, although during fifteen years of work in the industries I had little practical experience with any but the English system, I have come to believe in the advantages to be gained through the adoption of the metric system. I do not believe that because the English system has always met the practical needs of the industry in the past, it should, therefore, not be disturbed. It would be equally logical to say that an old type machine should not be replaced by a modern one, because the older machine had always met the needs of the work of the plant in the past, and that, therefore, a modern machine of greater efficiency should not be installed.

On the basis of the experience of the De Laval Separator Co., it is, therefore, safe to draw the following conclusions: (1) The change to the metric system can be made without causing confusion, or serious disturbance. (2) It is unnecessary to throw away patterns, gages, or tools made to the old system. (3) The simplicity of the metric system is the greatest factor in its favor, and due to its use, there has been a reduction of errors.

I believe that we have adopted and are using the metric system as fully as any conceivable legislation that could be enacted and enforced in this country could require; but, irrespective of the wisdom or unwisdom of compulsory legislation on this question, possibly the experience of the Swedish company to which I have referred might be of interest. Erik Forsberg is the chief engineer of the Swedish company. He has been much in this country and is quite familiar with our system of measurements. He has recently left here for home, after an extended visit, and speaking of the experience with the metric system in his country, he said: "When legislation was enacted there compelling the use of the metric system, ten years' time was given in which to accomplish the change. The manufacturers and others seemed to care nothing at all about the legislation or the ten years' time, or anything in connection with it, but simply went on with their old system until something more than nine years had elapsed when there was a grand scramble, which resulted in the metric system coming into use rather suddenly, but fully, and with astonishingly little confusion."

* * *

ERRORS IN SCREW THREAD TOLERANCE DATA

The original tables of screw thread tolerances, as furnished by the National Screw Thread Commission and published in the July number of MACHINERY in conjunction with the article "Allowances and Tolerances for Screw Threads," contained a number of errors which have later been corrected by the commission according to the following list:

Table 6: No. 3 screw size, minimum major diameter, 0.0919 instead of 0.0881; 9/16-inch screw, maximum pitch diameter, 0.5060 instead of 0.4960; minimum pitch diameter 0.4981 instead of 0.4881; and minimum minor diameter 0.4439 instead of 0.4339. The following corrections for screw sizes from $\frac{5}{8}$ inch to 3 inches, inclusive, apply to the minimum minor diameters; $\frac{5}{8}$ inch, 0.4958 instead of 0.4998; $\frac{3}{4}$ inch, 0.6081 instead of 0.6125; $\frac{7}{8}$ inch, 0.7176 instead of 0.7225; 1 inch, 0.8231 instead of 0.8287; $1\frac{1}{8}$ inches, 0.9231 instead of 0.9295; $1\frac{1}{4}$ inches, 1.0481 instead of 1.0545; $1\frac{1}{2}$ inches, 1.2646 instead of 1.2712; $1\frac{3}{4}$ inches, 1.4681 instead of 1.4773; 2 inches, 1.6872 instead of 1.6976; $2\frac{1}{4}$ inches, 1.9372 instead of 1.9476; $2\frac{1}{2}$ inches, 2.1484 instead of 2.1601; $2\frac{3}{4}$ inches, 2.3984 instead of 2.4101; 3 inches, 2.6484 instead of 2.6601. The maximum pitch diameter for the 9/16-inch nut should be 0.5163 instead of 0.5183.

Table 7: No. 10 screw size, maximum major diameter, 0.1889 instead of 0.1899, and minimum major diameter 0.1813 instead of 0.1823; $\frac{7}{8}$-inch screw, maximum major diameter 0.8729 instead of 0.8629, and minimum major diameter, 0.8589 instead of 0.8489; $1\frac{1}{2}$-inch screw, minimum major diameter 1.4818 instead of 1.3818; 3-inch screw, maximum pitch diameter, 2.9322 instead of 2.9332, and minimum pitch diameter, 2.9230 instead of 2.9240. Nut for $\frac{3}{8}$-inch screw, maximum pitch diameter, 0.3525 instead of 0.3425.

Table 8: $2\frac{1}{4}$-inch screw, minimum minor diameter, 1.9486 instead of 1.9386; 3-inch screw, minimum pitch diameter, 2.8236 instead of 2.8276. Nut for $\frac{3}{4}$-inch screw, maximum major diameter, 0.3885 instead of 0.3895.

Table 10: Nut for $\frac{3}{8}$-inch screw, maximum major diameter, 0.3872 instead of 0.3862; nut for $2\frac{3}{4}$-inch screw, maximum pitch diameter, 2.5973 instead of 2.6973.

Table 15: Nut for No. 5 screw, maximum major diameter, 0.1291 instead of 0.1289.

* * *

As many foreign-born workers have been returning during the last year and a half to their native countries, ignorant of the present conditions in Europe, an information service bureau for the benefit of these men has been established by the Inter-racial Council in the Woolworth Building in New York City. The object of the bureau is to distribute such information relating to the present conditions in the European countries as will check the tendency of the foreign-born population to return under the mistaken impression that prices are lower and living conditions better than in America. This information is spread mainly through the foreign language newspapers by sending them reports from unbiased sources relating to the actual conditions abroad. Employers of foreign labor will be interested in this information service, and may obtain from the bureau for distribution among their employes much valuable information.

Machine Tool Situation in Sweden

By OSCAR LINDBOM, President, Aktiebolaget Oscar Lindbom, Stockholm, Sweden

The author of this article has been in the United States for the last six weeks studying the conditions in the machine tool industry and making arrangements for representing American manufacturers in Sweden. Mr. Lindbom recently took over the machine tool department of the Galco, Ltd., in Stockholm. He is an engineer by education and training and has had several years' experience in machine building plants, both in the shop and as a designer. About ten years ago he turned to the commercial side of the field, and has since been engaged in selling machine tools in Scandinavia. Hence, he is exceptionally well informed upon the subject dealt with in this article, and his review of the machine tool situation in Sweden is of especial interest.

THERE has been a considerable change in the machine tool situation in Sweden in the last six months. During the whole of 1919 the German competition was exceptionally strong, German manufacturers selling at extremely low prices in the Swedish market. As a result, the Swedish machine tool builders had to reduce their output, and placed most of what they made in stock. Nor could any American machine tools imported at that time be disposed of. During the period when German machine tools were sold so cheaply, many manufacturers and dealers fully equipped themselves to take care of both present and future requirements; this is one reason why the machine tool business up to the present has not been as brisk as it would have been otherwise.

At present, the German competition is less formidable, because, while the German makers still sell their machines and tools from 10 to 20 per cent cheaper than Swedish or American manufacturers, their deliveries are very uncertain and buyers, therefore, show much less interest in German offerings. This makes it possible for the Swedish manufacturers of machine tools to sell in their home market, and even for export; but the importation of American machine tools is still difficult on account of the exchange situation which virtually increases the price of American machine tools in Sweden by somewhat more than 20 per cent.

Machine Tools that can be Sold in Sweden

Notwithstanding the exchange situation, it is possible to sell in Sweden such machine tools as are not being built there or in which Swedish makers cannot compete with the American product. These machines include types of high quality and productive capacity, and especially automatic and semi-automatic manufacturing machines; automatic screw machines; multiple-spindle drilling machines; grinding machines; universal milling machines; gear-cutting machines; and certain sizes of vertical boring mills and turret lathes. The classes of machine tools that are difficult, if not impossible, to sell in Sweden, because they are manufactured by Swedish makers, are especially, engine lathes, ordinary types of drilling machines, small plain milling machines, plain grinders, small and medium-size horizontal boring machines, shapers, and planers. As an example indicating why it would be impossible to sell American shapers in the Swedish market it may be mentioned that a 22-inch shaper of good quality, adjustable stroke, weighing 2700 pounds, is sold by a Swedish manufacturer for Kr. 2400, which at the present rate of exchange—twenty-two cents to one krona—is $528.

Small Tool Situation

There are several manufacturers in Sweden making both high-speed and carbon steel drills. The prices quoted by Swedish makers are in some instances slightly less than those for American tools, but on the whole the prices are about equal. It is possible to import the American product when it originates from the best known makers of small tools, because many of the Swedish shops want them. The prices of both American and Swedish high-speed steel drills are higher than those quoted by English drill manufacturers, and as a result many English high-speed steel drills are sold in Sweden.

In regard to taps and reamers, the situation is somewhat different. There is less English competition, and it is easier for the American product to compete with the Swedish tools. In drills, taps, and other small tools, however, the German competition is strong. These tools are still being imported from Germany at lower than world market prices; and last year many Swedish shops and dealers laid in tremendous quantities of these tools for future use on account of their cheapness. At present, the export prices fixed by the German Government prevent the selling of German tools at the former low price, but the export prices are fixed in accordance with the world's markets and are always from 10 to 20 per cent lower.

The Exchange Situation and Credits

The reason why the Swedish exchange is low is simply that at the end of the war Sweden found itself with depleted stocks in every possible direction and had to import enormous quantities of raw materials. As a result the exchange fell. Normally, one krona is equal to twenty-seven cents. It fell to a point slightly less than eighteen cents but has advanced again to about twenty-two cents. Just as soon as Sweden gets an opportunity to export more of the products for which the world's markets have need—especially iron, paper, and wood pulp—there will be an improvement in the exchange situation. Until that time the American manufacturer ought, whenever possible, to grant an export rebate in order to make it easier to sell. In the writer's opinion the improvement in the exchange situation will be steady from now on, and as it improves it will become easier to sell American machine tools in Sweden, provided American bankers do not permit their estimate of the Swedish currency to be influenced too much by the situation in eastern Europe—Russia and Poland.

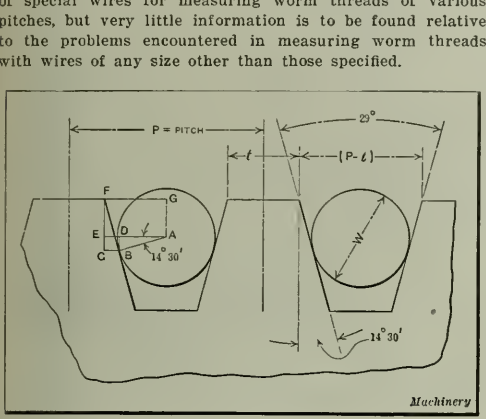
The credit situation is another important item. Most American manufacturers demand payment for machine tools before they leave New York, which means that they must be paid for several months before they are placed in the shop of the customer and begin to produce. Swedish manufacturers give their customers from thirty to ninety days' credit from the time of shipment; this means that the machine will produce for a period of from two to ten weeks before it has to be paid for. This naturally increases the difficulty in selling American machines. In order to sell at all, the agent of the American manufacturer often must extend credit himself to his customer.

As a remedy for this condition the writer proposes that in order to guarantee the payment to the American manufacturer, arrangements be made between his American bank and the Swedish bank of the customer, by which the American manufacturer would be guaranteed payment ninety days after actual shipment from New York. This method of handling export trade would greatly aid in increasing Scandinavian sales.

THREE-WIRE SYSTEM FOR MEASURING STANDARD WORM THREADS

By H. A. PEARSON

The pitch diameter, which is the most important dimension of a worm thread, can be measured either by the use of ball-point micrometers or by the three-wire system. Of the two methods, the three-wire system is generally considered the more accurate, but machinists frequently find it inconvenient to use the regular three-wire system, as it requires special wires. Nearly all handbooks give the size of special wires for measuring worm threads of various pitches, but very little information is to be found relative to the problems encountered in measuring worm threads with wires of any size other than those specified.



Enlarged Section of Standard Worm Thread showing how Wires of Any Suitable Diameter can be used to measure the Pitch Diameter of the Worm Thread

In the following is given the derivation of a general equation which can be applied when using wires of any suitable diameter to measure the pitch diameter of a standard 29-degree worm thread, the only restrictions being that the wires project above the top of the thread or come flush with the outside diameter, and that they be in contact with the sides of the thread. Referring to the enlarged section of a standard 29-degree worm thread shown in the accompanying illustration, P = pitch; t = width of thread at top; $(P-t)$ = width of opening at top; and O.D. = the outside diameter of the worm. Now, having given the width of opening $(P-t)$, the diameter W of the wires, and assuming that the thread angle is correct, the first step in solving the problem becomes simply a matter of expressing, in the form of an equation, the relationship between AG and the two known dimensions W and $(P-t)$.

Again referring to the illustration, it is evident that $AG = EF$ and that EF is the distance from the center of the wire to the outside of the worm thread. It is also seen that $AG = CF - BD$; $CF = BC$ cot 14 degrees 30 minutes; $FG = \frac{P-t}{2}$; and $BC = \frac{P-t}{2} - AD$.

Now

$$AD = AB \times \cos 14 \text{ degrees } 30 \text{ minutes}$$

$$BC = \frac{P-t}{2} - AB \cos 14 \text{ degrees } 30 \text{ minutes, or}$$

$$BC = \frac{P-t}{2} - \frac{W}{2} \cos 14 \text{ degrees } 30 \text{ minutes}$$

Therefore,

$$AG = \left(\frac{P-t}{2} - \frac{W}{2} \cos 14 \text{ deg. } 30 \text{ min.}\right) \times \cot 14 \text{ deg. } 30 \text{ min.} - \frac{W}{2} \sin 14 \text{ deg. } 30 \text{ min.}$$

The micrometer measurement taken over the three wires in the usual way $= 2\ (AB - AG) +$ O.D., which is equivalent to

$$2\left(AB - \left[\left(\frac{P-t}{2} - \frac{W}{2} \cos 14 \text{ deg. } 30 \text{ min.}\right) \times \cot 14 \text{ deg. } 30 \text{ min.} - \frac{W}{2} \sin 14 \text{ deg. } 30 \text{ min.}\right]\right) + \text{O.D.}$$

Now substituting values of sine, cosine, and cotangent, the micrometer reading equals:

$$2\left(\frac{W}{2} - \left[\left(\frac{P-t}{2} - \frac{W}{2}\ 0.9681\right) 3.8666 - \frac{W}{2}\ 0.2504\right]\right) + \text{O.D.}$$

Simplifying and uniting terms, this equation becomes

Microm. measurement $= 4.9937\ W - 3.8666\ (P - t) +$ O.D.

This is the general equation for three-wire readings, and from this equation it is evident that the value of the second term always depends upon the pitch of the worm thread. Therefore, this method of measuring the pitch diameter can be further simplified by preparing a table of constants such as given in the accompanying table. From this table the values 3.8666 $(P - t)$ can be readily substituted in a formula for any specific case within the range covered by the table. The following example will show the method of using: Suppose, for instance, that it is desired to obtain the micrometer reading for a worm thread having 4 threads per inch. Substituting the values from the table, we have:

Micrometer measurement $= 4.9937W - 0.6426 +$ O.D.

The table can be extended to include any pitch desired, and it is of such simple form that it should prove valuable to any machinist who finds it necessary to test the accuracy of standard worm threads, as it involves only simple mathematical operations. The accuracy of the results obtained by this method can be easily verified by comparison with the measurements given on page 1035 of MACHINERY'S HANDBOOK, for use when employing wires of special size. As an example, let a worm having 4 threads per inch and an outside diameter of 1 inch be arbitrarily chosen. Using wires 0.1287 inch in diameter, the micrometer reading would equal $4.9937\ (0.1287) - 0.6426 + 1.000 = 1.000$. From this it is evident that the wire comes flush with the outside diameter of the screw, thus verifying the accuracy of the derived equation.

TABLE USED TO MEASURE PITCH DIAMETER OF STANDARD WORM THREADS BY THREE-WIRE METHOD

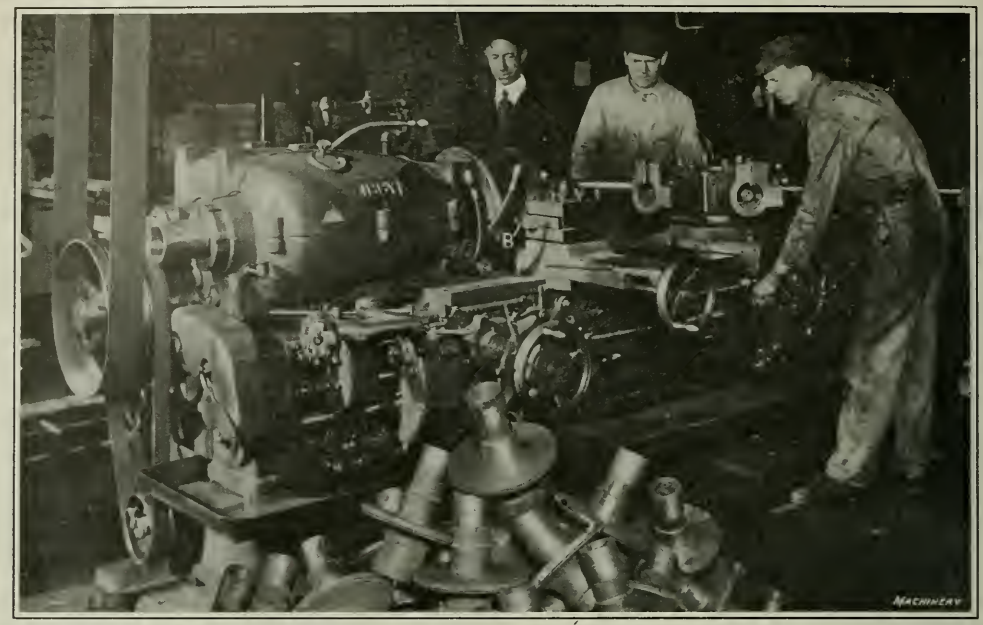
No. of Threads per Inch	Pitch P	Thickness t	(P—t)	3.8666 (P—t)
1	1.0000	0.3354	0.6647	2.5701
1½	0.6667	0.2236	0.4431	1.7133
2	0.5000	0.1677	0.3323	1.2849
2½	0.4000	0.1341	0.2659	1.0281
3	0.3333	0.1118	0.2215	0.8567
3½	0.2857	0.0958	0.1899	0.7342
4	0.2500	0.0838	0.1662	0.6426
5	0.2000	0.0671	0.1330	0.5140
6	0.1667	0.0559	0.1108	0.4284
7	0.1429	0.0479	0.0950	0.3671
8	0.1250	0.0419	0.0831	0.3212

Machinery

* * *

USING FREIGHT CARS FOR MOVING AND NOT FOR STORING FREIGHT

If freight cars were really used to move freight rather than to store freight, the freight situation would not be half as bad as it is. The Material Handling Machinery Manufacturers' Association points out that the 2,452,000 freight cars in the United States move only 9 per cent of the time. Loading and unloading each takes about 11.5 per cent of the time. The remaining 68 per cent of the time is really wasted, due to keeping cars a longer time than necessary before unloading and also to switching and yard delays. If everyone concerned in the use of freight cars did his best to see that the cars were kept moving as much as possible, and if the combined efforts saved only one hour a day in the case of each car, the economy would equal the 102,000 cars it is said our railroads are short of in their equipment.



Libby Turret Lathe Practice

Tooling Equipment Employed by the International Machine Tool Co., Indianapolis, Ind., in Machining Work on the Libby Turret Lathe

A SERIES of articles discussing the practice of performing those classes of machining operations that can be advantageously done on turret lathes would be incomplete without mention of the results obtained in handling such work on Libby turret lathes manufactured by the International Machine Tool Co., Indianapolis, Ind. Acknowledgment is made to the engineering staff of this company for the cooperation that was extended in the collection of data which forms the basis of this article.

Machining Malleable Iron Wagon Hubs

At the plant of the St. Louis Malleable Castings Co., St. Louis, Mo., the machine shop is called upon to finish malleable iron hubs for military escort wagons. These hubs are of the form shown lying on the floor beside the machine in the heading illustration, and outlined in Figs. 2 and 3 in the chucks which are employed to hold them while the required machining operations are being performed. To any experienced turret lathe operator it will be evident from the form of the work that two series of operations are required to finish these hubs. The heading illustration shows a lathe equipped for the performance of the first series of operations, and in Fig. 2 is illustrated one of the special tool-heads used for facing, with the work outlined in its proper relation to the tools. For handling this part of the work, a three-jawed chuck is employed, which has hardened jaws *A* to grip the flange as indicated in Fig. 2.

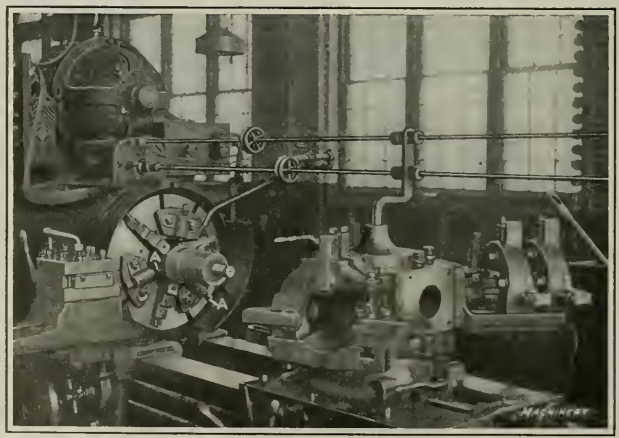


Fig. 1. Turret Lathe equipped for making Locomotive Cross-head Pins from Old Car Wheel Axles

Prior to starting the regular sequence of operations, a roughing tool *B* on the cross-slide (see heading illustration) is employed to remove the oxide scale from those surfaces which are to be finished by the first series of operations, the purpose being to protect the regular tools mounted on

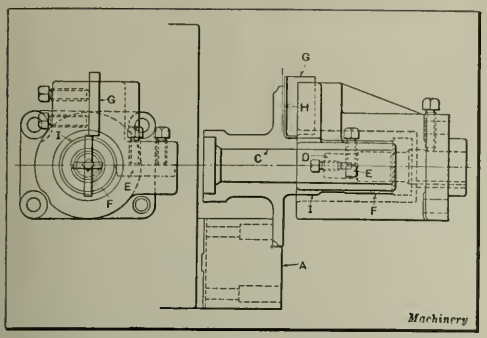


Fig. 2. Turret Tools for turning Two Hub Diameters and facing Flange

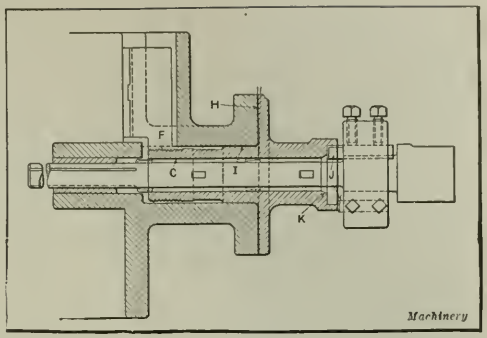


Fig. 3. Turret Tool for boring and counterboring Hub at Second Setting

the turret from the rapid dulling action of this hard scale. After taking this preliminary cut, the regular sequence of operations for the first set-up is as follows: (1) Start boring cored hole *C*, Fig. 2, with a boring-bar *D*, arranged with a follower pilot to run in the freshly bored hole and maintain alignment. The cut to be taken in bore *C* is of considerable length, and while this part of the work is in process, tool *E* is also engaged on the outside of the work turning diameter *F*, and tool *G* is used in facing the tapered surface *H* and in turning diameter *I*. All of the tools used for this operation are arranged in a combination holder. (2) At the second station on the turret there is a similar tool to the one which has just been used, this tool being arranged to perform finishing operations on those surfaces which have just been roughed out, but in this case a pilot is provided to enter the bored hole *C* ahead of the tools, to provide for maintaining them in accurate alignment. (3) On the third station of the turret a Geometric die-head is provided for threading diameter *F* on the work. This completes the first sequence of operations. The operations performed at the second setting will now be described.

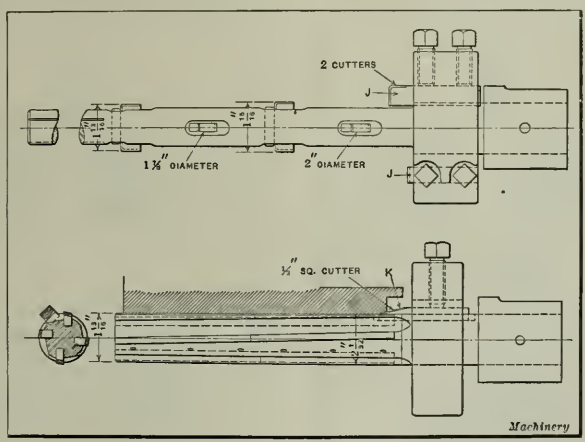


Fig. 4. Stepped Boring-bar and Tapered Reamer for Operation in Bore of Hub

After completing the first series of operations as described, the work is reset in a turret lathe equipped with a pot fixture on the chuck, as shown in Fig. 3, having threaded jaws into which diameter *F* of the work is screwed to bring tapered surface *H* back against a corresponding surface of the pot fixture. Referring to the tool set-up shown in this illustration, it will also be evident that diameter *I* enters the bore of the pot fixture, in which it is a tight fit. With these three locating surfaces all utilized to hold the work, assurance is obtained that an accurate setting and adequate support will be obtained. With the casting located in this manner, the sequence of operations to be performed is as follows: (1) Bore hole *C* to approximately the desired taper; a four-stepped cutter-bar is used, being fed through a distance equal to one-fourth the length of the work, so that the hole *C* is divided up into four sections of slightly different diameters. The boring-bar used for this purpose is shown in detail in the upper portion of Fig. 4, where it will be seen that each of the four cutter-bits varies by 1/16 inch from the size of adjacent cutters, and that there are also two cutters *J* on the bar to provide for counterboring

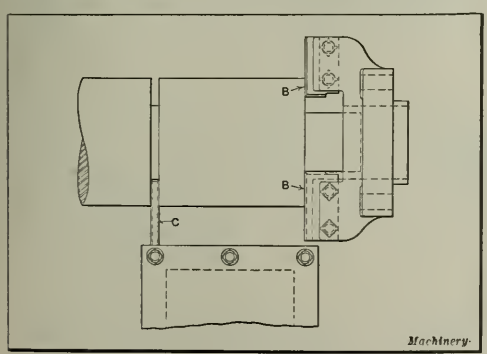


Fig. 5. Cutter-head for roughing down End of Cross-head Pin

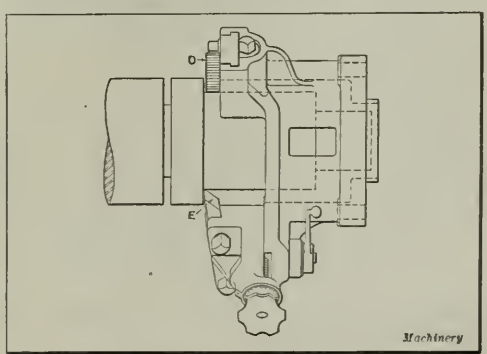


Fig. 6. Bar-turner for rough-turning Body of Cross-head Pin

and facing the end of the hub. This bar is piloted into a bushing in the pot fixture. (2) The next step is to ream the four-stepped hole *C* produced by the boring-bar, with a nicked roughing reamer, which also provides for cutting the chamfer *K*. (3) On the third station of the turret there is a reamer which provides for finishing bore *C* in the work. This reamer is shown in detail at the bottom of Fig. 4, where it will be seen that there is a tapered section at the rear end of the reamer to provide for finishing chamfer *K* on the work. On this job the rate of production obtained is one casting every eight minutes, which is the time taken for completing all the operations that are performed during the two settings of the work.

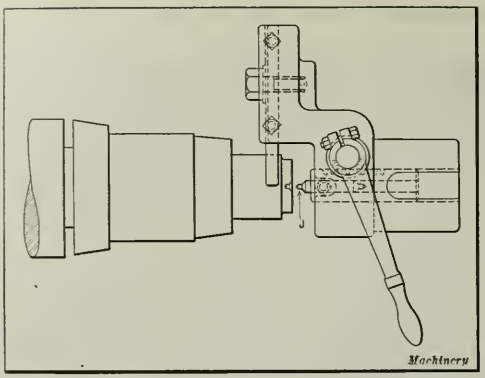


Fig. 7. Centering Tool for drilling the Center Hole in Cross-head Pin

tween each pair of jaws, to enable concave-pointed set-screws *A* to be turned down into contact with the work, the concave point of these screws biting into the work and gripping it securely.

On this job the order of operations to be performed is as follows: (1) Rough down the end of the work with a cutter-head, Fig. 5, that has two blades *B*, each of which takes one-half of the cut. While this operation is in progress, a parting tool *C* in the cross-slide turret toolpost starts cutting off the work. (2) On the second face of the turret there is a bar-turner, Fig. 6, that provides for taking a roughing cut to reduce the work to the form shown, this tool being furnished with a roller back-rest *D* to hold the work against the cutter *E*.

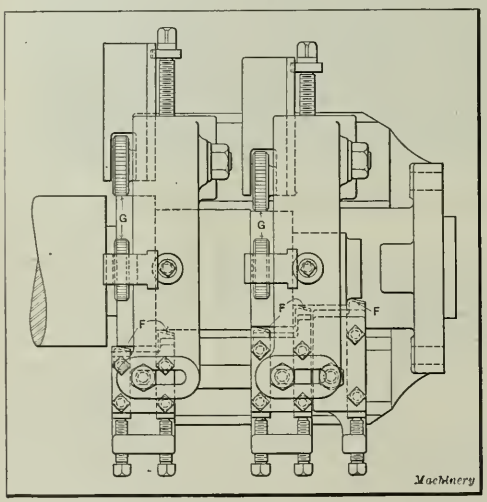


Fig. 8. Box-tool for finish-turning Five Diameters on Cross-head Pin

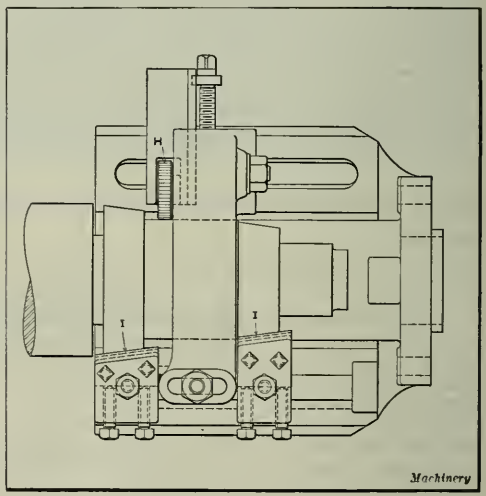


Fig. 9. Box-tool for finish-turning Tapered Surfaces on Cross-head Pin

Making Locomotive Cross-head Pins from Old Car Axles

With a view to utilizing material which would otherwise be discarded, and also because experience has shown that this steel gives unusually satisfactory results owing to thorough seasoning of the metal, the Altoona shops of the Pennsylvania Railroad, at Altoona, Pa., make a practice of using discarded car wheel axles for making locomotive cross-head pins. Fig. 1 illustrates a Libby turret lathe set up for performing the first sequence of operations on this job, and Figs. 5 to 10 inclusive show the tools provided for operation on the work while it is mounted on the machine. Referring first to Fig. 1, it will be seen that the work is held in a three-jaw chuck and that special brackets are mounted on the faceplate be-

(3) Next in the order in which tools are used on this machine comes a box-tool Fig. 8, with five blades *F* that are used for taking a finishing cut, and it will be seen that there are roller back-rests *G* to hold the work against the tools. (4) A finishing box-tool, Fig. 9, with roller back-rest *H* is now employed, which has tapered blades *I* to provide for finishing the inclined surfaces on the work. (5) The next operation is to drill the center hole with a centering tool *J* shown in Fig. 7. (6) At the sixth station there is a Geometric die-head *K*, Fig. 10, that provides for threading the nose of the work. After this operation has been completed, the parting tool *L* in the turret toolpost on the cross-slide completes cutting off the finished pin from the bar. The time required for the entire series of operations is twenty-three minutes.

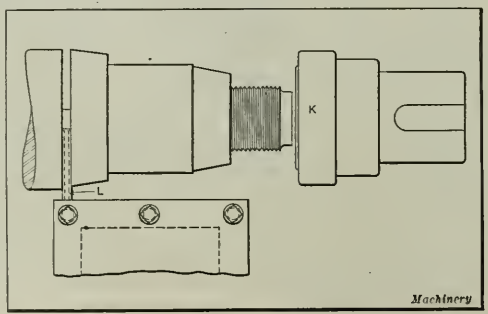


Fig. 10. Geometric Die-head for threading Outer End of Cross-head Pin

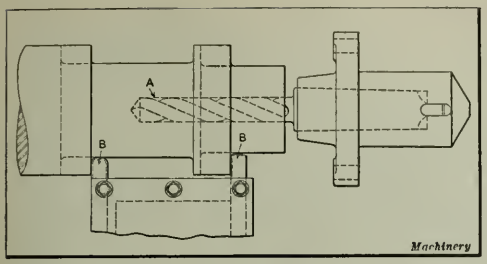


Fig. 11. Drilling Hole with Turret Tool and Rough-turning with Tools mounted on the Cross-slide

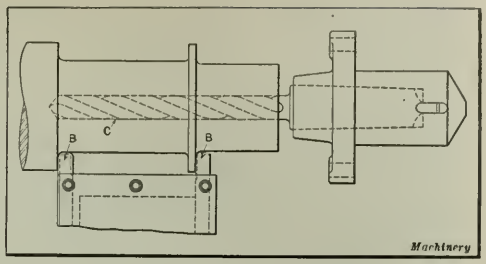


Fig. 12. Completing the Work of drilling from the Turret and turning with Tools on the Cross-slide

Method of Machining Locomotive Crankpins

Figs. 11 to 16, inclusive, show tools for the performance of a sequence of operations on a locomotive crankpin that is machined in the Pennsylvania Railroad Shops at Altoona. As in the preceding case, the work is held by a three-jaw chuck, with set-screws located between the chuck jaws to assist in holding the work. (1) This type of crankpin is hollow, and on the first station of the turret there is a twist drill *A*, Fig. 11, which provides for roughing out the hole part way through the work. During the time that this operation is being performed, two turning tools *B* carried by a

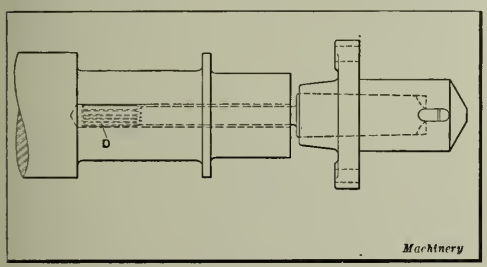


Fig. 13. Reaming the Hole through the Crankpin with a Tool mounted on the Turret

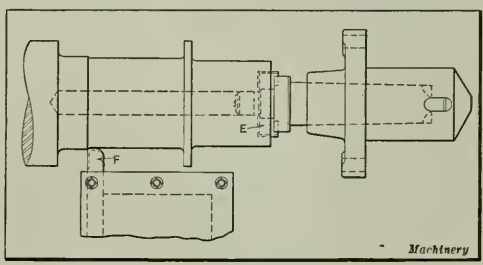


Fig. 14. Rough-counterboring with Turret Tool and finish-turning with Cross-slide Tool

turret toolpost at the front of the cross-slide are engaged in rough-turning the outside diameter of the work. (2) On the second station of the turret, a twist drill *C*, Fig. 12, completes drilling the hole that was started by a drill on the preceding turret face; and the same tools *B* carried by the turret toolpost on the cross-slide complete rough-turning the outside diameter of the work. (3) The third station of the turret carries a chucking reamer *D*, Fig. 13, which finishes the hole that has just been drilled; and conforming with usual practice, no other tools are working on the piece while this reaming operation is in process, owing to difficulty which might be experienced in holding the bore to the required size if such a practice were followed. (4) Next in the order of operations comes rough-counterboring the end of the crankpin with a tool *E*, Fig. 14, carried on the next face of the turret; and while this operation is in progress, a tool *F* carried on the cross-slide turret toolpost is utilized to finish-turn the back part of the crankpin. (5) On the next station of the turret there is a counterbore *G*, Fig. 15, which completes the operation started by tool *E* on the preceding face of the turret. While this work is being done, the cross-slide tool *F* completes finish-turning the back part of the crankpin. (6) A box-tool, Fig. 16, with two cutters *H* and roller back-rests *I* is next utilized for finish-turning the outside of the work at the forward end, and a parting tool *J* on the cross-slide cuts off the crankpin from the bar, thus completing the sequence of operations.

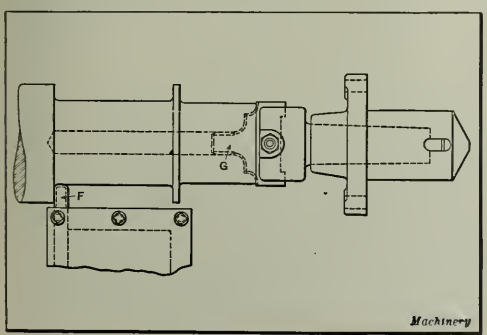


Fig. 15. Finish-turning the Back of the Pin with a Cross-slide Tool and finish-counterboring with a Turret Tool

Turret Lathe Operations on Differential Gear Housings

At the H. J. Walker Co.'s plant in Cleveland, Ohio, Libby lathes are used for performing a sequence of operations required in the manufacture of malleable-iron differential gear housings. To provide for holding these irregular shaped pieces of work, a pot fixture with three adjustable clamping points is mounted on the lathe head to supplement the three-

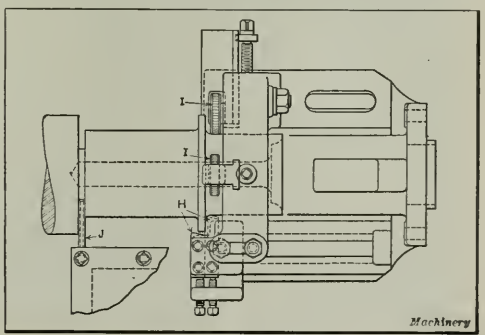


Fig. 16. Finish-turning Two Diameters with a Box-tool mounted on the Turret and cutting off with a Cross-slide Tool

jaw chuck, the arrangement being shown in Figs. 17 and 20. It will be seen that the chuck jaws grip the outside diameter of hub *A* and are simply depended upon to hold the work back in the fixture, the location and supporting of the casting being accomplished by means of adjustable clamping points *B*. These supporting points are steel plungers with a compression spring behind each of them, so that when the casting is pushed back into the fixture the spring plungers are brought firmly into contact with the work. Then after the chuck jaws have been tightened to hold the casting back in the desired position, a headless set-screw *C* is tightened against each plunger to lock it securely in place. One of the plungers, which is not shown in the illustration, bears against the side of a lug that is cast on the work, and in this manner constitutes a positive driver.

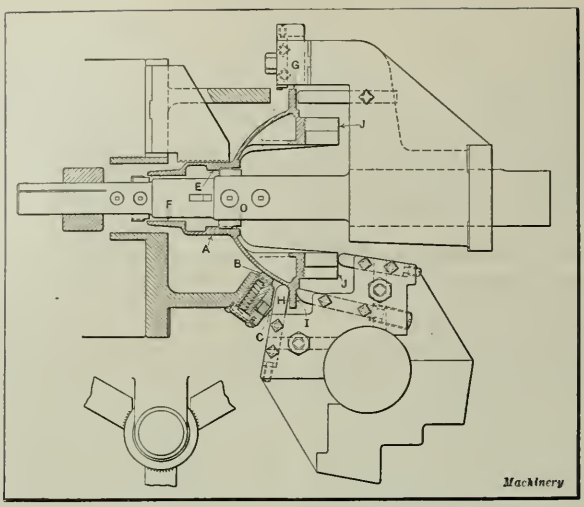


Fig. 17. Arrangement of Work-holding Fixture for machining Differential Gear Housings, and Combination Turret and Cross-slide Tools for simultaneously boring, turning, and facing

This job is completed at a single setting of the work, and the operations are performed as follows: (1) On the first station of the turret there is a combination boring and turning tool that bores diameters *D*, *E*, and *F* on the work and turns the outside diameter *G* of the flange. While this cut is being taken, tools carried by a turret toolpost at the front of the cross-slide provide for rough-facing surfaces *H* and *I* of the flange and faces *J* of the cross-bearings. (2) On the second face of the turret, a similar tool equipment is provided for finish-boring and finish-facing the surfaces that were roughed out by the preceding tools. (3) On the third face of the turret a collapsible tap is provided, as shown in Fig. 20, to provide for tapping sixteen U. S. form threads per inch in bore *E*. On this job the production time for completing each casting is ten minutes.

Turret Lathe Equipped for Machining Steel Artillery Hubs

In the United States Arsenal at Rock Island, Ill., Libby turret lathes are equipped as shown in Fig. 21 for use in machining steel artillery hubs of the form indicated by cross-sectional views in Figs. 18 and 19. A comparison of this job with the operations discussed in connection with the heading illustration and Figs. 2 to 4 will be of interest, because the work is of quite similar form in both cases, but the machines used at the St. Louis Malleable Castings Co.'s plant were equipped with special tools, while standard tools were adopted for use at the Rock Island Arsenal. An exception to the general plan of using standard tools at the arsenal was made in the case of boring-bars for operation in the hub, which are of special design. From Fig. 21, it will be apparent that a three-jaw chuck is employed to hold the work, the gripping power of this chuck being supplemented by three set-screws, that are depended upon to support the end pressure. After a casting has been set up on the machine, tools mounted on the cross-slide turret toolpost are brought into operation to take a preliminary cut over all the faces that have to be machined, in order to remove

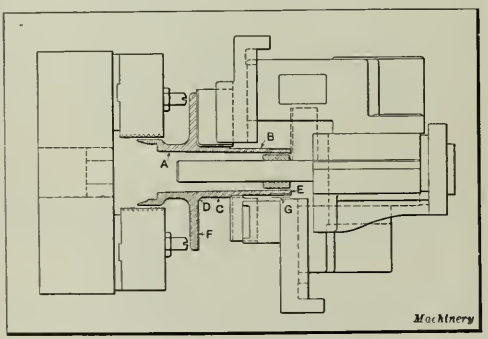


Fig. 18. Provision for chucking Work for First Sequence of Operations on Wagon Hubs. A Combination Turning and Facing Tool is shown in Operation

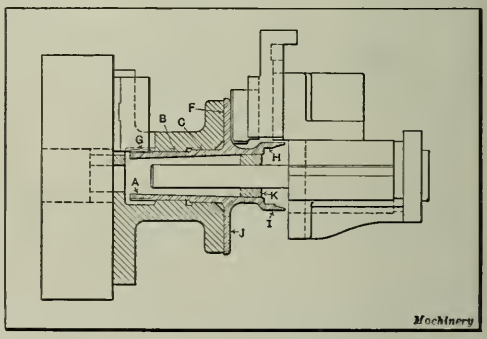


Fig. 19. Provision for holding the Work for performing the Second Sequence of Operations. A Piloted Facing Tool is shown in Operation

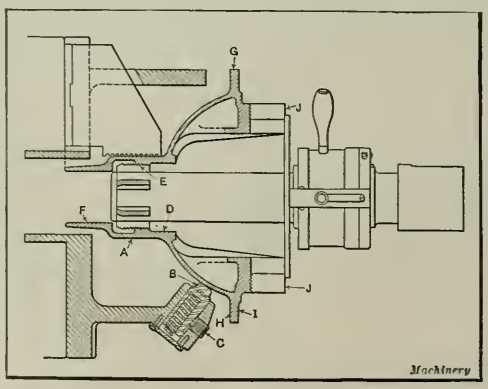


Fig. 20. Collapsible Tap for threading the Previously Bored Hole E in Differential Gear Housing

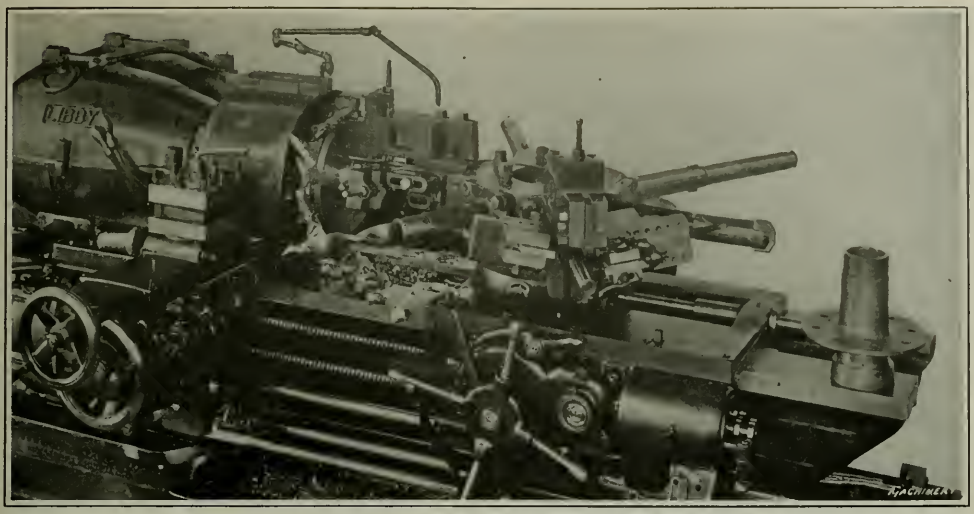


Fig. 21. Turret Lathe equipped with Standard Tools for machining Hubs of Military Wagons

scale and thus protect the regular production tools from damage. In addition to removing the hard oxide scale from those surfaces of the casting which are to be machined, the tools provided on the cross-slide have "stocked" off a majority of the excess metal, so that subsequent turning operations can be performed under more favorable conditions.

After this preliminary work has been accomplished, the method of procedure in handling the regular operations is as follows: (1) On the first face of the turret there is a Celfor flat twist drill of the type made by the Clark Equipment Co., Buchanan, Mich., which drills out bore *A*, Fig. 18, from solid metal. (2) The next face of the turret is equipped with a special stub-end boring-bar which takes an intermediate cut in the hole. (3) On the third turret face there is a Davis piloted boring-bar which takes a semi-finishing cut. (4) A similar tool on the fourth face of the turret finish-bores hole *A* in the hub. (5) Before bringing the tool on the fifth face of the turret into operation, a bushing is inserted in the finish-bored hole in the work, this bushing being a sliding fit in the work and a running fit on the pilot of the combination turning and facing tool which is next brought into operation. This tool is of standard design, except for the over-arm, and it is depended upon to turn diameters *B* and *C*, to form radius *D*, and to face surfaces *E* and *F*. (6) On the sixth face of the turret a tool of similar design to the one just used provides for finish-turning and facing surfaces *B*, *C*, *D*, *E*, and *F*. (7) Mounted in the turret toolpost on the cross-slide there is a single-point thread-chasing tool which is next brought into operation to provide for chasing a thread as indicated at *G*. For the performance of this sequence of operations the production time is seventy-two minutes.

Operations Performed at Second Setting of Artillery Hubs

After completing the sequence of operations which has just been described, the partially machined artillery hubs are reset on a turret lathe equipped with a special pot fixture of the form illustrated in Fig. 19. Reference to this illustra-

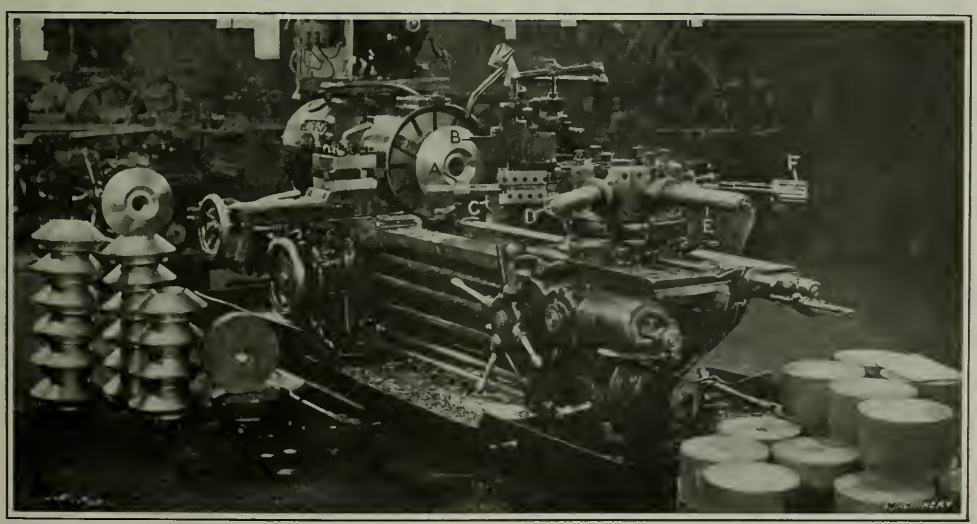


Fig. 22. Turret Lathe set up for performing First Sequence of Operations on Bevel Gear Blanks

tion will make it apparent that surfaces *F*, *C*, and *B*, previously machined on the work, are utilized as locating points, while thread *G* is screwed into the threaded chuck jaws to provide for holding the work back in place in the fixture. On this job the sequence of machining operations to be performed is as follows: (1) To protect the regular production tools from unnecessarily rapid wear, a so-called "stocking" cut is taken over all the surfaces which are to be machined. (2) On the first face of the turret there is a stepped boring-bar which provides for taking a preliminary cut to bring hole *A* to the required tapered form, and at the back of this tool there is also a formed counterbore for taking a preliminary cut in the work at *H*. (3) On the next station of the turret a tapered reamer provides for removing the excess metal that is left by the stepped boring-bar. (4) The next turret face is furnished with a reamer of similar design, which completes the taper-cutting operation. (5) On the fourth turret face a combination turning and facing tool of the type shown in Fig. 19 is provided for use in turning twist drill. While this drill is in operation, a wide-faced shaving tool mounted on the same face of the turret is brought into use to provide for taking a stocking cut on the face of the gear blank, and a second tool takes a preliminary cut in the counterbore, to quickly remove excess metal. (2) On the second face of the turret there is a tool-head with a pilot *A* to enter the drilled hole in the work. This head is provided with a tool *B* to take a finishing cut over the face of the gear blank and a tool *C* for finishing the counterbore. (3) The third face of the turret is provided with a boring-bar *D* which takes an intermediate cut in the hole. (4) Bar *E* mounted on the next face takes a semi-finishing cut in the bore. (5) On the fifth face of the turret there is a reamer *F* for finishing the hole in the gear blank. Carried by the turret toolpost on the cross-slide there is a cut-off tool that runs down the back of the gear blank and produces a clearance for another tool in this turret toolpost that is used for forming the back angle of the gear blank. The time taken for this sequence of operations is fifty-four minutes.

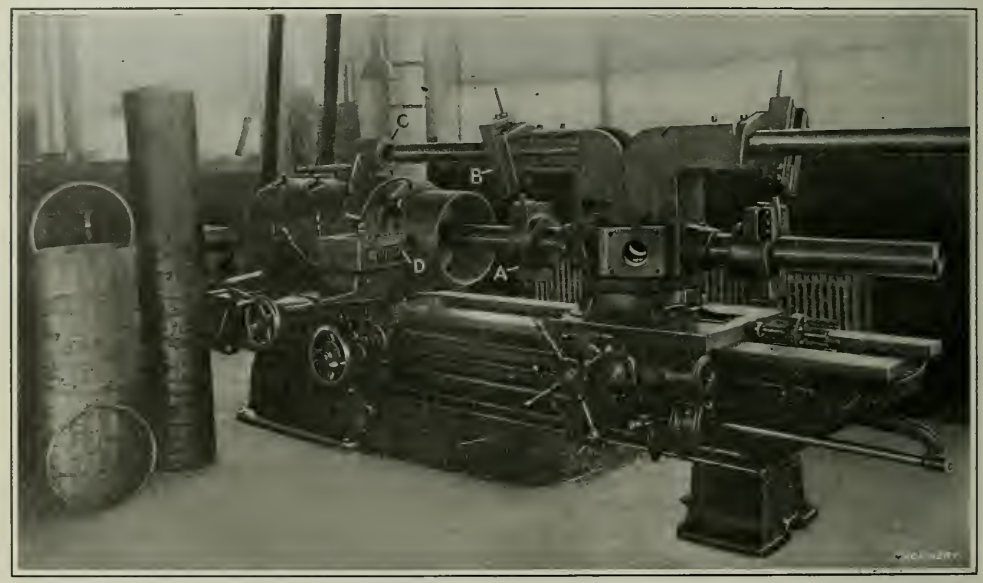


Fig. 23. Turret Lathe equipped for turning, boring, and cutting off Piston Rings from a Pot Casting. Provision can be made for machining either Concentric or Eccentric Rings

diameter *I* and facing flange *J*. It will be evident that this tool is of the piloted type, and a bushing *K* is introduced into the finished bore of the work before this tool comes into operation, in order to assist in maintaining perfectly accurate alignment. On this job the production time is seventy minutes for performing the sequence of operations.

Turning Bevel Gear Blanks

An ideal turret lathe job, that is to say, one on which the turret lathe can show the most advantageous results, is one where there is a sequence of boring, reaming, tapping, turning, facing, and similar operations to be performed. Several good examples have already been presented. Another case where the turret lathe shows its possibilities to good advantage is in the machining of bevel gear blanks. Fig. 22 shows a Libby lathe used at the R. D. Nuttall Co.'s plant in Pittsburg, Pa., for performing the first of two series of operations that are required to bring these blanks to the desired form. The material to be machined is steel billets. At the first setting of the work, the blank is held in a three-jaw chuck and the sequence of operations is as follows: (1) Drill out the central bore from the solid metal with a 3-inch Celfor

For the second setting of the work, the gear blank is held by a three-jaw chuck furnished with special soft V-shaped jaws that fit over the face and back angles of the work. In preparing for the performance of this sequence of operations, a bushing is first entered into the bore of the gear blank to receive pilots on the tools used for performing the required operations, which are as follows: (1) Conforming with the usual practice, a preliminary or so-called "stocking" cut is taken over the surfaces to be machined with a tool mounted in the turret toolpost on the carriage, to provide for removing the oxide scale. (2) On the first turret face there is a piloted combination turning and facing tool that turns and faces the hub of the gear blank. (3) A tool of the same type, mounted on the next face of the turret, performs a finishing operation on the same surfaces. For the performance of this second sequence of operations, the time required for machining is sixteen minutes.

Turning Piston Rings on the Turret Lathe

The Wasson Piston Ring Co., of New Brunswick, N. J., uses a method of machining piston rings on the turret lathe, which gives very satisfactory results. This equipment was

designed and developed by the International Machine Tool Co. The rings are machined from so-called "pot" castings, which are molded from patterns that form a V-shaped lug at one end of each pot, to furnish a convenient and secure means of holding the pot in place on the lathe chuck. Fig. 23 shows a Libby turret lathe set up for this job. The sequence of operations performed on these parts is as follows: (1) Remove oxide scale from the casting with a stellite tool supported in the turret toolpost on the cross-slide. (2) Mounted on the first face of the turret there is a combination boring and turning tool, with cutters to provide for taking a straddle cut on the wall of the pot, that is to say, for boring the inside diameter and turning the outside diameter. Reference to Fig. 23 will make it apparent that each of these tools is piloted, the pilot on the boring tool *A* entering a bushing in the chuck, while the pilot on the turning tool *B* enters a bushing *C* mounted at the top of the lathe headstock. (3) After taking the roughing cut with these tools, the turret is indexed 180 degrees to provide for bringing into operation a similar pair of tools that is mounted on the opposite side of the turret. These tools are piloted in the same manner as those used for roughing, but the bits are arranged to take a finishing cut over the inside and outside surfaces that have just been rough-bored and rough-turned. (4) Carried by the toolpost on the cross-slide there is a stepped, multiple cutting-off tool *D* which provides for cutting up the turned and bored pot casting into individual piston rings, the successive tool bits being arranged so that they cut off the rings in progressive order from right to left. This cutting-off tool is provided with spacers between the tool bits, so that any required spacing may be obtained to conform with the width of the piston rings. With this equipment a pot casting can be machined and cut up into twelve piston rings in a period of three minutes per ring; and provision can be made for producing either concentric or eccentric rings by this method.

* * *

UNUSUAL DRILLING IN CHROME-NICKEL STEEL

Demonstrations made during the convention of the American Railroad Association held recently at Atlantic City showed that hard and tough alloy steels can be economically drilled on a real production basis. In these demonstrations various sizes of holes were drilled in pieces of open-hearth chrome-nickel steel 3 inches thick, a penetration rate of 20 inches per minute being obtained with 1-, 1⅛- and 1¼-inch drills. Twenty inches per minute is equivalent to 1 inch every 3 seconds, which is considered a remarkable rate of penetration in drilling steel of this nature. The results of the tests are shown in tabular form and were obtained by using high-speed drills, made by the Whitman & Barnes Mfg. Co., Akron, Ohio, on an American 6-foot radial drilling machine. The composition of the material drilled was: Carbon, 0.50 per cent; chromium, 0.90 per cent; nickel, 1.00 per cent; and manganese, 0.75 per cent. These demonstrations were made at speeds and feeds which can be duplicated under shop conditions, and indicate how production can be economically increased.

DATA OF RESULTS OBTAINED IN DRILLING CHROME-NICKEL STEEL

Size of Drill, Inches	R.P.M. of Drill	Feed per Rev., Inch	Drilling Rate per Min., Inches	Drilling Time, Seconds	Average No. of Holes Drilled per Grinding
1	500	0.040	20	9	32
1⅛	500	0.040	20	9	24
1¼	500	0.040	20	9	27
1½	500	0.029	14½	12½	29
2	206	0.040	8¼	22	27
2½	206	0.022	4½	40	12

Machinery

THE METRIC SYSTEM IN SCANDINAVIA

Through the Publicity Service of the American Institute of Weights and Measures, 115 Broadway, New York City, we have received the following communication signed by J. Christian Barth of the firm of Carl G. Barth & Son, Philadelphia, Pa., which refers to the conditions in regard to systems of measurements in Sweden and Norway. Mr. Barth writes:

"I recently returned to the United States after three and one half years' visit to Sweden and Norway. I first came in contact with the metric system in my work in 1916-1917 in Finspong, Sweden. It was necessary for me to make some drawings of equipment, and not being acquainted with the metric system, I was told to use the English system which I was accustomed to, writing plainly on the drawing that it was drawn to the English system. I later discovered that the Swedish metal industries use no less than four systems of measurement; in Norway, there are three systems.

"In the work of arranging store-rooms, I had great difficulty with bolts, nuts, etc. Piping, iron bars, and shafting, etc., are always stated in English measure; bolts, nuts, and similar articles in both the English and metric measures. Quite frequently we received these in metric sizes when they were ordered in English sizes, and the reverse. I recall one instance of rivets, where the diameter comes in inches and the length in millimeters.

"There is a similar confusion with the measures of weight; though nominally there is only the metric system in use, the old Norwegian terms are still largely used. Thus we still buy a pound, though it weighs ½ kilogram. From my experiences in Norway and Sweden, I am much averse to changing the system in use in this country, because of the confusion due to the conglomeration of terms that creep into use, and the length of time it takes to get the old system out and the new in. In Norway, I frequently met with the assertion that it was only the passing generation who held to the older systems, but my observations were to the contrary.

"On the whole, I consider that the burden of changing in our country would be too great to warrant changing. We have our goods scattered over the world which need repairs for a long time. The confusion would certainly last for generations to come."

* * *

MACHINERY IMPORTS INTO SOUTH CHINA

The port of Hongkong is the main port of entry for machinery imports into South China, and the figures given in a report by Consul General George E. Anderson of Hongkong are therefore of interest as indicating the possible demand for machine tools and other classes of machinery in this part of the world. During 1919, Hongkong imported $278,000 worth of machine tools, of which about two-thirds came from Great Britain and one-third from the United States. The total imports of all classes of machinery amounted to $2,550,000, and included steam engines and boilers, internal combustion engines, pumps, electrical machinery, and textile machinery. In steam engines and internal combustion engines, the United States led, supplying about 75 per cent of the total imports valued at over $500,000. The same proportion held true in regard to electrical machinery, of which about $500,000 worth was also imported. Great Britain furnished practically all of the remainder both in the engine and the electrical machinery field. In pumping machinery and general machinery for use on shipboard, Great Britain furnished over 75 per cent.

There is some uncertainty as to the future in the business circles of China; the political conditions in South China are especially uncertain, and the imports of machinery in 1919 were considerably less than in 1918. It is evident, however, that there is a considerable market for machinery of all kinds there, and the United States ought to secure its share in the machine tool lines as well as in the other lines.

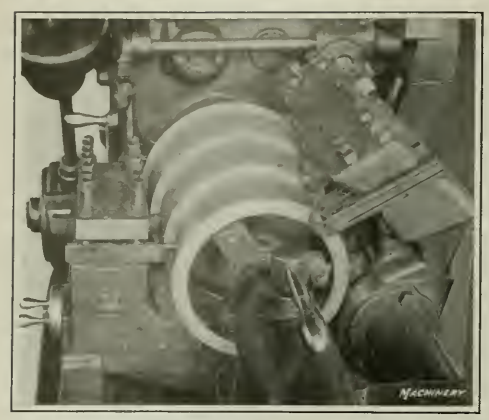


Fig. 1. Machine provided with Tooling used in Finishing Operations on a Three-step Cone Pulley

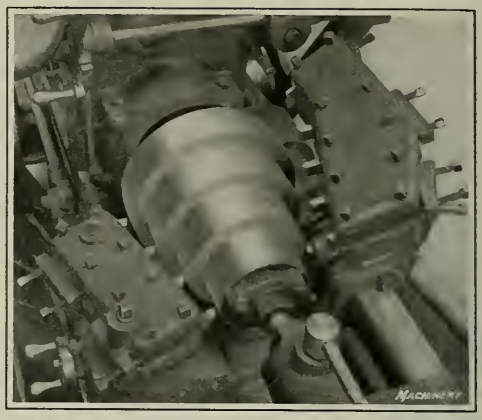


Fig. 2. Set-up of Machine employed in Roughing Operations on a Four-step Cone Pulley

Machining Cone Pulleys

Tooling Equipment and Methods Employed in the Quantity Production of Three- and Four-step Cone Pulleys

By RALPH E. FLANDERS, Manager, Jones & Lamson Machine Co., Springfield, Vt.

THE machining of cone pulleys on an engine lathe is necessarily a slow method due to the large number of cuts which must be taken one at a time. Thus, it is obvious that if large quantities of pulleys are produced on machines of this type, the rate of production will be comparatively low. The purpose of this article is to describe a way in which the production rate can be materially increased for work of the kind mentioned. The machines employed in the method to be described are Fay automatic lathes provided with a sufficient number of tools so that the turning or facing cuts on the various surfaces to be machined can be taken simultaneously. This is made possible by the construction of the lathe, which provides multiple tool-holders for both turning and facing, operated by independent cam movements. In this way the machining of all the surfaces can be accomplished in the time required for machining the longest one. These machines are automatic in all their movements, and are stopped automatically by a brake at the end of an operation.

Two machines are used in the operations on a pulley, one being provided with equipment for taking the roughing cuts, while the other takes the finishing cuts. These two machines are placed adjacent to each other, and are so timed that the work removed from the roughing machine is at once placed on the finishing machine, after which a new piece of work is put in the roughing machine. The work is mounted on arbors which are placed between the centers of the machines during the operations. Three arbors are provided so that one can be used for changing the work while the other two are in action. This eliminates having the machine idle while a finished pulley on an arbor is being replaced by a rough one.

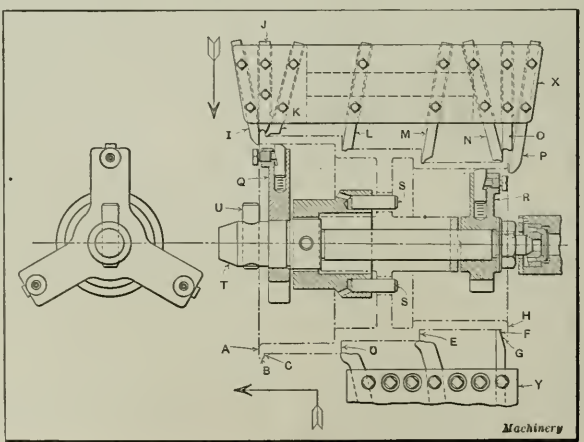


Fig. 3. Tool Lay-out used in Turning and Facing Operations on a Cone Pulley

Machining a Three-step Cone Pulley

The lay-out of the tooling equipment provided for rough-turning and rough-facing a three-step cone pulley is illustrated in Fig. 3, in which the outline of the work is shown by dot-and-dash lines. The work is mounted on arbor *T* by means of the reamed hole through the pulley hub, and is located longitudinally on the arbor by the hub faces. The hole and hub faces of the pulley are finished in a preceding operation. The rims of the two outer steps are adequately supported on the inside by the three-armed spiders *Q* and *R*. The arms of these spiders are each provided with a pin that is forced against the work by an expansion coil spring, placed in the same hole as the pin. When the pins are in contact with the pulley rim, they are clamped in this position by means of screws bearing on plugs machined to suit a taper surface on each pin. The arbor is rotated by a driving pin on the faceplate of the machine, which comes in contact with pin *U* on the arbor, the pulley, in turn, being driven by pins *S* which extend through holes in a rib on the pulley beneath the middle step, as can be clearly seen.

In operation, the arm on which the rear tool-holder *X* is mounted, swings forward, thus causing the tool-holder and the tools to rock toward the work in the direction indicated by the arrow shown adjacent to this tool-holder. When this occurs, surface *A* is faced by tool *I;* surface *B* is

rounded by tool *J;* surfaces *C, D, E,* and *F* are faced by tools *K, L, M,* and *N;* surface *G* is rounded by tool *O;* and surface *H* is faced by tool *P.* At the same time that these tools are being operated, the front carriage *Y* is first moved toward the work until the tools mounted on the carriage are taking the proper depth of cut, and then longitudinally forward, during which movement each of the three steps on the pulley are straight-turned by one of the three tools mounted on the carriage. The direction of the two carriage movements is indicated by the arrow in the lower part of the illustration. It is evident that the pulley is machined in the time necessary for one of the tools on the carriage to take a complete cut on one of the steps. Fig. 1 shows the machine used for finish-turning and finish-facing the various surfaces, during which operation a curved crown is produced on each of the three steps. A former beneath the front carriage gives the tools the required movement for accomplishing the crowning. The actual production on this work is six pulleys per hour, roughed and finished complete, one man running two machines.

Equipment for Finishing a Four-step Cone Pulley

A machine provided with the tools used in taking the roughing cuts on a four-step cone pulley is illustrated in

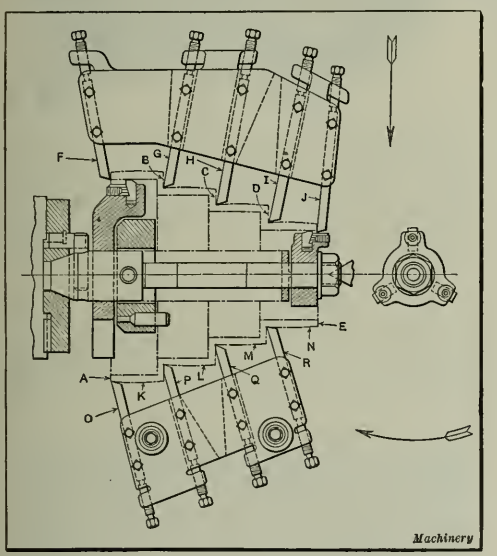


Fig. 4. Tooling Equipment furnished for the Final Operation on the Four-step Cone Pulley

Fig. 2, the operation having been completed when the photograph was taken. In this operation the several steps are straight-turned. The equipment employed in the finishing operation is very similar, as shown in Fig. 4. The arbor on which the work is mounted is of practically the same construction as the one used in connection with the machining of the three-step pulley previously considered. In this operation, when the rear tool-holder is rocked toward the work, surfaces *A, B, C, D,* and *E* are faced by tools *F, G, H, I,* and *J,* respectively. At the same time that these cuts are being taken, the front carriage is moved in the direction indicated by the arrow near the bottom of the illustration, during which movement surfaces *K, L, M,* and *N* are crowned by tools *O, P, Q,* and *R,* respectively. The curved movement of the tools in this case also is obtained by means of a former placed beneath the carriage. As in the preceding example, this operation is completed in the time required for one of the tools on the carriage to be fed longitudinally a distance equal to the width of one step.

MOVING PICTURE SHOWING BELT MANUFACTURE

Few men realize the great number of operations and the time and labor necessary to produce a finished belt from a raw hide. From six to eight months time is required for the purpose, the greater portion of this time being consumed in cleaning the hide preparatory to its tanning and in the tanning process. With a view to educating the mechanical public along these lines, the Charles A. Schieren Co., New York City, produced a moving picture of all the stages of the belt-making industry from the time that the raw hide arrives at the company's tannery at Bristol, Tenn., until the finished belts are shipped from their New York factory ready for service. This interesting moving picture, which consists of 3800 feet of film, was shown for the first time at the Machinery Club, New York City, on June 29.

The portion of the film devoted to the preparation of the hides for the tanning process shows the methods and machines used in removing the flesh and the hair and in soaking the hides before this can be accomplished. The picture then shows the method of extracting the tannic acid used in tanning. This is extracted from chestnut oak bark that is dried and ground, after which the tannic acid is obtained by a leaching process and pumped to storage tanks. For the purpose of tanning, the hides are placed in a rocker for eight days, and then in layers in vats for 120 days, the rocker and vats containing a tannic acid solution. Ground bark is also placed between the layers of hides in the vats. During the time that the hides are in the vats, they must be frequently removed and replaced for the purpose of putting a fresh solution in the vats and fresh bark between the layers. After the tanning is completed, a number of operations, including stretching and polishing, are performed, and then the hides are ready for the manufacture of belting.

Among the various things shown in the part of the film taken at the New York plant, are the methods used in cleaning the hides from all dirt and grease that may have accumulated during shipment, in sorting them according to weight and grade, in cutting them into proper belt widths, in cementing the various belt sections together, and in waterproofing the belts when completed. The process of cementing two-, three-, and four-ply belts is also shown, as is the manufacture of round belting and leather link belts. The clear, concise captions and the fact that all machines are shown in actual operation, permit everything that is seen in the picture to be readily understood. The educational value of such a film cannot be overestimated and it will be made available for exhibition before engineering societies, schools, and colleges, and in industrial plants upon application to the Charles A. Schieren Co.

* * *

AMERICAN MACHINERY TRADE IN INDIA

In his report on the conditions and prospects of British trade in India, Thomas M. Ainscough, British Trade Commissioner, states that competition from the United States is becoming particularly keen in electrical, mining, steelworks plant, oil-crushing, and refining machinery, machine tools, and miscellaneous engineering supplies for industrial purposes. Before the war British makers had such a hold on the trade, largely because purchases were usually made in London by the managing agents of Indian industrial concerns and because British engineering practice and standards were preferred, that foreign competition made little headway. During the past four years orders have had to be placed in the United States for immediate requirements, and it is likely that the American connections, having once been made, will be retained. So far, very few American manufacturers have opened offices in India, but their representatives are very active. Previous to the war, the United State's share of machinery imports into India was only 3 per cent; at the present time it is 28 per cent of the total.

Training Electric Welders



Methods Used by the General Electric Company, Schenectady, N. Y., in the Training of Operators of Electric Welding Equipment

THE arc welding school maintained at the Schenectady works of the General Electric Co. originated during the drive to train men in industrial pursuits demanded by the requirements of the war. The specific purpose for which the school was instituted was to train commercial welders for the Emergency Fleet Corporation. After the exigencies of the industrial program of that period had passed, it was deemed advisable to continue the school as a permanent institution. The school was the first of its kind established in the country, and it attained a reputation for turning out men of high proficiency in the art of electric arc welding. It is at present operated on practically the same basis as when it was first opened.

The training of men as electric welders is just as essential in obtaining satisfactory results as the training in any other line of trade. The General Electric Co.'s school is primarily intended for the training of operators of the welding equipment that the company sells to its customers. The customer sends his own employes to the school to receive the training. Instruction is furnished without any charge to the customer, other than the transportation and living expenses of his employes and prospective welders. While, therefore, the men trained are usually in the employ of users of the General Electric Co.'s equipment, many also receive instruction regardless of connection with any industrial concern.

Scope of the Training

The object of the school is to train men in the manipulation of the arc, and to instruct them in regard to how the equipment should be handled, as well as the proper current values for use with different sizes of electrodes and work. The theoretical explanation of the causes of stresses produced in heated metals and the chemical action of various metals in the weld is not a part of the instruction. A lecture is given once a week by various members of the engineering and laboratory forces of the company upon the fundamentals of welding and metallurgy. These lectures are attended by the students in a body, and an attempt is made to answer all questions which the students ask. All equipment is furnished free of charge either to the student or to his employer. The capacity of the school is sufficient to take care of about twenty men at a time, there being a constant turnover in the personnel of the student body. There is no set time for the length of the course, because the time required may vary greatly for different students. In general, it has been noted that younger men can become proficient welders more readily, and that men above forty years of age do not generally become good and speedy welders. The average length of time required in the instruction, in order to produce a finished welder, is from forty to fifty days, although the entire training is often completed in considerably less time. It is not necessary for the student to receive the full course of instruction. He may qualify for such welding work as making repairs in castings, carbon arc welding, or recovering broken taps and drills from castings, the training for which may be acquired in a very short time.

Primary Instructions and Duties

The student, upon entering the school, is assigned to a booth such as shown in the heading illustration, and the various courses, of which there are six, are fully explained by the instructor in charge. An attempt is then made by the instructor to ascertain just what courses the various students are desirous of learning, or the special line of work which would be of the greatest advantage to the particular concern from which the new students have been sent. After this has been determined, the basic principles of arc welding are taught. These principles concern the length of the arc; the proper position in which to hold the electrode; the method of breaking the electrode from the work should it become frozen to it; the current values for electrodes of various temperatures; and the combination of current value and electrode size for various classes of work. These elementary instructions are then followed by the first four simple exercises in depositing metal and controlling the rate of deposition.

Fig. 4 shows of what the various exercises included in the course consist. For example, the first four elementary exercises involve depositing 6 inches of metal on 6 inches of plate; welding parallel rows $\frac{3}{8}$ inch wide the entire length of the plate, leaving a $\frac{1}{2}$-inch space between each row; laying a second layer of metal on the previously deposited parallel rows, maintaining the same width of spacing; and finally, filling in the $\frac{1}{2}$-inch spaces with one layer of metal. The fifth, sixth, seventh, and eighth exercises consist of depositing metal in the same manner as the first four exercises but with the plate set at an angle of 45 degrees, the operator making the weld from the bottom up. The next four exercises are performed in like manner with the plate set in a vertical plane, the metal being deposited from the bottom upward. By this time the welder has acquired the

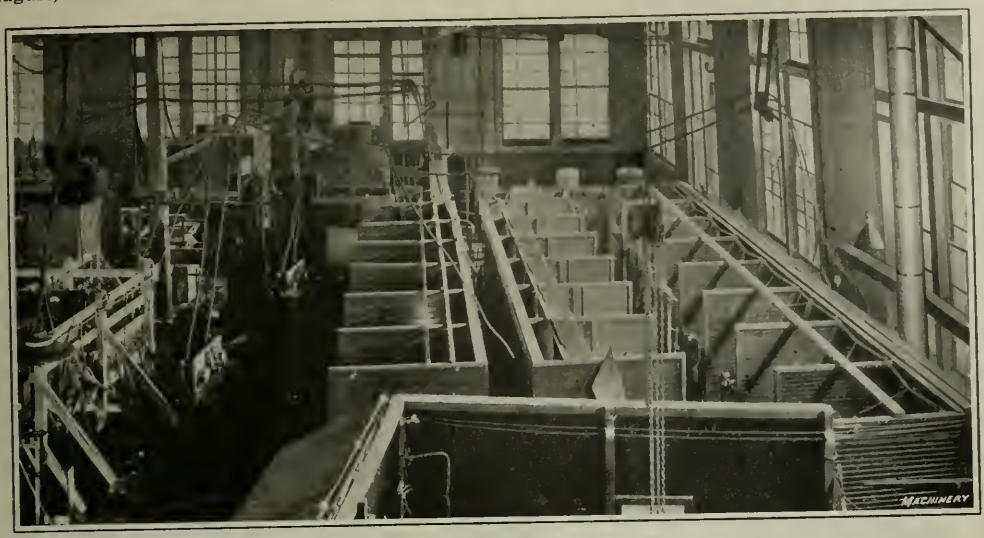


Fig. 1. View of General Electric Co.'s Welding School, showing Booths for Operators

ability to manipulate the arc and to judge the rate of depositing the metal with a known amount of current. Before the student has progressed too far, he is given a week's training on practical work under the supervision of the welding foreman, after which he is started on any special course of study that may have been decided upon. If no provision for the student's further advancement has been made, the right is reserved by the instructors to teach the student the course that seems of most value to the company that will later make use of his services.

Procedure after the Student has Acquired the Fundamentals of the Course

As soon as the students have reached the point where they are capable of performing certain production jobs they are put on this class of work for a time, until they have demonstrated that they have acquired the necessary degree of skill. This method, which enables the student to actually produce, is a factor in reducing the maintenance cost of the school. The men are then shifted back to the exercises for more advanced instruction, and this procedure is continued throughout the course. The complete instruction program includes forty specific exercises. The first actual welding, as shown in Fig. 4, occurs in Exercise 13, in which the student is required to make a butt-weld with two ¼-inch plates in a horizontal position. Exercises 14 and 15 consist of butt-welding with the plates set at a 45-degree angle, and in a vertical position, respectively, the welding in both cases being performed from the bottom of the plates upward. Exercises 16, 17, and 18 consist of butt-welding two ¼-inch plates together at an angle of 90 degrees, in three positions—horizontally, at 45 degrees, and vertically, respectively. In the two latter cases the weld is made from the bottom upward.

Exercise 19 consists of making a horizontal weld in the corner of two ¼-inch plates arranged to form an inverted T.



Fig. 2. Welder at Work depositing Metal

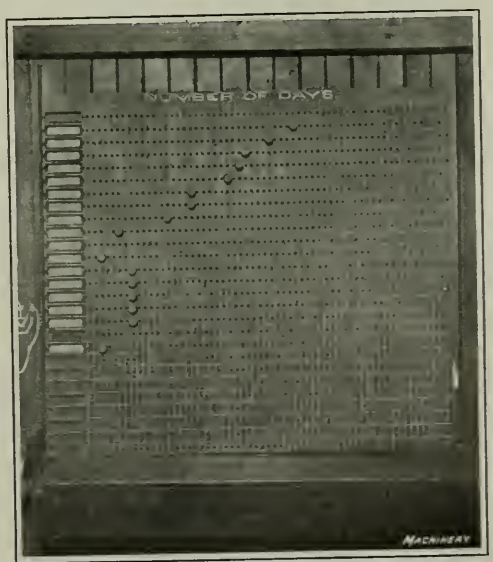


Fig. 3. Board for indicating Progress of Students

In Exercises 20 and 21, T-welds are made, as shown in the illustration, the work being tipped at a 45-degree angle in one case, and set in a vertical position in the other. The welder is required to deposit four layers of metal and to chip and brush the scale from each layer before adding the succeeding layers. The next four exercises are performed with the plate in a vertical plane, the weld being made in a horizontal direction. In the first of these—No. 22—parallel beadings are laid, spaced ½ inch apart; the next exercise consists of filling in the ½-inch spaces in the parallel rows just deposited; and the two following exercises consist of depositing row upon row of metal first from the bottom up and then from the top down. In Exercise 26 the plate is placed in a vertical plane, and a 3-inch diameter circle of beading, ¼ inch wide, is made in the face of a plate, and then circular beading is welded inside and outside alternately, until the plate is entirely covered. Exercises 27, 28, and 29 are lap-weld exercises performed with the plates first in a horizontal position, and then in a vertical position and an inverted vertical position, respectively. The last exercise calls for considerable skill on the part of the student, it being the first overhead work that he has been required to do.

of which is filled with a ¼-inch metallic electrode and the other with a carbon arc using a ½-inch diameter filling rod. This exercise is furnished so as to enable the student to make a comparison between the metallic and carbon arc for filling purposes. Exercise 38 consists of cutting steel with the use of the carbon arc. Exercise 39 consists of welding ⅞-inch holes in ⅝-inch plate, both in a vertical and in a horizontal position. The last exercise in the course, No. 40, requires the student to run ⅜-inch beads on cast iron and to make a satisfactory butt-weld.

Recording the Progress of the Student

As previously mentioned, the work is not limited to exercises, but practice is also given on various odds and ends of practical welding when the students have advanced sufficiently to warrant this. A blackboard is in use in the welding school by means of which the progress of the student is recorded, and from which the relative advance that he has made can be readily seen. This board is illustrated in Fig. 3. The first column of the board gives the name and other identification notations of the students. To the right of this column, spaces are provided for each working day. It is not

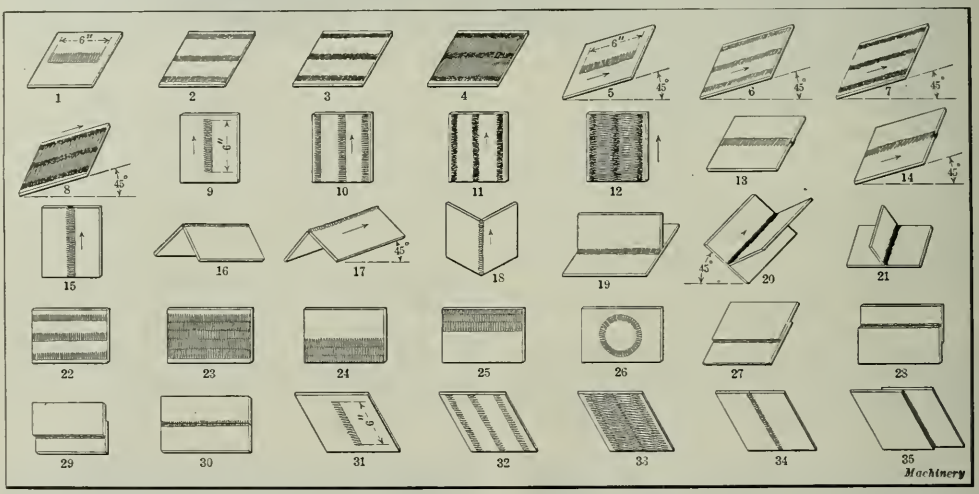


Fig. 4. Diagrammatical Representation of the First Thirty-five Exercises that the Student is required to master in the Course of his Instruction

The next exercise in order, No. 30, is that of butt-welding two plates in a vertical position, making a horizontal joint. The student is now required to gain control of the electrode for overhead work, and the remaining exercises illustrated in Fig. 4 are overhead exercises. Exercise 31 is that of depositing 6 inches of metal on 6 inches of plate, the work being placed in a horizontal plane. Exercise 32 consists of making parallel rows of beading, spaced ½ inch apart. In Exercise 33 this ½-inch space between the parallel rows just deposited is filled in. An overhead butt-weld with two ¼-inch plates is required in Exercise 34, while Exercise 35 consists of making an overhead lap-weld with ⅝-inch plates.

The five remaining exercises in the course are not shown, but they are as follows: Exercise 36 requires two men to perform a butt-weld on ⅝-inch plates which have not been beveled for receiving the metal. Both men are required to work together on each side of the work. This is a condition which they will surely encounter in their practical experience, and the exercise enables each man to become accustomed to the presence of another man on the job, and also to so regulate his rate of depositing the metal, that the amount deposited and the heat produced on each side of the joint will be balanced. The next step, Exercise 37, involves the making of two pens 3 inches square by ¾ inch high, one

presumed in any case that more than sixty days will be required to train the student completely, and therefore spaces for sixty days are provided on the board. As the student completes one lesson, a wooden plug bearing the number of that exercise is inserted in a hole in the board under the day on which he has completed the lesson. A number of these plugs are shown in the illustration, and the plugs travel from left to right on the board as the student advances. By this means, the instructor is enabled to tell at a glance just which of the men are the most proficient and also which may need special attention.

Selective Courses of Training

As previously stated, there are six courses which may be pursued. One of these consists of making repairs on steel castings. It is especially recommended to those students who come from foundries and machine shops where a knowledge of the manner of filling blow-holes, and repairing defective and worn parts and broken castings is necessary. The students are also made acquainted with the proper allowances to make for contraction and expansion and how to prevent depositing hard and unmachinable welds. The course on repairing cast iron has met with marked success, and although the welding of cast iron is not looked upon with

favor by some, yet to make the instruction complete, a course in this branch of the art is included.

The welding of steel plates and tanks offers the most complete training, and is especially recommended to the all-around welder. In this course the student is taught flat, vertical, horizontal, and overhead welding. He is also taught the proper heat value to use to correspond with the size of electrode, thickness of plates, and angle of work. In the course on welding tanks, the student becomes familiar with the proper precautions to take in preventing warping of the sheets, and the relative amount of metal to deposit to obtain the required strength.

There is a course provided in recovering broken taps and drills from castings. Among the various requirements of this course, the student is required to remove a number of taps and drills in an allotted time. The course in welding high-speed steel to low-carbon steel is very difficult and requires close study, due to the difference in melting points of the two metals. The course is particularly useful from a tool-room point of view, and has been the means of saving considerable money due to the cost of high-speed steel and the saving that can be realized by welding low-carbon shanks to high-speed tools.

The course in carbon arc welding and cutting is entirely different from that of metallic welding. With the carbon processes it is necessary to use the carbon arc as a preheater and to take the metal from a filling rod held in the left hand. With the use of the carbon arc, a much higher rate of depositing metal can be maintained owing to the higher values of current which may be used. For cutting large castings, the carbon arc is quite useful, as well as for salvaging scrap material.

The student is required to break up the weld that he has made on scrap material, and to examine it and determine where the weakness, if any, lies, as well as, if possible, what has been the cause for the failure. In such a case the aid of the instructor is often solicited, and any doubtful points are cleared up by him. In the course in making tanks, the welder is always present when they are put under pressure test, and may witness the results of his work. If the tank is a failure, the defective weld is examined, the cause for the deficiency is explained to him, and a method pointed out by which he may prevent a repetition of his mistake. Every exercise must be thoroughly mastered before the next is attempted. Just pointing out the cause of failure will not permit the student to proceed—he must demonstrate that he not only knows *how* to do the work, but *can* do it as well.

Fig. 1 shows a general view of the welding school, from which the locations of the individual booths may be seen, as well as an operating panel from which six welders are enabled to work simultaneously.

The progress of the student is carefully noted and a close check is kept on him from the time he enters the school until he leaves. A merit system is in use, and attendance and punctuality are closely recorded. A record of each student's rating is kept on file in the power and mining engineering department of the plant, and may be furnished to any employer who has sent a student for instruction, upon request. There are no certificates or diplomas presented to the welder on leaving the school, but a personal letter is given if desired, in which the particular kind of work for which the student is fitted is stated.

* * *

Previous to the war Belgium had fifty-five blast furnaces, of which seventeen were running on June 1 this year. The pre-war output per day was nearly 8000 tons of pig iron. The daily output of the fourteen furnaces now running is somewhat less than 3000 tons, indicating that while Belgium is rapidly resuming its industrial activity, there is yet much to be done. The main reason for not starting up all the blast furnaces is lack of fuel.

QUESTIONS FOR THE MACHINIST

By A. W. FORBES

The accompanying list of questions was posted in the Forbes & Myers shop near where the operation referred to was being done. The sketch shows the operation, one surface only being faced, as marked. The writer believes that by a thorough study of questions of this kind, rapid advancement in machine work is possible.

FACING CORE FLANGES

A Few Facts You Should Know About this Operation

1. There are two operations—roughing and finishing.

2. The object of roughing is to remove the excess metal in the shortest amount of time.

3. What shape should the tool have to do this?

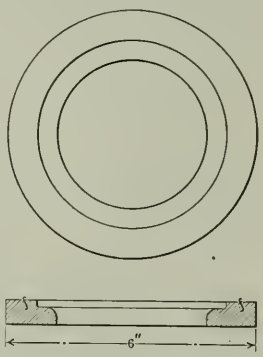
4. What material should be used for the tool? Stellite will cut faster, but will not stand shock as well as high-speed steel.

5. Should the tool be rigid or spring?

6. What is the highest speed at which the tool will stand up in this work? How does this speed compare with the speeds ordinarily recommended?

7. How long does it take to make the roughing cut at this speed, taking it all in one cut?

8. Can you take enough greater feed if two cuts are taken, so that the total time is less?



9. If you take the next speed slower, can you take enough larger chip so that the total time is less?

10. The object in finishing is accuracy and appearance.

11. Can you give the required degree of accuracy and finish on the same cut as the roughing, by using a slower speed, feed, or both? If so, will this take a longer or shorter time than to take a separate cut?

12. The finishing can be run faster than the roughing. Can you save enough time in this way to pay for shifting the belt?

13. What shape of tool is best for finishing this piece?

14. What material is best for this tool? High-speed steel will more readily give a good finish, but stellite will cut faster.

15. Can you save time and still get a good finish by using the same tool for roughing and finishing?

16. Are your answers to the above standard practice, or are special methods necessary due to the quality of iron, kind of lathe, or other special reasons?

After working at this job for a few days you should be able to answer all these questions and more. Most machinists cannot, but most machinists do not advance as rapidly as they might. This is one of the simplest jobs in the shop. With most of the jobs there is much more that you should know.

* * *

Whether there is any likelihood of a drop in the cost of building construction is a question of great interest to all manufacturers who contemplate building new shops or making additions to old ones. The Aberthaw Construction Co. of Boston expresses as its belief that there will be no immediate drop in the cost of building construction. There is no evidence that building materials will be reduced materially in price for some time to come; and while there is, at present a decline in building activities, it is not likely that this will directly influence the cost of construction.

Developing Initiative in Your Men

By WILLIAM A. ROCKENFIELD, General Manager, Baldwin Chain & Mfg. Co., Worcester, Mass.

DURING the writer's varied experience, it has often appeared that while systems may not be designed to deaden initiative, they very frequently have that effect. Initiative can be developed in a number of ways, and in many cases when there is an obvious lack of initiative, it is not altogether the person himself who is at fault. In order to develop initiative, the individual must be placed in a position where he is able to learn and understand all the interrelated factors which are known by the general term "the policy of the company." In many manufacturing plants men holding quite responsible positions often are not given an opportunity of learning exactly what the policy of the company is and hence their initiative is naturally curbed.

The capacity for initiative may be born in some men, but generally it is developed by a sense of responsibility that comes by increased duties. One way in which initiative may be developed in subordinates is to ask for the solutions of problems from the men themselves, rather than to provide the solution for them in every instance. When a man is seeking for the solution of a question of policy, instead of telling him the answer, ask him what he would do if the decision depended entirely upon himself. By your manner, try to impress upon him that you believe his judgment will be right and that he can solve the problem himself, and in nine cases out of ten he will do it. He is put in a position where he has to show what is in him—in other words, where he has to make good. The problem will be before him until he has found a solution, and generally the solution will be the right one.

Bringing Out Men's Latent Abilities

An executive should not take it upon himself to know all the details, or to embody within himself all the composite skill of the whole organization. As a matter of fact, an executive who undertakes to do this generally will accomplish less than the one who knows when the proper moment has come to delegate some of the details to others. In order to bring out the best that there is in a man, it is important not to make him feel that there is any doubt about his ability to do a certain job. On the contrary, he should be impressed with his superior's confidence that he can do it right. The results are often surprising. As a rule men will work harder to earn good-will and praise, than they will to avoid criticism; and they surely find more joy in the work, if the purpose is to win commendation rather than simply to avoid blame. While excessive praise is as objectionable as constant nagging, an executive should be as quick to commend good work as he is to find fault. In this way, many latent abilities may be brought out in men who otherwise would never have been suspected of great capacity.

The Value of Taking Men into Your Confidence

A plan that the writer has always found to work well, is to select some faithful, promising men in the organization and to let them understand that there are possibilities of better positions for them in the future in view of plans that are being made for expansion or changes that are always occurring in any progressive business. By so doing he will gradually direct the minds of these men into the channel which will later fit them for the position that he has in mind when the expansion of the business calls for an additional number of executives. Managers who claim that they get no response from their subordinates will be surprised to note the diligent and faithful efforts that most men will make in order to fit themselves for future jobs that will probably have to be filled from within the organization.

The Value of Consulting with Men in the Organization

When a change or rearrangement of a department is contemplated, the chief executive should not attempt to do all the planning himself—it is far better to tell the department foreman of the general plan and to ask him to make a sketch and a written proposal as to what he considers best. In nine cases out of ten his proposition will be a good one, because he understands many of the minor problems of the department with which the executive could not possibly have become familiar.

In buying new machinery when there is some doubt as to the size or make to be bought, it is often good policy, before deciding, to consult not only the foreman of the department where it is going to be used, but also the man who is going to run the machine. If it is a machine with which the foreman is not familiar, it is well to have him see it before it is actually bought. Greater efficiency will be obtained in that way. If the machine is bought with his approval, he will do everything in his power to make it a success. If it is bought against his wishes or without consulting him, he is very likely to find fault with it, not because he is of an unusually mean disposition, but because he is simply human.

As an example of the value of consulting the shop man, the following incident will prove of interest. It was recently practically decided to buy a second-hand planer that was in exceptionally good condition and sold at a reasonable price. The man who was to run the planer was taken to a plant where the machine was for sale to see it. He was delighted with it and fairly beamed at the prospect of running such a fine, modern planer. But having thoroughly inspected it, he said, "I am afraid it will prove troublesome because there is no place to put it except on the present foundation, and it is so long that it will cut the shop in two and waste the time of every man who has to pass around it." That point had not occurred to the manager or to any of the executives who were supposed to have a "broad view" of things. Bear in mind that this man did not like to give up the prospect of running that fine planer, but it was evident that the plant meant more to him than just a place where he drew his pay.

An Understanding of Human Nature Makes Management Problems Simple

If every executive would remember when dealing with men that regardless of their station or accomplishment, their education or training, they are all inherently the same, having similar ambitions, hopes, and desires, and particularly very much the same emotions, they would be more successful in dealing with men. It is important to remember that most men are guided much more easily and more often by emotion than by careful thought and consideration. This will be questioned by some people who believe that everything they do is dictated by clear business judgment, but the fact remains that the world's business is to a considerable extent based upon action dictated by emotions.

Honesty of purpose is the simplest rule for successful dealing with men. The executive who puts his cards on the table, deals directly with his men, puts himself in the men's place, and acts in accordance with his own policies and not merely puts them on notices, will find that it is a good deal easier to manage men and to find men with good qualities and loyal tendencies than is ordinarily believed.

Special Machines in a Tractor Shop



Machines Designed by the Bates Machine & Tractor Co., Joliet, Ill., for Producing Tractor Parts

By EDWARD K. HAMMOND

IT will usually be found desirable to employ standard machine tools for the majority of the machining operations involved in the manufacture of metal products. The two chief reasons for their selection are that machines of standard design are less expensive than those which have been especially designed and constructed for a given purpose, and that standard machines can be utilized for many different operations instead of being restricted to one class of work. However, there are certain instances in which machines that have been built to meet the requirements of specified jobs are found far more efficient for their work than standard machine tools. As a general proposition, this is the case where a special design makes it possible to perform a number of operations simultaneously, and thus effect savings in production time, labor costs, and, by combining the functions of a number of machines in a single unit, greatly conserve the amount of floor space that is occupied by manufacturing equipment. The first cost of special machines of this type is usually quite high, and for that reason there must be a sufficient volume of work for the machines, if they are to earn a satisfactory return upon the investment.

Special Machines Used in a Tractor Plant

At the plant of the Bates Machine & Tractor Co., Joliet, Ill., a number of interesting special machine tools have been designed and built to meet this firm's requirements in producing certain parts of the "Steel Mule" tractor of its manufacture. These equipments have been developed for machining tractor parts of rather unusual form, but this article on the application of single-purpose machines will emphasize the possibilities of such a practice by manufacturers who at present are using nothing but standard equipment; and in certain cases, machines of very similar design to those which are described could be successfully employed for operation on numerous other parts, by merely making requisite changes in details of the design. Attention should be called to the fact that the satisfactory results that have been secured, are due to the care taken by experienced machine designers to make these equipments adapted for their work. Unless experienced men are able to devote a sufficient amount of time to the design of special machines to make suitable provisions for all special requirements of the job, it will be found the best practice to use standard machine tools in all cases, including those for which special machines might be found profitable under more favorable conditions.

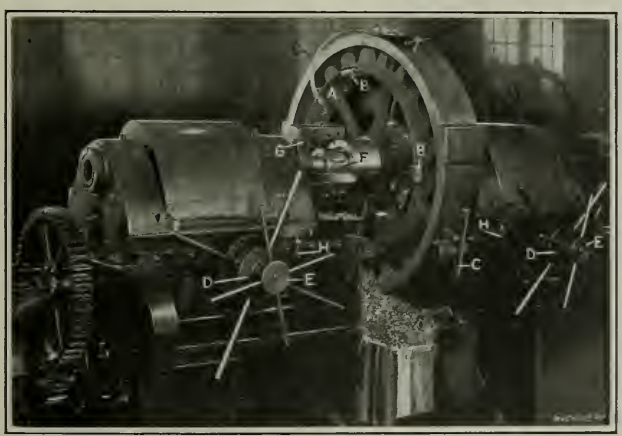


Fig. 1. Special Duplex Boring, Facing, and Turning Machine for finishing the Hubs of Cast-steel Driving Sprockets for Tractors

Machine for Boring, Turning, and Facing Hubs of Cast-steel Sprockets

On the Bates tractor, cast-steel driving sprockets are used, which are of the form shown set up on the machine at *A* in Fig. 1. The first step in machining is to bore and face the sprocket hub at one end, and to turn the outside of the hub to two different diameters at the opposite end, in addition to boring and facing. After gaining some experience with another method of performing these operations, it became apparent that much time would be saved if a special machine could be devised that would make it possible to operate simultaneously from both ends of the hub without requiring the piece to be reset. A duplex machine seemed to be the logical equipment for handling this job, and a machine of that type was built for the purpose. As shown in Fig. 1, it will be evident that the designers provided a chucking ring between the two opposed heads, inside of which the sprocket is held in position for machining. Four hooks *B*, which are actuated by bolts from the rear, clamp the work back against a flange inside of the chucking ring, and there are four radial screws *C* which project inward through the ring and center the work. Both of the heads on the machine are gear-driven and furnished with capstan wheels *D* for moving their position on the bed; capstan wheels *E* provide for engaging the power feeds when the cutting

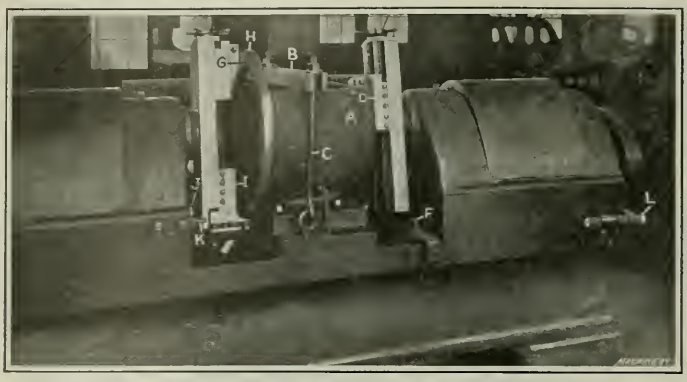


Fig. 2. Duplex Turning and Facing Machine for finishing Opposite Ends of Semi-steel Clutch Housings for Tractors

tools have been advanced into the desired position. By simply moving each head toward the work, provision is made for automatically engaging the gears of the driving train to start the spindle rotating; similarly, when the head is withdrawn from the work, the gears are disengaged and rotation of the spindle is stopped.

After the work has been set up as described, the method of procedure in performing the required machining operations is as follows: A number of tools are used for the performance of a sequence of operations, and to provide for the rapid setting up of these tools, the nose of each spindle is tapered and furnished with keys for driving the interchangeable tools that are made to slip over the spindle nose. At one end of the hub that is to be machined, a nicked and a smooth-toothed facing cutter are used for rough- and finish-facing the hub, respectively; then an inserted-tooth cutter rough-bores the hub, after which a reamer takes a finishing cut in the bore. Similar tools are used at the opposite side of the work for facing and boring, and a stepped cutter-head is set up on the spindle for use in turning the outside of the hub to two diameters as clearly shown in the illustration. This turning head operates simultaneously with the boring tools, being mounted on the spindle behind the boring tool *F*, as clearly shown at *G*. At each end of the hub, the bore is machined to a depth of 2¼ inches, and adjustable gages shown at *H* indicate when the cutters have entered the work to the desired depth. On this job the rate of production obtained is twelve sprockets in a ten-hour working day. Formerly the work was done on a lathe of standard design and as compared with this method, the saving effected by the special machine is $1.26 per sprocket.

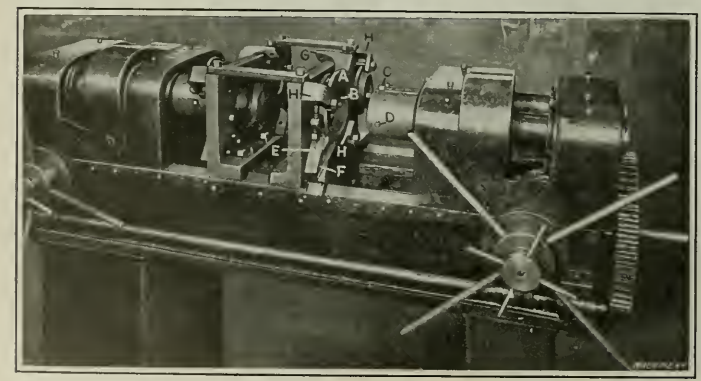


Fig. 3. Duplex Machine for simultaneously rough- and finish-boring Two Holes in Two Rear Axle Housings

Machine for Facing and Turning Semi-steel Clutch Housings

In Fig. 2, one of the semi-steel clutch housings to be machined is shown at *A*. Before they come to the machine, these pieces have been milled and drilled so that a locating surface is provided on which the work can be set up on a pad provided on the machine for that purpose. The desired location is secured by pins on the fixture which enter the drilled holes in the work. Clamping is accomplished by means of a strap *B* and bolt *C*. At the right-hand end, it is merely necessary to face the clutch housings, and for that purpose it will be seen that a rotary cutter-head is mounted on the spindle of the machine, this head being provided with a tool-block *D* that runs on a slide on the head. Feeding of the tool-block on this head is accomplished by means of a capstan wheel, mounted on the end of a screw, and a stop *F* secured to the lathe bed. For each revolution of the cutter-head, stop *F* engages the wheel, thus giving a transverse movement to the tool-block.

At the left-hand end there is a cutter-head of identical design to the one at the right, which provides for facing the vertical surface *G* on the work. In addition, it is necessary to turn the outside diameter *H* of the flange, and for that purpose a second tool-block *I* is mounted on a slide at the opposite end of the rotating cutter-head from that at which the facing tool is supported. This turning head is of similar design to the facing cutter-head, being furnished with a small capstan wheel *J* that strikes stop *K* and turns the capstan through one space for each revolution of the main spindle, thus imparting the desired feed movement to the turning tool carried by block *I*. The only difference between the turning and facing heads is that one moves in a direction perpendicular to the axis of rotation while the other moves parallel to this axis. On both the facing and turning operations one cut completes the job, there being approximately 3/32 inch of metal to be removed. After a casting has been set up on the machine, it is necessary to provide for bringing the cutters up to opposite ends of the work. Provision for doing so is made by having an adjusting screw *L* at each end of the machine. This screw runs in two lugs, one of which is secured to the bed, and the other to the head; and by turning the square end of the screw with a wrench, provision is made for advancing the heads to the work or withdrawing them after the turning and facing operations have been completed. On this job the rate of production obtained is twenty-two clutch housings in a ten-hour day.

Machine for Boring Cast-steel Rear Axle Housings

At *A* in Fig. 3, there is shown one of the cast-steel rear axle housings for a Bates tractor, and to provide for simultaneously boring the two holes in these parts the special machine shown in this illustration was developed. These housings are made in pairs, a right-hand and a left-hand housing being required for assembly in each tractor; and by equipping the machine with two opposed heads and a duplex work-holding fixture, provision is made for simultaneously boring two holes in a pair of housings. As it was originally built, and as still used at the plant, this machine has a cutter-head for working in each of

the holes, which is furnished with two bits, the first of which takes a roughing cut and the second a finishing cut in the hole. In the illustration, the bits on the cutter-head for working in hole *B* will be clearly seen at *C* and *D*.

It will be apparent that each of the opposed heads on this machine is furnished with a large capstan wheel that provides for advancing it to the work, and when the cutter-head has reached the desired point, the driving clutch is automatically engaged to start rotation of the spindle. The small capstan wheel at the center provides for engaging the power feed. As the castings come to this machine they have not had any preliminary operation performed on them. Location of the work in the fixture is accomplished by means of a channel *E*, which locates arm *F* on the work; and a second arm *G* prevents the casting from turning. Three straps *H* hold the casting back in place in the fixture. On this job the production is twenty-two pairs of rear axle housings in ten hours.

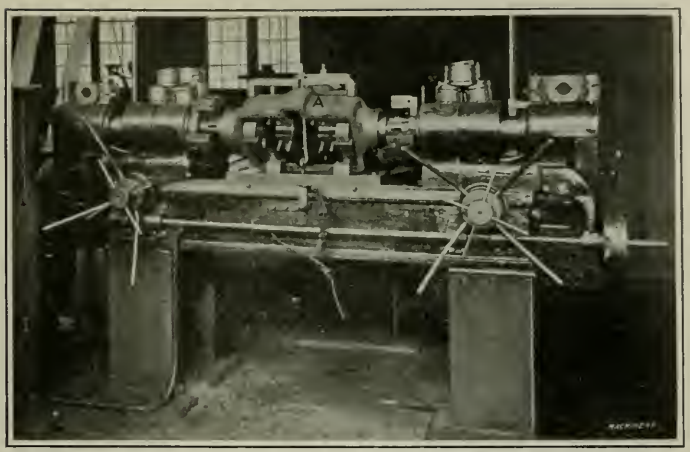


Fig. 4. Triplex Machine for Boring, Turning, and Facing Operations performed simultaneously from Three Directions on a Tractor Transmission Gear Case

Triplex Machine for Boring and Facing Cast-iron Transmission Cases

All of the machines which have been previously discussed have been so designed that provision is made for operating simultaneously from two sides of the work. In Fig. 4, there is shown a special machine designed for operation on transmission cases of the form illustrated at *A*, which makes it possible to work simultaneously from three sides of the casting. No emphasis need be laid upon the saving of time that is accomplished by such a principle of machine design. On this machine it will be evident that the arrangement of capstan wheels for automatically engaging the drive as the heads are advanced to the work, and for engaging the power feed, is the same as that on the machines shown in Figs. 1 and 3; but in addition, an auxiliary clutch has been provided to enable rotation of the spindle to be stopped at any point without requiring the head to be backed away from the work. As they come to this machine, the ends of the transmission cases have been straddle-milled on an Ingersoll miller, but these finished surfaces are not used as locating points. There is also a flange, shown at *B* in Fig. 6, which has been milled and drilled at a previous operation, and this is used as the locating point. A pad on the fixture engages the milled flange, and holes which have been drilled in the flange receive locating pins.

On these castings the operations to be performed are as follows: At each end of the casting, as shown in Fig. 6, it is necessary to turn the outside diameter of a hub *C* and to bore three holes *D*, *E*, and *F*, and also to face the inside end of a bearing which can just be seen at *G*. Machining operations also have to be performed at the back of the casting (as shown on the machine in Fig. 4), and for this purpose a third head is provided at the rear of the machine, as illustrated in Fig. 5. This head provides for boring hole *H*, Fig. 6, and facing the flange surrounding this hole, and also for facing flange *I*. In performing each of these machining operations, a roughing and finishing cut is taken, and in boring the fits to receive seven Timken roller bearings which enter holes *D*, *E*, *F*, and *H*, and three holes at the opposite ends, corresponding to *D*, *E*, and *F*, it is necessary to hold the diameter within a limit of 0.005 inch.

It will be apparent that in each of the holes *D*, *E* and *F*, one of the cutters is shown in the position it occupies in machining the opening in the work. Then the corresponding cutters for performing the finishing operations in these holes are shown at D_1, E_1, and F_1, respectively. The tool provided for turning the outside diameter of hub *C* is shown at C_1, while the tool for facing the end of bearing *G* is shown at G_1. All of these tools fit over a tapered spindle nose which is provided with keys to drive the tools; and in order to enable facing tool G_1 to reach the desired position on the work, an extension *K* is provided for the spindle, this extension being furnished with a tapered hole that fits over the spindle nose, while there is a corresponding taper at the end of the extension to enter the opening in the facing tool G_1.

Referring to Fig. 5, it will be evident that the head provided for operating on the work from the rear is mounted on ways which run at right angles to those supporting the two heads that operate on opposite ends of the transmission case casting. The rear cutter-head is furnished with a small



Fig. 5. Rear View of the Triplex Boring, Facing, and Turning Machine illustrated in Fig. 4, showing the Head for performing Boring and Facing Operations from the Rear

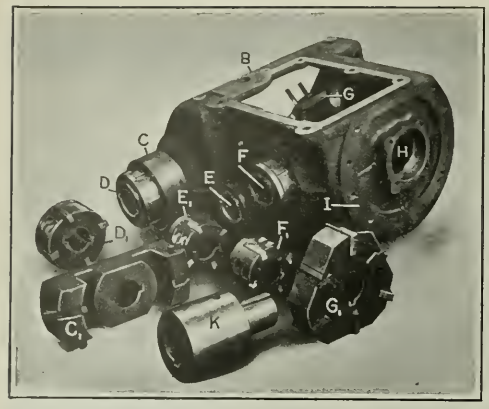


Fig. 6. One of the Transmission Gear Cases, showing the Operations to be performed and Tools used for Various Purposes

capstan wheel *L*, which is used to engage the power feed, and at the front end the spindle is tapered to provide for receiving the boring and facing tools which operate in the hole *H* and on the flange surrounding the hole, as shown in Fig. 6. For facing flange *I*, Fig. 6, it will be seen that there is a facing head *M*, Fig. 5, which is of similar design to the facing heads used on the machine shown in Fig. 2, this head being provided with a tool-block, mounted on a slide and actuated by a star feed that is operated by capstan wheel *N* striking a fixed stop secured to the bed of the machine. In this way the facing operation can be conveniently performed. On this job the rate of production obtained for performing the roughing and finishing operations in all of the different holes and on all of the different surfaces mentioned is twenty-one transmission case castings in a ten-hour day.

Machine for Drilling Cast-steel Caterpillar Shoes

Reference to the heading illustration, which shows a completely assembled Bates tractor, will give the reader a good idea of the way in which the caterpillar treads are assembled on the machine. There are two pivot holes which have to be drilled in each end of these treads, and Fig. 7 shows the work set up on a special machine that was designed and built for the performance of these drilling operations. The pieces of work *A* are mounted on a vertical turret, two of the caterpillar shoes to be drilled being held on each face of this turret by means of a strap *B*. Attention is called to the fact that the holes in the work, shown at *C* and *D*, do not extend all of the way through, so that the four drills carried by the spindles of each of the opposed heads can work simultaneously. In operating this machine the method of procedure is to have an operator stationed at each side. The man at one side of the machine sets up fresh castings in place on the turret while holes are being drilled in castings mounted on the adjacent face of the turret. While this drilling operation is proceeding, the operator at the other side of the machine is also busily engaged removing drilled pieces from the next face of the turret.

After the drilling operation has been completed, the turret locking pin is withdrawn by depressing a foot-pedal shown at *E*, which withdraws the locking pin *F* from one of the steel-bushed holes which are distributed around the turret to provide for locating it successively in the desired positions. The castings which have been set up at one side of the machine are then advanced into the drilling position, and after the turret has been relocated, the heads are advanced to the work and the power feed is engaged, the two operators can immediately busy themselves in setting up fresh castings on the unoccupied face of the turret and in removing drilled shoes, respectively. It will be apparent that a large capstan wheel, of the form mentioned in connection with the machines previously described, is used on this multiple drilling machine for advancing the heads to the work; and a smaller size capstan wheel provides for engaging the power feed. A similar pair of capstan wheels for operating the left-hand head is located at the opposite side of the machine. To provide for feeding the heads along the bed of the machine, the geared drive transmits power to the spindles by means of splines. Also, the spindles carrying different sized drills are driven at suitable speeds to give the proper peripheral cutting speed to the drills. The holes to be drilled are 1 9/16 and 1 1/32 inches in diameter, respectively, there being one hole of each size at each end of the casting. On this operation, the rate of production averages 500 drilled caterpillar shoes in a ten-hour working day.

* * *

INJECTOR FOR LUBRICATING ENGINE CYLINDERS

An injector suitable for feeding lubricants such as graphite, boiler compound, soapstone, and other powdered materials into cylinders, boiler feed-lines, etc., has recently been placed on the market by the Pulso Injector Co., Philadelphia, Pa. Among the various types of apparatus to which this device can be applied are steam, gas, gasoline and oil engines; steam hammers; suction pumps; and hydraulic and pneumatic systems. When graphite is used in the injector, no oil is mixed with it, the claim being made that oil envelops the particles of graphite and tends to prevent them from adhering to the surfaces to be lubricated and from filling up pores and cracks. It is further claimed that pure graphite will readily adhere to metal surfaces and form a veneer which virtually eliminates friction between the moving and the stationary parts. After sufficient graphite has been injected into a cylinder to give the proper amount of veneer, the injector is regulated to feed only enough graphite to maintain this amount.

Some of the reasons why graphite is an especially suitable lubricant for the types of apparatus mentioned are because it is non-explosive, decarbonizing, unaffected by heat, acids, or alkalies, and has no corroding or chemical action. When the injector is placed on pneumatic or hydraulic systems or on boiler-feed lines, it is located on the suction pipe so that the particles of graphite are carried with the air or fluids through the entire system.

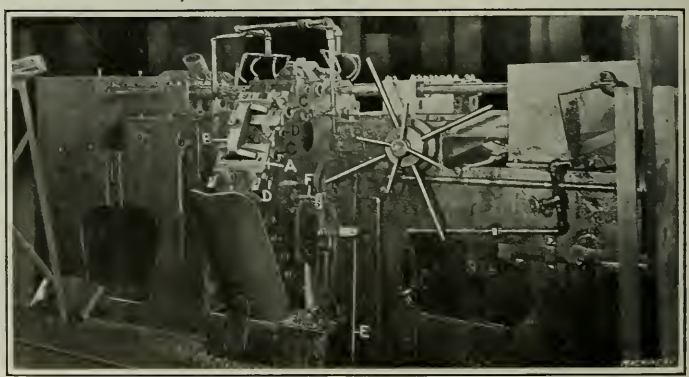


Fig. 7. Continuous Rotary Drilling Machine for simultaneously drilling Two Holes from Each End of Two Caterpillar Tractor Shoes

Relieving Attachment for Lathes

Device for Obtaining the Relief on Teeth of Formed Cutters

A DEVICE which can be attached to any thread-cutting lathe for turning the relief on the tops of the teeth of formed cutters is shown in the accompanying illustrations. This attachment, recently described in *Engineering*, has been developed by E. M. Wildey and is being manufactured by Messrs. Milton, Ltd., London, England. The tool is rocked alternately toward the work in order to produce the relief on each tooth. The attachment does not need to be removed from the machine in order to perform straight turning or threading operations.

Construction of Relieving Attachment

The attachment is designed to be mounted on the cross-slide, the main body *A*, Fig. 1, which is a steel casting, being supported on the gibbed plate *B*. This plate is bolted to the cross-slide. Body *A* is provided with a large hole through which the work, or the arbor on which the work is mounted, passes. Tools *C* and *D* are held in a slot on two oscillating toolposts *E* and *F*, respectively, by means of a nut and bolt. The tools can be operated simultaneously on the front and back of the work, although only the front tool *D* is employed in relieving operations, tool *C* being withdrawn so that it does not come in contact with the work as toolpost *E* oscillates. The toolposts are steel castings and are mounted on shafts *G* which are contained in the lower part of the body casting. These shafts have an eccentric on each end, and by turning these eccentrics, the toolposts are raised vertically. In this way it is possible to adjust the height of the tools to compensate for grinding. Transverse adjustment of the tools is effected by means of a stud *H*, which is fixed in each toolpost, and a knurled nut *I* mounted on each stud.

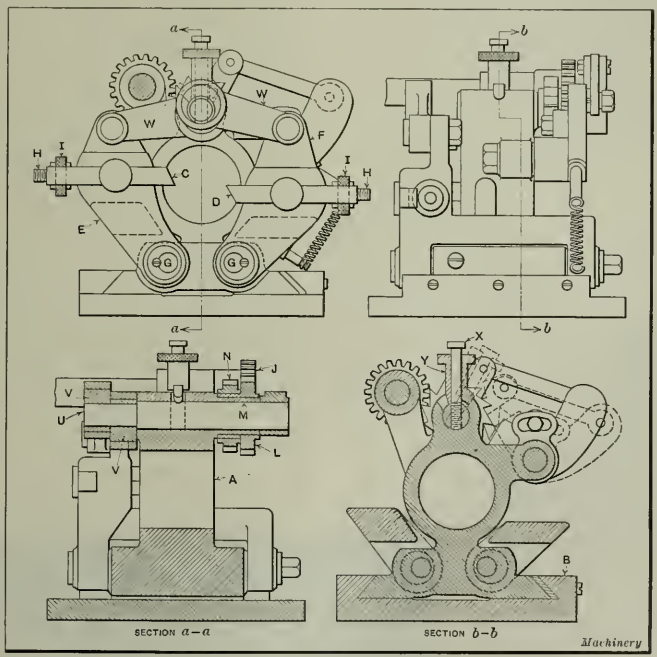


Fig. 1. Device designed for turning the Relief on Formed Cutter Teeth

The manner in which the rocking movement is given to the toolposts is as follows: The relieving attachment is driven by gears and a shaft which transmits motion from the faceplate of the lathe to gear *J*. The key of gear *J* slides in a long keyway on the driving shaft, thus permitting the whole attachment to follow the traverse of the lathe carriage in thread-cutting or other operations. Gear *J* meshes with gear *L* which is a loose fit on shaft bearing *M*. A ratchet-toothed cam *N* is secured on the hub of gear *L* and rotates with it. Cam *N* rotates at the same speed and in the same direction as the work, and has the same number of teeth as the work. The actual diameter of the cam and the shape of the teeth are immaterial, but the teeth must be similarly spaced to the teeth on the work and have feather edges. Special types of reamers and cutters in which the teeth are unequally spaced can also be relieved, but the teeth of the cam must, of course, be spaced correspondingly.

The teeth of cam *N* engage with an adjustable pawl mounted on one arm of the bellcrank lever *P*, Fig. 2, which is pivoted on body *A*. As the cam rotates in the direction indicated by the arrow, the arm of the bellcrank lever is pulled downward until the pawl escapes from one of the cam teeth, after which it is pulled up into engagement with the next tooth by the action of the light compression coil spring *Q*. The combined effect of the cam and spring is to impart an oscillating motion to the bellcrank lever. There is a groove in the opposite arm of lever *P* in which block *R* can be clamped in any position. One end of link *S* is connected to block *R*, while the other end is attached to arm *T* which is keyed on shaft *U*. Through the medium of these parts, the oscillating motion of the bellcrank lever is transmitted to shaft *U* and also through eccentrics *V*, Fig. 1, and links *W*, to toolposts *E* and *F*. A short spring *X*, Fig. 2, is placed between a projection on the toolposts and the main casting to take up any lost motion due to wear of the links, etc.

It is obvious that the position of block *R* in the groove of lever *P* determines the magnitude of the angular oscillations of shaft *U* and consequently those of the toolposts. However, by adjusting block *R*, the amount of relief can be varied independently of the shape of the cam. The actual amount of relief is indicated by a graduated scale on the arm of lever *P* which gives the amount of relief in millimeters. The oscillating motion, of course, ceases entirely when block *R* is brought down to the center of oscillation of the bellcrank lever, and this enables plain turning or thread-cutting operations to be performed without removing the attachment from the lathe. The forward and backward movement of the tool used for relieving is ordinarily limited by bolt *X*, Fig. 1, which is screwed into shaft *U*, and the

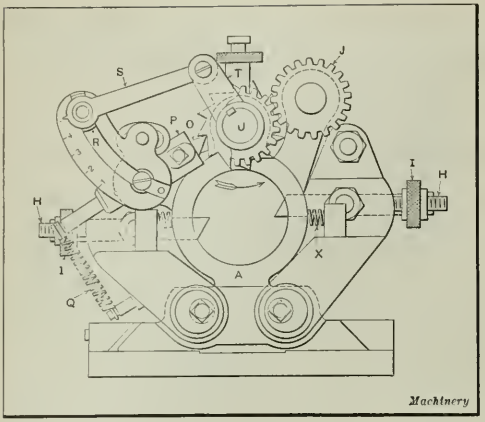


Fig. 2. View of Right End of Attachment showing Oscillating Mechanism

sliding sleeve *Y* which is mounted on the bolt. The lower end of the sleeve is machined to suit a slot in the main body casting, and the movement of the tool is limited by the sleeve coming in contact with the ends of the slot. The tool, however, can be brought sufficiently clear of the work to permit the lathe carriage to be returned to the position for commencing a new cut, without altering the setting of the tool in the toolpost. This is accomplished by withdrawing sleeve *Y* from the slot in the main body, which permits spring *Q*, Fig. 2, to swivel lever *P* on its bearing into the position indicated by the dotted lines in section *b–b*, Fig. 1. This effects the withdrawal of pawl *O*, Fig. 2, from engagement with the cam and permits a greater motion to be given to shaft *U* by moving block *R* in the groove in lever *P*. which, of course, increases the movement of the tool. This is particularly advantageous when relieving threaded hobs.

Application of the Device for Straight Turning and Threading Operations

As previously mentioned, only tool *D*, Fig. 1, is used in relieving operations, but when performing plain turning or threading operations both tools are employed. In the latter case it is convenient to be able to feed both tools into the work simultaneously and to withdraw them together at the end of a cut. To accomplish this purpose toolpost *E* is connected to the oscillating mechanism in a similar manner to toolpost *F*. When operating both tools, the pawl is disengaged from contact with the cam in the way previously described when dealing with the method of backing the tools away from the work in order to return the carriage to the starting position. After the pawl has been disengaged, tools *D* and *E* can be operated simultaneously either forward or backward by simply moving block *R*, Fig. 2, up or down, as the case may be, in the groove in lever *P*. Thus it will be seen that it is a simple matter to adapt the device for straight turning and threading operations.

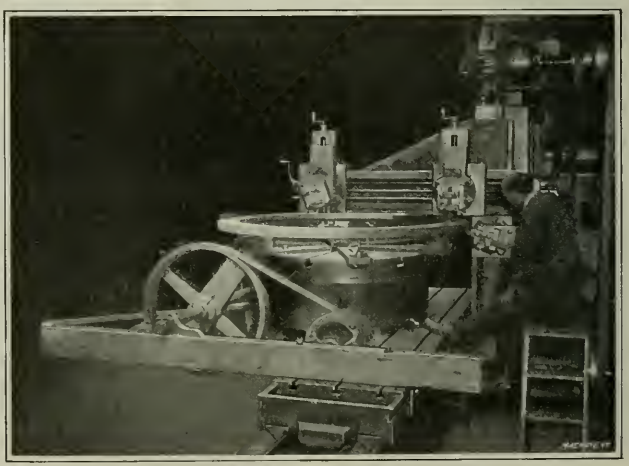
An important advantage of the pivoting tool-holder used in this relieving attachment, over the horizontal slide of an ordinary relieving lathe, is that in the former the tools can be so adjusted that the cutting angle remains constant at all stages of the cut. Consequently, greater cutting efficiency is obtained and a tool with less clearance can be employed. The attachment has been designed for handling work up to 2¼ inches in diameter.

USING AN OPEN-SIDE PLANER AS A BORING MILL

In manufacturing a special universal hobbing machine to generate gears up to 96 inches in diameter and 36 inches face width in the works of the Newark Gear Cutting Machine Co., Newark, N. J., it was found that the large faceplate and the upper and lower rings of the index worm-gear blank were larger than the capacity of the laregst boring mill in the plant. On first consideration, it appeared as though it would be necessary to either have the parts machined in some shop with a larger boring mill, or machine these parts directly on the hobbing machine by equipping it with toolholders and slides. From the accompanying illustration, it is evident that none of these methods were resorted to, but instead a "Liberty" open-side planer was adapted for the work as shown.

This large universal hobbing machine, strictly speaking, was not designed in each particular as a new 96-inch by 36-inch capacity machine, but was in many respects an adaptation of a smaller machine for the work, as it had been determined that the smaller machine was sufficiently rigid and powerful to withstand the strains and stresses and deliver the required power. The work-table of the smaller machine was readily adapted for handling the larger work by mounting a large faceplate on it.

As a larger capacity machine requires an index worm-gear of a larger diameter to maintain the required accuracy, this index worm-gear blank was made of two rings secured to the large faceplate. The problem of machining the faceplate and index worm-gear blank rings was solved by fastening to the planer table the work-table which is to be equipped with the larger faceplate on the new machine. To secure the rotary motion, the hobbing machine work-table was temporarily equipped with the index worm and index worm-gear regularly applied to a smaller hobbing machine. A pulley was placed on the temporary worm-shaft, driven by a motor bolted to the planer table; the only special parts necessary were three supports of wood. The regular planer feeds were used. By performing the turning, boring, and facing of the faceplate and rings directly on the work-table to which these parts were afterward permanently secured, accuracy was more easily obtained than would have been the case had a boring mill been used, and it required but little time to set up the machine for this work. The accompanying illustration shows the upper index gear blank ring being faced and turned on the "Liberty" open-side planer, equipped in the manner described in the foregoing.



Using a "Liberty" Open-side Planer as a Boring Mill in the Plant of the Newark Gear Cutting Machine Co.

MACHINE FOR CUTTING OFF AND COUNTERBORING TUBING

By JOHN A. H. PHILLIPS

In a certain plant, the demand for large quantities of cylindrical pieces led to the designing and building of a special machine, which was equipped with the chuck and counterbore shown in the accompanying illustrations. With this machine, the required pieces were satisfactorily produced by cutting off and counterboring tubing 6 inches in diameter, having a wall thickness of 3/16 inch. In order to meet the requirements, it was necessary that the finished cylindrical pieces be cut to various specified lengths and be accurately counterbored to a depth of 5/16 inch from each end. As the peripheries of the cylindrical pieces were required to rotate concentrically about bearings fitted into the counterbored holes, it was necessary to provide a chuck for holding the work, which would not only hold the tubing firmly and in accurate alignment with the counterboring tool, but which would also bear evenly at all points on the circumference of the tube and at the same time possess sufficient strength to force the tubing into shape in case it should be out of round when inserted in the chuck.

The chuck developed for this purpose, which was found to provide sufficient gripping power, is shown in Fig. 1. As the tubes were held inside the chuck body, this chuck eliminated the necessity of providing any additional means of support for tubes up to 20 feet in length. In order to provide a suitable foundation for the chuck, the head was removed from an old type 16-inch lathe. The tailstock of the lathe, however, was retained in order to provide a suitable means for holding the special counterboring tool shown in Fig. 2. The regular handle was removed from the tailstock and replaced with a 10-inch handwheel in order to give the operator better control over the tool when feeding it forward. The carriage was also retained for the purpose of holding the cutting-off tool, which was of the ordinary forged type. The power feed was eliminated, and a series of gears *F*, Fig. 1, installed to provide a suitable means of driving the spindle from the back-gear shaft at a speed previously found to give the best results. This shaft was equipped with tight and loose pulleys, and a belt shipper *H* was provided for shifting the belt. The bearings were all fitted with bronze bushings, the two spindle bearings being split to allow adjustment for wear.

The chuck, which is of the cam type, is constructed as indicated by the detail and assembly views in Fig. 1. The spindle *A* contains two sets of milled radial slots *I*, which form the bearings for the jaws *C*, of which there are sixteen. These jaws are kept in contact with the cams *L* in the two rings *B* by means of two springs *E*. A thin steel plate *P* is attached to the front end of the chuck body by means of machine screws, in order to keep the front row of jaws in position. Three studs *J* having right- and left-hand threads hold the two cam-rings together. When in operation, the tube is inserted and the screw *K* given about three turns with a chuck wrench. Sufficient gripping power is thus obtained by closing the jaws to hold the work firmly in place without danger of slippage. It will be noted that the adjusting screw acts against the dog *D*, which is bolted to the spindle and which remains stationary, preventing the inner ring *B* from becoming disassembled while both the cam-rings revolve. To remove the tube, the screw *K* is loosened, and a slight downward pull on the wrench is given to free the jaws and release the work.

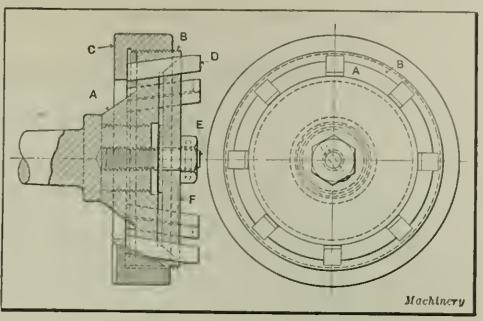


Fig. 2. Tool used to counterbore 6-inch Tubing

A second machine was built soon after the first one was put in operation and after four years of almost continuous service these machines remained in very good condition. One of the machines has been used with equal success on tubing of much smaller diameter by simply making a set of jaws of suitable length.

The counterbore shown in Fig. 2 is held in the tailstock, as previously stated, being prevented from turning by means of a pin located in the shank, which fits into a slot in the tailstock sleeve. The boring head proper is built up of two parts *A* and *B*, in order to facilitate machining. After turning the inner member *A* to the required size and milling the eight cutter slots, the outer section *B* is bored and shrunk on over part *A*. The cutters *D* are hardened and ground all over. After pinning the two body members together, the outer member is turned and threaded to fit the adjusting ring *C*. After assembling the tool, the adjusting ring is turned back as far as possible without subjecting it to the danger of loosening, in which position the cutters are clamped in place by means of screw *E* and disk *F*, and then ground. When the cutters become dull, it is a simple matter to readjust and grind them. In order to move the cutters forward, it is only necessary to loosen the clamping screw and turn the adjusting ring.

The construction of this tool is such that the cutters can be advanced and ground without changing the size of the counterbore. If desired, the diameter of the bore may be changed a small amount after grinding as conditions may require, by simply adjusting the ring. The machine described was provided with two of these tools having cutters 2¾ inches long. One set of cutters in each of the tools was in continual operation for more than a year on work which required the counterboring of 6-inch tubes to a length of 5/16 inch and a depth of about 3/32 inch. By the use of these machines it was possible to attain a production rate of 500 tubes every twenty-four hours.

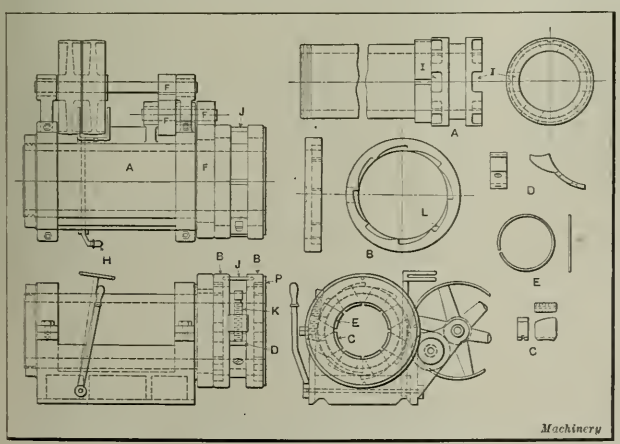


Fig. 1. Chuck employed to hold Tubing during Cutting-off and Counterboring Operations

Simplified Recording System for Maintenance Work

By ARTHUR F. OWEN

IN most factories having a maintenance or upkeep department, the responsibility of the entire factory upkeep is placed on one man, who is usually designated master mechanic or superintendent of maintenance. It is essential that this man be able to ascertain quickly the status of any or all machinery and equipment, either by department or by individual machine. When the production department requests a certain additional piece of equipment or a new machine tool, it is necessary that the cost of upkeep and repair, as well as the initial cost, be carefully considered. It is well known that certain makes or types of machines of standard sizes and capacities prove superior in economy, on account of the low erection and repair costs. For this reason records showing these data are invaluable to the maintenance superintendent. There is also a further use for this information, namely, it can be used to check time slips turned in by the repair and erection crews on similar repairs or erections at a later date. A simple filing card such as shown in Fig. 1 gives all necessary information regarding the upkeep cost of the individual machine or appliance. This card, as will be noted, has spaces for the time used in making the repairs, etc., so that it gives a complete record of the actual upkeep cost of the individual machine. In most shops the machines are numbered, and this number, as well as the number of the department and the general description of the machine, should appear on the card. Then by referring to a general lay-out drawing, the maintenance superintendent can readily ascertain the location of the machine, etc.

146 MACH. NO.
6 DEPT
Atlas 14 Spindle Drill DESCRIPTION

MAINTENANCE RECORD

DATE	REPAIRS	CAUSE	PARTS USED	MAN NO.	TIME
5-26-18	Feed gear	Operator	Feed gear and key	1868	3 hrs 15 min
6-14-18	Feed shaft bush	No oil	Bushing	1868	1 hr 35 min
7-18-18	Counterweight chain	Wear	New chain	1868	7 hrs 30 min
7-20-18	Oil pump clogged	Waste in oil tank	None	179	15 min
9-16-19	Feed gear	Operator	Feed gear	1600	3 hrs 45 min
					Machinery

Fig. 1. Sample Filing Card showing Upkeep Cost of Drilling Machine

The maintenance departments of large and medium-sized plants are usually composed of millwrights, belt men, tinsmiths, plumbers, electricians, yard men, laborers, sweepers, and janitors. The great variety of work which this department handles makes necessary a simple system of reporting and recording work to be done. For this purpose the card shown in Fig. 2 may be supplied to department foremen. When a machine is to be repaired, a belt tightened or replaced, a new electric light installed, or any other job which is taken care of by the maintenance department needs to be done, the foreman of the department requiring this work simply fills in the machine number, department number, and date, and checks the nature of the work wanted. He then turns the card in to the maintenance department, where the job is numbered and a man, or gang of men if necessary, is despatched to attend to the work. The workman's number is entered on the lower portion of the card, and this portion is torn off and given to him so that the time consumed in making the repair can be entered on it by him upon the completion of the work. As the material used on any repair job is usually withdrawn from stock on a requisition stating either the job number or the purpose for which it is to be used, it is unnecessary for the workman to make any record of stock used on the job. At the time of assignment, the upper portion of the card is either hung upon a board, each card being placed on an individual nail assigned to the workman; or, the cards may be filed in a rack where they are instantly available. These upper portions of the cards show, at a glance, just where each job with its workman or crew of workmen is located, and the work they are engaged in; hence it is a comparatively easy matter for the supervisor or foreman to determine where men may be obtained to meet an emergency or breakdown, with the least inconvenience or hindrance to production.

When the repair job is completed, the man in charge of the work turns in the lower portion of the card with the time consumed entered upon it. The upper portion is then stamped "Completed," and returned to the foreman in whose department the work was done, giving him a record of its completion. The advantage of this method over the older system of written orders and requisitions, with the troubles caused by lost orders, illegible writing, and consequent misunderstandings, is apparent. Furthermore, it is a constant reminder to the maintenance superintendent of the work in progress and its urgency. Of course, on large erection and installation jobs, which require the services of a large crew, an additional card may be attached with a paper clip, showing material ordered, sequence of the operations to be performed, and the names of the men in each branch or trade who are responsible for carrying out the work.

Besides a system of notification and record of maintenance jobs, data should be gathered as to the speeds, sizes, etc., of lineshafts in each department, electric motor equipment, etc. These data are absolutely essential to an efficient maintenance department, and if not at hand, a check of the lineshaft speed by a millwright or other mechanic, consuming anywhere from fifteen to forty-five minutes, must be made when ordering new equipment. It is commonplace things like these that are so apt to be slighted in maintenance work. Drawings showing machine lay-outs, pipe lines, and sizes and locations of valves, etc., are time-savers, and if they are drawn to scale, many accurate estimates of proposed changes or extensions may be made from them, which will eliminate considerable tedious measuring and tracing of existing lines. A simple set of standard bolts, struts, and beams with which to hang countershafts may easily be prepared for use in plants where some uniformity of structural details in the different departments or buildings exists. Of course, in countershaft erection, many deviations may be expected, but the time saved in laying out and measuring, and procuring suitable materials is greatly reduced by keeping on hand a supply of standard bolts and beams of various sizes and lengths.

WORK REQUISITION

146 MACHINE NUMBER — 6 DEPARTMENT — 5-26 19-18 DATE

✓	MACHINE REPAIRMAN	✓	HOLDING UP PRODUCTION
	BELT MAN		URGENT
	OILER		REGULAR
	ELECTRICIAN		NOON HOUR
	PLUMBER		OVER-TIME
	TINSMITH		NIGHT
	CARPENTER		SUNDAY
	LABORER		WARNING ONLY
	SWEEPER	✓	SEE DEP'T FOREMAN
	SPECIAL		
	SPECIAL		
	STAMP WHEN COMPLETED COMPLETED		

NATURE OF WORK- feed gear broken must be repaired or replaced

Robt Miller FOREMAN

TEAR HERE

146 MACH. NO.	6 DEP'T	741-A JOB NO.	5-26-18 DATE

WORK DONE

DESCRIPTION	MAN NO.	TIME
Put in new feed gear and key	1868	3 hrs - 15 min

REMARKS- feed gears O.K. but operators are careless in this Dept

Machinery

Fig. 2. Card supplied to Department Foremen on which Requisitions for Repairs are written

Oiling is a task usually performed by one or more men, who are constantly going from one department to another. Sometimes they are responsible for the polishing of the shafting as well. Usually these men are proficient and rarely skip a bearing, but there is a possibility, in the event of a new man being employed on the job, that bearings will be passed over without oiling. In one large plant, a complete oiling schedule was worked out, which not only furnished the oiler with the requirements in each department, and scheduled or arranged his work so that all bearings were oiled regularly, but also enabled the maintenance superintendent to locate his men at any time during the day.

The department bulletin board is almost an absolute necessity in maintenance work. On it may be posted the names or numbers of workmen wanted for over-time work, etc., also information which should be generally known to workers in this department. As the workers are usually scattered over the entire plant during working hours, the superintendent will find the bulletin board a convenient means of giving out such information as will be helpful to the department in general. By using a few simple methods of control, such as are here mentioned, the work of the maintenance department can be made more efficient, the production of the plant thereby assisted and increased, and the overtaxed superintendent of maintenance relieved of a great mauy worries.

* * *

A computation of the distribution of the various metals in the crust of the earth indicates that about 1½ per cent of the weight consists of iron and about 5 per cent of aluminum. Of the various chemical elements, oxygen enters into the crust of the earth, into water, and the atmosphere to a weight of more than the combined weight of all other elements, and hydrogen is about 16 per cent of the total.

SLIP-FRICTION WRENCHES

By GEORGE C. HANNEMAN

The extreme amount of care and accuracy required in the construction of airplane motors is quite well known. The production of these motors in large quantities during the war led to means being devised for obtaining an even amount of tightness in the bolts which secure the main crankshaft bearing caps in place. This point, which caused considerable trouble, would not have been noticed on the average kind of work, but since extreme accuracy must be maintained in these bearings it was found necessary, when placing the crankshaft in position, to devise a wrench which would tighten these bolts to the same degree as was obtained in the final reaming operation.

Experiments were made with various forms of slip-friction devices—cylindrical, flat disk, and cone, in combination with a T-socket wrench. It was found that the type of wrench shown in Fig. 1 gave the best results and that it was possible to set the friction to release within narrower limits than could be obtained by the use of any other type, and also that it would hold its adjustment longer after having been set. This wrench consists of a socket *A* which fits the nut and which may be made either in one piece as shown, or as a two-piece construction; in either case there should be a cone at its upper end as shown in the illustration. The cone is held in the holder *B* by means of the retaining collar-nut *C*, and is locked by means of the check-nut *D*. Between the sides of the cone and the conical seat in the holder a liner of thin sheet fiber is interposed as at *E*, and a fiber washer *F* is also employed in the retaining collar as a seat for the head of the cone. The fiber should be filed smooth before being used. By adjusting nut *C*, the wrench may be set to slip when the nut on the motor is tightened to a predetermined degree.

Various lubricants were tried on the fiber contact pieces, with the result that the best lubricant for increasing the length of service to which the wrench could be subjected without requiring adjustment was found to be dry graphite. Greases and oils caused the wrench to stick when being used after lying idle for some time.

Method of Setting Wrenches so as to Produce Slippage when Subjected to a Known Torsional Stress

The construction of the wrench, however, did not entirely solve the problem, because it then became necessary to determine just how much stress was required and to devise the means for setting the wrenches to correspond with this known amount. This would enable quantities of wrenches to be adjusted to the same degree so that each workman could be supplied with an individual wrench, interchangeable, so far as slippage was concerned, with all the others in the factory. To measure the amount of torsion required to cause the wrench to slip, the gage shown in Fig. 2 was devised. This is simply a tension spring stretched by a lever

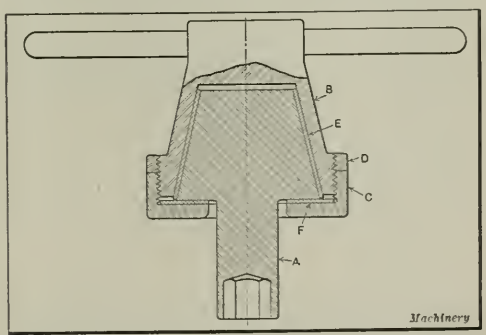


Fig. 1. Socket Wrench designed to slip when a Certain Amount of Stress is applied

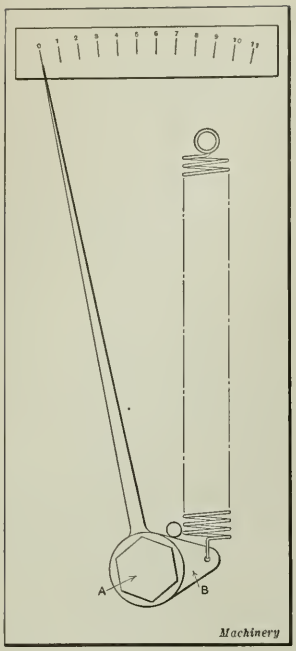


Fig. 2. Gage for measuring the Amount of Torsion which will cause Slippage in Wrench

arm *B*, and operated by the friction wrench. The wrench is simply set over the nut at *A* and turned until it slips, causing the pointer to move across the graduated scale until slippage occurs; the more the wrench is tightened, the further the pointer will move across the scale. By adjusting the collar and nut on the wrench, slippage can be made to take place at any desired torsional stress.

The graduations on the scale read directly in foot-pounds of torsion, and are located on the gage by means of the arrangement shown in Fig. 3. This consists simply of a bar having a hexagonal hole in one end which fits over the nut *A* of the gage shown in Fig. 2, and which has a small round hole located 12 inches from the center of this hexagonal hole. The lever is placed on the gage, a spring scale hooked in the round hole as shown in the illustration, and the foot-pound graduations marked off on the scale of the gage to correspond with the spring scale readings; that is, 1 pound on the spring scale represents 1 foot-pound on the gage, etc. In this way every wrench can be set to the same degree, with the assurance that uniform results will be obtained with any of the various wrenches employed. The operator must, of course, be instructed to turn the wrench until it slips. All the wrenches are numbered, inspected every morning, adjusted when required, and a written report made showing both the condition in which the wrench was found when inspected, and the condition in which it was placed by the inspector. The accuracy of the wrenches will vary when new for the first few days, but after they have been used and limbered up a little very little adjustment is required. In order to be sure that the action of the gages is correct, they should be checked occasionally by means of the lever and spring scale, as described in connection with the illustration Fig. 3.

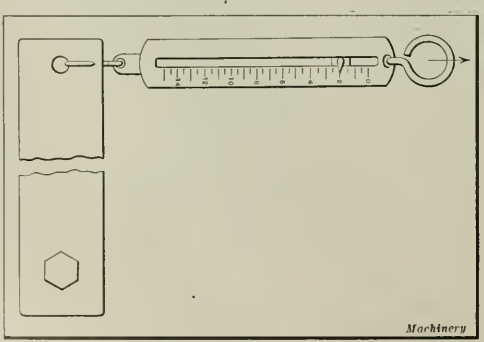


Fig. 3. Simple Method used when graduating Test Gage Scale shown in Fig. 2

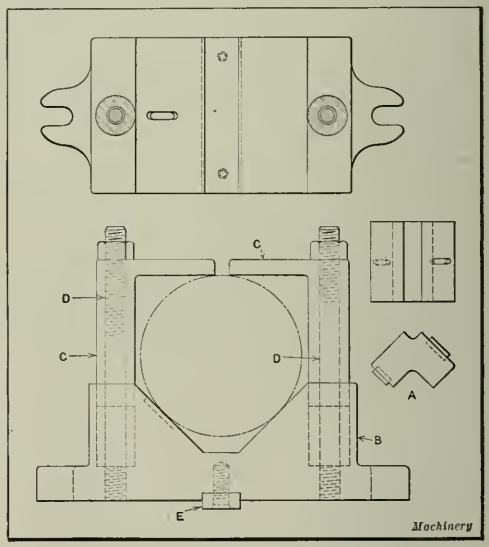
Stud-setting

Another use to which this type of wrench may advantageously be put is setting studs. The difficulties commonly experienced in this work were almost entirely obviated by the use of the slip-friction wrench. These wrenches were made the same as those shown in Fig. 1, except that a spring-action automatic drill chuck was fitted to the lower end in place of the regular socket. Each man was provided with one of these wrenches and each inspector was also furnished with a wrench, different from the workmen's wrench only in that it was set to slip when subjected to a smaller amount of torsion. Thus, if the inspector found it possible to turn a stud with his wrench it showed plainly that the workman's wrench had not been turned sufficiently to slip.

* * *

V-BLOCK FOR MILLING OPERATIONS

The accompanying illustration shows a type of V-block which has proved useful in performing several operations on milling machines. Before using V-blocks of this design, the writer had considerable trouble in keeping the work from shifting while milling long keyways in shafts. However, by the use of a number of the V-blocks illustrated, which were spaced along the length of the shaft, no trouble from this source was experienced and the machining of the work was



V-block used in milling Splines on Cylindrical Work

readily accomplished. The number of V-blocks required for holding the work depends upon the length of the shaft and the depth of cut to be taken.

The device consists essentially of a base *B*, which has a V-groove on the upper side, and clamps *C*, which secure the work to the base. These clamps extend into counterbored holes in base *B*, and are tightened on the work by means of the nuts on the screws *D*, which are attached to the base. The tongue *E* provides means for aligning the V-block with the table of the milling machine. This tongue is removable, so that one of another size and shape can be substituted when it is desired to place the V-block on a machine table having either narrower or wider slots. A small reversible block, drawn to a smaller scale than the V-block, is shown at *A*. This block is machined to fit the groove in base *B* and is provided with keys that fit a corresponding keyway on one of the groove surfaces. By means of this reversible block, the larger V-block can be readily made to accommodate work of smaller diameters. R. F. M.

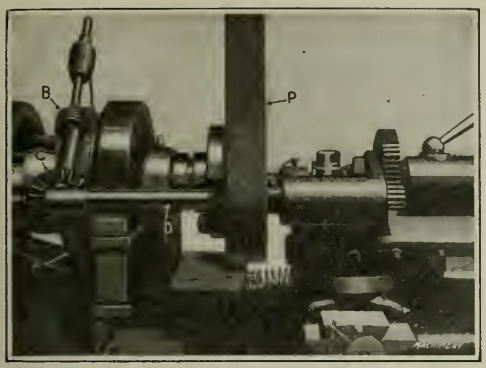


Fig. 1. Thread Milling Attachment used to rough-mill Gage Blanks

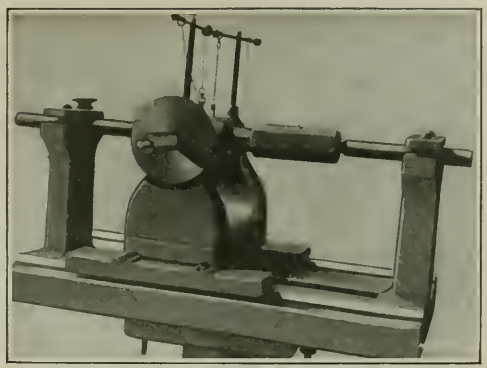


Fig. 2. Apparatus employed in testing the Pitch and Root Diameters

Making Whitworth Thread Gages

Method which Utilizes the Disintegration of the Grinding Wheel During the Grinding Operation to Produce the Final Thread Form

By C. EDGAR ALLEN

ONE of the mechanical problems met with in Great Britain during the war was that of producing plug gages for Whitworth threads in large quantities within the required limits of accuracy. The difficulties that are usually experienced in the quantity production of parts having this form of thread are considerably increased in the manufacture of these gages, due to the fact that the threads become distorted by the hardening process and must be finished by either lapping or grinding. While accuracy and surfaces of good quality are obtained by lapping, the rate of production by this method is slow, and for this reason it was apparent that some other method of truing the threads must be resorted to in order to produce the gages rapidly.

It was evident that if some satisfactory means of grinding the threads accurately could be found, the problem would be solved. While the United States form of thread is often ground, the problem of grinding the Whitworth form is more complex on account of the rounded crests and roots of the latter. For this reason, the United States form of thread can be more readily produced by a form grinding wheel than the Whitworth, and the wheel dressing fixture used in connection with grinding the former type of thread can be of a much simpler design than the device necessary to true the wheel used for grinding Whitworth threads.

After considerable experimenting, J. H. Jones, of Newport, England, developed a method by which Whitworth threads could be ground to the correct contour. This method is based upon the fact that while a grinding wheel having a simple angular edge loses its edge by wear, it nevertheless gradually assumes a shape which will produce an approximately true tooth form. At first the experiments along this line were unsuccessful, but it was finally discovered that by using a wheel to grind the root forms and sides of the thread, and another wheel to form the crests, the true thread form could be produced.

Process Employed in Grinding Threads to Correct Form

In grinding a thread that has been rough-shaped by milling, a wheel, the edge of which has been dressed to an angle as shown at *A* in Fig. 3, is fed into the work and traversed through the threads. After the wheel has traversed across the thread several times, the edge becomes rounded as shown at *B*. The wheel is then again dressed to a fine angular edge and the process repeated until the sides and root of the thread reach the required form and limits. Suitable adjustments of the work and wheel speeds are necessary in order to give the requisite initial wear, and special conditions of rigidity and accuracy are required in the mounting of the wheel. The crests of the threads are produced in a manner similar to that used to generate the roots and flanks except that the face angle of the wheel is enlarged to 85 degrees or more in order to provide contact with two adjacent crest corners. After a few traverses of the wheel, the condition of the crest becomes similar to that of the crests on the threads to the right of the wheel shown at *C*, which are roughly polygonal. The curvatures on the wheel and the work gradually develop after repeated traverses of the wheel until the edge of the wheel and the crest of the thread become as shown at *D*. Finally, the thread is produced to the true form which is shown at *E*, while a corresponding concavity is produced on the edge of the wheel. As in the previous operation, occasional applications of a wheel dresser are necessary to restore an easy wearing condition on the wheel.

Continuous inspection of the work is necessary until the required form and limits have been reached, and it is the exactness of this process of inspection rather than the actual manipulation of the machine employed in grinding the threads that determines the accuracy of the work. For this reason, women operators, suitably selected and trained, were found satisfactory.

The process just described has been criticized because it belongs to the "cut and try" category, and is therefore lacking in those positive features so desirable in quantity production. The same objection, however, may be urged against lapping and, in some cases, even cylindrical grinding, since the progress of such work must also be continually tested by a working gage or some suitable gaging method. This much may be said, however, that whatever drawbacks the method may have, the results achieved entitle it to recognition. During a period of three years, from 150 to 200 hardened gages were produced per week by two shifts of 15 girls each, and 95 per cent of these gages were passed on the first test. Besides this, the process received the commendation of the National Physical Laboratory of Great Britain.

Gashing Thread Gage Blanks Preparatory to Grinding

Before grinding, the gage blanks are roughly gashed out by thread milling. This operation is performed on a 7-inch tool-room lathe, equipped as illustrated in Fig. 1. A worm-wheel *A* is placed on the largest step of the cone pulley. Meshing with the teeth of this worm-wheel is a worm *B*

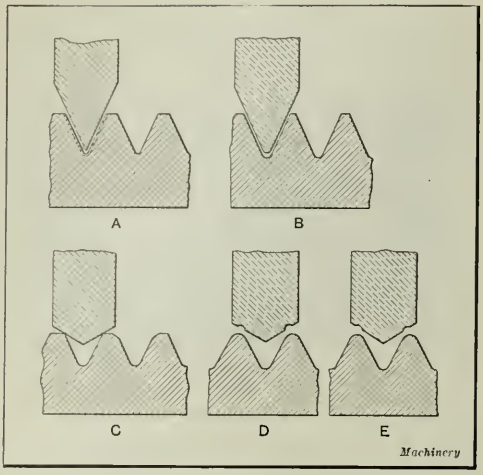


Fig. 3. Diagrammatic Representation of the Formation of Roots and Crests with the Corresponding Development of Curvature in the Wheel

that is held in engagement by a weight attached to one end of its supporting shaft. The worm sleeve terminates in a bevel pinion *C* which engages with another bevel gear on the horizontal shaft. The latter passes through a bracket on the top slide and supports a spur pinion on one end of the slide which drives the cutter-spindle through an idler gear. Traverse of the cutter is obtained by the ordinary saddle movement, through the lead-screw, change-gears, and cone pulley. The lathe is driven by the pulley *P* and the mechanism described. This attachment can be quickly removed from the machine, thus readily adapting it for the performance of ordinary work.

In the preliminary thread milling operation, the gage is machined to very nearly the correct root and pitch diameters, or to within, say, 0.010 inch on a 2-inch gage, while the outside diameter is left the same amount greater than the finished size. The gage thus prepared is carburized and hardened by quenching at a full cherry red heat.

Machine Used for Grinding Operations

The machine designed by Mr. Jones for grinding threads by this process was built by Drummond Bros., Ltd., Guildford, Surrey, England, and is illustrated in Fig. 4. The general features of this machine are similar to those of that class of grinding machines in which the wheel-head and its slide are held stationary while the work-head and tailstock are mounted on a slide which traverses to and fro past the wheel. As the grinding wheel must pass through the entire thread of the gage, the rotation and traverse of the work must be in correct relationship with the pitch of the thread being ground. To effect this, the lead-screw principle was adopted but without the use of change-gears, which means that a special lead-screw is required for each pitch to be ground.

This screw, the end of which is seen at *S*, is of sufficient length to provide the necessary travel for the work to be ground, which is about 3½ inches. It is mounted in a direct line with the work axis, thus giving direct control and obviating errors resulting from uneven feeding due to twisting stresses on the slides. A buttress thread is cut on this master screw because the force to be resisted from the tailstock always acts in the same direction. The screw is connected with the front work-spindle which runs in a bearing in the headstock. The driving mechanism of the screw consists of a cross-shaft driven by open and crossed belts through the pulleys *P* and their clutches. A worm is mounted on the cross-shaft which meshes with a worm-wheel on the spindle. Flywheel *F*, which is mounted on the front end of the cross-shaft, is provided for overcoming the inertia of the reverse movement of the machine. This reversal is obtained through the levers *L*, which are connected by rods and a cross-member to an extension of the spindle, so that at the termination of the traverse, the forward and reverse clutches of the pulleys *P* are alternately operated through the shaft *Q* and its connections. It will be seen that by these means the work is traversed past the wheel and back again, thus permitting grinding during both travels. Spring pressure was first adopted to hold the tailstock center up to the work, but it was found subsequently that in view of the special need for accuracy in replacing the work correctly, after it had been removed for testing, greater constancy was obtained by employing a gravity arrangement consisting of a weight and a series of pulleys.

The compound rest *R* is stationary during the operation of the machine, as previously mentioned, and carries the wheel-head on its top slide. Adjustment of the cross-feed is obtained by means of a screw of fine pitch and a graduated dial. The wheel-spindle is mounted in three-point ball bearings specially designed to eliminate vibration and end play. The wheel is roughly adjusted lengthwise to position by the lever *H*, which operates the supporting slide *A* through a rack and pinion. After the slide has been roughly located, it is locked in place by the handle *J*. Fine adjustment of the wheel lengthwise is obtained by a movement of the lower slide of the compound rest through a screw and handwheel *B*. No special provision has been made in the rest for setting the wheel over to the helix angle of the thread, as it is one of the peculiarities of this method of grinding that a very slight set-over suffices to secure the elimination of the differences in the respective flanks being ground, which show up if no such adjustment is made. The required set-over is secured by using different thicknesses of packing inserted under one end of the lower slide.

The grinding wheel that was used on a gage having 14 threads per inch was a Norton 6-inch, 80-grit, 2½-grade, elastic type, which ran at the rate of 4000 revolutions per minute. The grade of the wheel employed depends to a considerable extent on the pitch of the thread; because, while a soft wheel is suitable for a coarse pitch, a fine hard wheel should be used for a fine pitch. The wheel is sup-

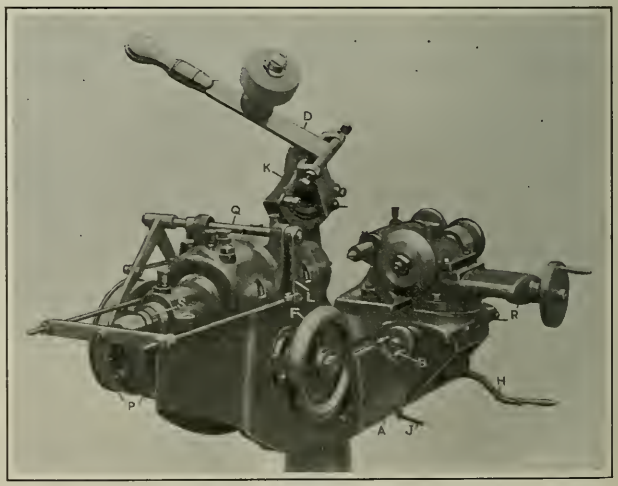


Fig. 4. Grinding Machine used for grinding Plug Gages

ported by a pair of aluminum clamp washers, 3½ inches in diameter. As the wheel is subjected to side thrust, it was necessary to extend the support of these flanges to as near the edge of the wheel as possible, their diameter being determined by trial. It was found that if the diameters of these flanges were too small, considerable variation in the thread angle resulted, due to wheel flexure. The periphery of the wheel is dressed to the required angle by means of a dresser which is mounted on the arm *D*. Excellent results are obtained by this simple arrangement, as it allows the wheel to be dressed to a fine edge without chipping. The arm is held between centers on a quadrant bracket *K*, about which it can be swung to within the limits imposed by stops which are set to produce the required angle on the edge of the wheel. Very little practice is required to enable the operator to handle this dressing attachment capably, and it takes only a few minutes to secure the requisite truth of angle and fineness of edge.

Microscopic Examination During Grinding Operation

A V-edged grinding wheel, as shown at *A* in Fig. 3, which is dressed to the correct angle for the flanks of the thread, is used for the first grinding operation. A selected number of gages—for example, ten—should be ground in succession, applying the same number of cuts to each member of the series before proceeding to the next. The grinding throughout is dry and is conducted in two operations, each on a separate machine. In the first operation, the milled thread is corrected to the required limits in respect to five elements, namely, root form, root diameter, pitch, angle, and pitch diameter. After a few traverses of the wheel, the work is taken out, and the operator tests the progress of the grinding by using a microscope for the general observation of the form of the thread, for checking the root form, errors in angle and straightness of the flanks, and for detecting the existence of local inequalities. In this microscopic apparatus, the gage is held between centers mounted so that by means of screws of fine pitch the gage can be moved in two directions at right angles to the axis of the microscope. A small filament lamp is arranged to project a beam of light along the helix angle of the thread, then the gage is adjusted and the microscope focussed until an image of the profile of an axial section of the screw is obtained. Stretched across the eye-piece of the instrument is a cross-wire, and secured at right angles to the eye-piece is a pointer which moves over a metal scale furnished with adjustable stops which, when set, limit the travel of the pointer. The use of the pointer renders the matter of observation simple.

A standard reference bar, having a V-groove, which has been previously tested and approved by the National Physical Laboratory, is inserted in the apparatus, and the pointer is adjusted until the wire coincides with one flank as shown by wire *O* at *A* in Fig. 5. One stop on the eye-piece is then set to the pointer when in this position, after which the pointer is turned until a similar coincidence is obtained between the cross-wire *P* and the opposite flank, when the second stop is set in this position. After the stops are set, it is a simple matter to place the gage in position and test for coincidence of the cross-wires and flanks. The result shown by the wires *R* and *S* at *B* would probably be obtained by such a trial after the wheel had been traversed once or twice across the roughed-out gage, whereupon the grinding would be proceeded with until a step further toward coincidence of flank and wire was obtained, as shown by wires *T* and *U* at *C*.

The process of wheel-truing is resorted to when the relation between the root and pitch diameters is out of proportion. If the root diameter is too great, a keen edge must be produced on the wheel, while a high pitch diameter is corrected by moving the slide laterally, which causes the wheel to remove material as indicated by the dotted line shown at *A* in Fig. 3.

Testing Pitch and Root Diameters

After reaching the stage shown at *C*, Fig. 5, the gage is tested for pitch and root diameters by means of a measuring apparatus of the type shown in Fig. 2. The gage is held between adjustable centers that are clamped in V-grooves in the uprights. Two other V-grooves are machined in the base to accommodate a sliding saddle, the latter being guided by short cylinders which slide in the grooves. On the top of the saddle is another pair of V-grooves in which run steel balls that support a carriage on which a micrometer is mounted. A graduated dial is fixed on the carriage, and the micrometer thimble carries a pointer. The graduations on the dial correspond to the required readings of the micrometer, so that the amount of excess metal to be removed in order to obtain a true pitch or root diameter is easily ascertained. The needles and vees used for obtaining the measurements are suspended by chains as indicated. Every thread in the gage is successively examined and the grinding operation repeated until the size is within 0.0005 inch, when a final touch of the wheel across the gage generally suffices to give the required dimensions. The sequence in which the series of gages is subjected to the finishing operation by the wheel when worn to its required shape is that in which the gages were operated upon in the preliminary grinding process whereby the wheel became worn. The gage is finally ground on its outside surface to the correct outside diameter.

Thus it is apparent that general reliance is placed upon the standard reference bar and microscopic comparison to secure correctness of root form and pitch, a method which is at once accurate and capable of being put into use by unskilled operators. The same principle of stops and indicators applied to the subsequent testing of the root and pitch diameters renders this operation an almost equally simple matter and well within the capacity of girls who have received

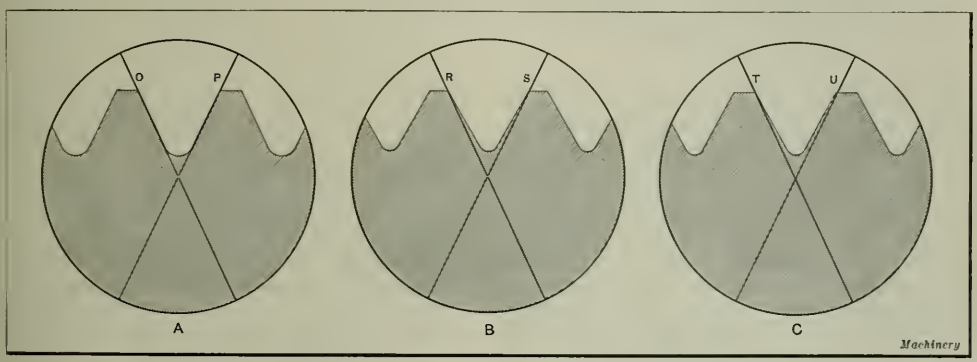


Fig. 5. Successive Stages of the Root and Flank Development as seen through a Microscope

no more than an elementary education. As previously stated, the first grinding operation secures the truth of five elements, namely, form of root, pitch, angle, and the root and pitch diameters. The rounding of the crests and the correct outside diameter are obtained by the second operation.

In this operation a series of gages is ground in succession, as was the case in the first operation. After the wheel has been traversed several times across the first gage, it is traversed a like number of times across each succeeding gage. Supposing the first gage to receive the correct contour were the last one in the series, then every other gage, beginning with the first one in the series, would be treated with the now worn wheel in the same order as formerly. As in the preceding case, inspecting by microscope with the use of a reference gage is resorted to from time to time, the outside diameter measurements being taken with a micrometer. The same method of truing is adopted as in the former instance, namely, a touch or two on alternate faces of the wheel with the dresser, which in this instance is arranged to swing through an angle of 85 degrees to suit the wheel.

* * *

MARKING PATTERNS TO PREVENT IMPROPER CORING

By M. E. DUGGAN

Core-prints on patterns are employed as a means of obtaining an impression in the mold to support the core. The core-print is made to the same sectional dimensions as the core desired if the latter is of a plain design, and so a molder selects a standard core of the same dimensions as the core-print when preparing the mold. When the core is of unusual design, a special core-box must be supplied for producing the core. Patterns having special core-boxes should be marked in such a manner that the molder will readily be made aware of the fact. The location of special cores is often indicated on the pattern by core-prints of the usual type, and unless the molder is notified in some manner, it is likely that a standard core of the same dimensions as the core-print will be placed in the mold instead of the special core desired. In such cases, the loss of the casting is the usual result. The following incident is an example of such an occurrence:

The pattern and core-boxes for a large printing press side frame were sent to a certain jobbing foundry for the production of the casting. This part was to have seven babbitted journals when completed, and a special core-box was required for molding the cores to be used in coring the openings for the babbitt. There was no information on the pattern to warn the molder of the necessity of using special cores, and the core-prints were of the ordinary type. The foreman also neglected to instruct the molder to use special cores, the result being that he selected standard cores of the

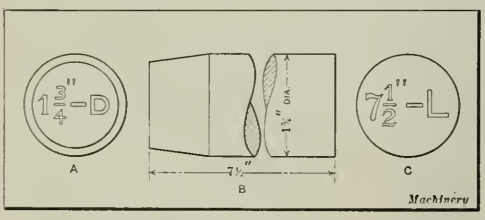


Fig. 1. (A and C) Markings on Core-prints indicating Dimensions of Core to be used. (B) Core furnished when Prints are marked as shown

same diameter as the core-prints on the pattern, and the casting was poured with the wrong cores in the mold.

In order to prevent errors of this sort, all patterns and core-boxes should be so marked that the molder can readily understand what is required. The writer installed the following system in a shop in which he was employed: The dimensions of the core to be placed in the mold are marked on the core-prints when a standard core is to be used, and if there are no dimensions on the core-prints, it indicates that special cores must be used. At *A* in Fig. 1 is shown the manner of marking the core-print on one end of the pattern, the dimension and letter indicating the diameter of the core. The marking for the print on the opposite end of the pattern is shown at *C*, the dimension and letter in this case indicating the length of the core. A drawing of the core which would naturally be selected by referring to the markings on the prints is shown at *B* in the same illustration. The markings on the core-prints eliminate the necessity of the molder measuring the prints when selecting the proper core. When a cored opening does not extend entirely through a pattern, so that a core-print is shown on only one side of

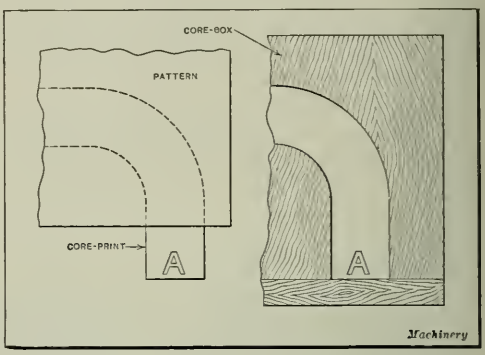


Fig. 2. Method of using Letters to identify Core and Core-box corresponding to any Particular Core-print

the pattern, both the length and diameter of the core are given on the same core-print.

When special core-boxes are required, the core-print and core-box are marked in such a manner that the core-box corresponding to any core-print can be easily determined. The method of identification is illustrated in Fig. 2, in which the core-print on the pattern is marked by a raised letter A. Another identical letter is similarly placed in both molds of the core-box, and after the core is molded and baked it will contain the impression of the letter on each half of the core. This system eliminates the danger of placing the improper core in any of the impressions left in the mold by the core-prints, and assists in the selection and matching of the core halves. Another advantage of marking core-prints and core-boxes is that the employes of the pattern storage loft are enabled to select readily the core-boxes that belong to a pattern, and no time is wasted in searching for special core-boxes when none are required for the part.

* * *

The statement of Dr. Van H. Manning, former director of the Bureau of Mines, in his letter of resignation to President Wilson, when he left the bureau to become director of research of the American Petroleum Institute, relating to the compensation paid to men in government service engaged in engineering and scientific work, deserves publicity. In leaving the government service Dr. Manning wrote:

"There has come to me today the thought that although this Government spends each year many millions of dollars in useful scientific work for the benefit of the whole people, the monetary recognition of its scientific and technical servants is not sufficient to enable them to continue in the service for the people. This has been especially true within the last few years when it has been impossible for many men to remain in the government service. With the marvelous expansion of industry in this country and the growing necessity of science to industry, the scientific bureaus have been utterly unable to hold their assistants against the competition of industry which is taking their highly trained men at salaries the Government does not pay or even approach."

The Problem of Overhead in the Repair Shop

By L. W. ALWYN-SCHMIDT

THERE are examples of well equipped repair shops which have started on a promising basis but which have come to grief because of their inability to show returns commensurate with the investment. In a great many cases, such failures may be traced to the fact that the owners have not given due consideration to the various factors entering into the cost of running their shops. The result is often that men who have started well, and who have had a good engineering education have scarcely been able to eke out more than a mere wage-earner's livelihood from the operation of their repair shop. Failure to make proper charges for services rendered is usually the cause, an example of which may be cited. A small machine shop located in a mixed agricultural and industrial district has been doing general repair work for a number of years. The owner has worked diligently to make his enterprise a success, but he has not prospered in the way he had expected. The capital invested in the plant is gone. If an estimate of his resources were made, this man would no doubt find that he had worked these fifteen years for less than he would have accumulated as a foreman, without the additional trouble and worry connected with a business.

The output of a machine tool shop has a definite selling value, whereas the work produced in a repair shop is more in the nature of selling service and therefore has no standard fixed rate. The cost of a repair job is usually set according to the customary local charge for similar work performed by competing establishments. Customers for whom repair work is being done do not as a rule prefer good work to cheapness, yet this condition is exactly reversed in the case of the purchaser of new tools. This tendency to keep the cost of making repairs down within the expectations of the customer has in many cases proved disastrous to those engaged in this line of business.

Usual Methods of Charging for Repair Work

The case cited is not a rare one and, like many others, is due to a lack of commercial knowledge. This lack of knowledge may be expressed as a failure to make provisions for overhead expenses. The usual method of charging for repair work is to compute the cost of labor and material, and add to the sum an additional 25 or 33 per cent. Another method is to find the sum of the cost of labor, plus 50 per cent of this cost, plus the cost of material. In either case, the additional percentage is expected to protect the owner against losses and to provide him with the necessary profits. It is rarely that the owner possesses a real knowledge of what the labor for each job costs and what charges must be included properly in the overhead. The fact that the proportion of the additional charge frequently varies, indicates that it is unsafe to base the charges for repair work upon either of these rules.

Suppose, in a shop in which six men are employed eight hours per day, that three are engaged on a job for a period of two days. The wage rate being 50 cents per hour, the cost of labor for the entire job would be $24. If 50 per cent of the cost of labor is added, the charge is increased to $36. During the time that these men have been at work on the job, they have made use of the facilities of the shop, they have occupied the building, have used one or more of the machine tools, and a proportionate charge should be made to cover all the overhead expenses such as advertising, taxes, the wages of the owner as manager, etc. Assume that the original cost of equipment is $30,000, the rent $800, and the general overhead $2000. It follows that the sum of these expenditures should be apportioned so that each job will bear its share, which in this case may be assumed at $17 per day. Now since only three of the six men employed in the factory are involved in this particular job, the overhead expenditure will be $8.50 per day or $17 for the entire job. Adding the wage rate of $24 to the overhead expenditure of $17 gives a total of $41, or $5 more than the $36 cost previously estimated.

In other words, the time plus percentage should be increased to equal $41 if the job is to share its proportion of the overhead burden. The case would be similar under any system where the overhead charge is made upon the basis of time and material. In the case cited, no provision has been made for the services of the owner, who is thus rated as giving his work, knowledge, and capital free of charge. This system is weak and should be replaced by one which is simple in application and which will give a more correct result for the cost estimate.

Suggested Method for Estimating Overhead Charges

The cost-plus-percentage rule is not very accurate in its results and is very likely to lead to considerable financial loss if it is used. The main trouble with the system is that not enough flexibility is allowed by the percentage scheme when determining the overhead expenditures. In a machine shop employing twelve men instead of six, as assumed in the example, the overhead cost per man is immediately affected. If, as in the previous assumption, the burden of overhead expense is apportioned at the rate of $8.50 for three men per day, or $2.83 per man, it would equal $1.41 per man, approximately, per day, if twelve men were employed instead of six. It follows that the overhead expenses per man and day decline with every additional man employed in the shop, provided the existing equipment is sufficient and that the employment of extra men does not require any additional expense.

In estimating costs, it is essential that they be based upon the actual proportions of overhead expenditure, determined upon by the time of each man on the job and not by employing an assumed rate, for such an assumption is very likely to be too low. To make a fairly close estimate of what the proportions of overhead expense should be is not a very difficult task. For the purpose of making an estimate, take as a basis the original investment and allow on this amount an interest charge which will insure an income equivalent to that which the money will bring if invested in any other stable business. If the investment is $30,000, as assumed previously in this article, at a rate of 5 per cent the interest charge would amount to $1500. Provision should be made for deterioration of the machine equipment and its maintenance, in the form of an 8 per cent allowance, taking into account the increased re-purchase value when making this estimate. For example, if the equipment was valued at $18,000 at the time of its purchase ten years ago, the present-day cost of the equipment can well be considered as $36,000. The deterioration charges should be based on this figure rather than on the original cost figure, which gives a charge of $2880. To these two items—interest on investment, and deterioration and maintenance of equipment—add such items as taxes or rent, as the case may be, advertising, salaries for salesmen, postage, light, power, and all other general expenditures. This amount should form the basis for the overhead factor which enters into the charge esti-

mate, and should not include labor cost, except that performed for maintenance and similar work; nor should it include the profit of the owner or the cost of material.

Reducing the Overhead by Increased Business

This established overhead affects the daily operation expense, and regardless of the number of men employed in the shop or the amount of work performed, should always be carefully estimated and should be increased from year to year with the higher cost of equipment or with the rising tax or rent rate. It is necessary that it should be checked annually and re-established in the manner just described. The important point to bear in mind is that the overhead expense is borne proportionately by the work performed by each man in the plant and that the more men employed, the smaller the allotment to each. If the overhead is $12,000, and if the number of working hours is 2400 per year, one working hour costs the establishment $5. If ten men are employed, the share of the overhead expense for each man's working hour is 50 cents; if twenty men are employed, the share is reduced to 25 cents. It is a simple matter to work out a standard overhead cost scheme giving the manager or owner the exact figure of how much should be added to the hourly rate of each man employed.

For a shop which normally employs ten men but which has a capacity of twenty men, one rate should be established for use when the payroll carries ten men, one when it carries more than ten but less than sixteen, and one when it carries sixteen or more. This should take care of all fluctuations in number of workmen, for in actual practice the variation in the monthly employment will rarely amount to 100 per cent. In a case where the share of overhead for each working hour is 25 cents, then a job taking three men sixteen hours, would cost an amount obtained by multiplying the entire number of hours used on the job, that is forty-eight, by 25 cents, or $12. To this should be added the wages of the men, the cost of material and, say, 15 per cent profit. Such a system would safeguard the repair shop against danger of failure and would eliminate the possibility of undercharging.

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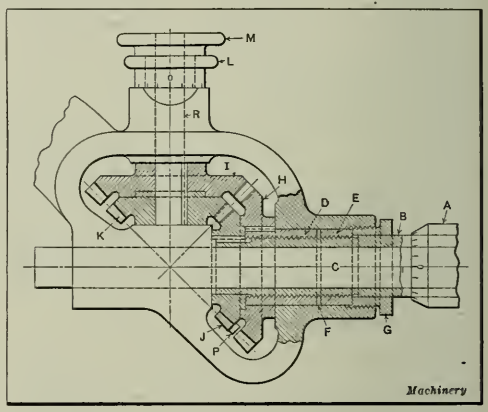
MICROMETER READING DIRECT TO A TEN-THOUSANDTH INCH

By M. JACKER

A micrometer head reading direct to 0.0001 inch, invented by the writer, is shown in the accompanying illustration. The graduated thimble *A* and spindle *C* are the same design as those of any micrometer of standard make. The ten-thousandth inch reading is obtained by a revolving threaded sleeve *B* which, by a sliding key connection with gear *J*, may be revolved by means of the differential gear train shown in the illustration. When the device is properly set, the micrometer can be used just as an ordinary micrometer is used when measuring to thousandths of an inch. When readings of 0.0001 inch are required, the micrometer is set to the nearest 0.001 in the usual way; then by turning the knurled nut *M*, the sleeve and the spindle which is set to the nearest 0.001 inch, is caused to move forward. The reading to 0.0001 inch can then be made direct from the graduations on the knurled collar *L*. Thus it will be seen that the device simply provides a means of advancing the spindle and its holder without disturbing the setting obtained by thimble *A* and sleeve *B*, and that the amount of this additional movement can be read directly in ten-thousandths inch. For instance, if it is required to set the micrometer to measure 1.9001 inches, the thimble on sleeve *B* is first set in the usual way to 1.9 inches; next the zero mark on friction sleeve *L* is set to the index line on the frame, and the knurled nut *M* turned just as if a reading were being taken by adjusting the thimble.

The spindle *C*, as previously stated, is made exactly the same as in the ordinary type of micrometer. The part *B* is also made the same except that instead of being fastened to the frame, it is feathered to the gear *J*, and provided with a threaded portion which screws into the two-part member composed of nuts *E* and *D*. The nut *D* is keyed to the gear *H*, and is separated from *E* by a corrugated spring washer *F* which is so designed that it will transmit motion from one nut to the other, and at the same time take up any lost motion which may result from worn threads. The nut *G* holds the threaded nut *E* in position, and also takes all the thrust from the measuring point. The knurled nut *M* is fastened to a shaft *R*, which, in turn, is keyed to the gears *I* and *K*. The friction collar *L*, on which the ten-thousandth graduations are marked, can be turned to read zero independently of the position occupied by the knurled nut.

Since there are forty right-hand threads to the inch on the lower end of the sleeve *B*, it follows from the way in which the differential gearing is arranged, that twenty-five revolutions of the knurled nut *M* will cause the gear *J* to make one less revolution than gear *H*. This action produces the same result as would be obtained by screwing *B* down one revolution when the two-part member and gear *H* are held stationary, which would cause the spindle and sleeve



Micrometer reading Direct to a Ten-thousandth Inch

to advance 0.025 inch. Thus one revolution of *M* causes the spindle to advance 0.001 inch, and one-tenth revolution advances the spindle 0.0001 inch.

In order to prevent the gears from making more revolutions than is necessary to obtain the required traverse of *B*, relative to the spindle frame, a lug is put on gear *J* at *P*, and two similar lugs are attached to gear *H* in such a position that gear *J* will be permitted to make only about one-eighth of a revolution in relation to gear *H*. This arrangement will permit a maximum travel of 0.003 inch to be transmitted to the spindle by rotating nut *M*, which is much more than would ordinarily be required.

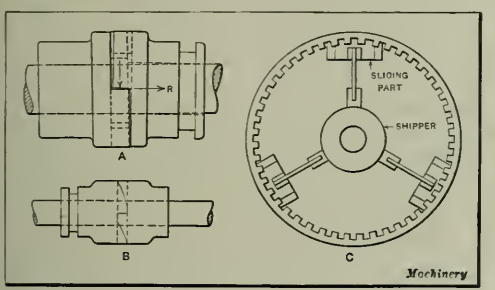
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The relative positions of Germany and France in regard to iron ore resources are at present as follows: Germany, about 1,270,000,000 tons, and France, 5,630,000,000 tons. It is estimated that the production of iron ore in Germany, excluding Luxemburg but including Alsace-Lorraine, during 1913 was 28,608,000 tons, and in France 21,918,000 tons. It is further estimated that at present it is possible for Germany to produce about 7,000,000 tons and that France should be able to produce about 43,000,000 tons, due to the recovery of Lorraine. The coal situation however, is somewhat different, as according to present indications, France will require 40,000,000 tons more than can be produced in her own mines, while on the other hand Germany has sufficient coal resources, but a limited supply of iron ore.

JAW CLUTCHES

By JOHN G. WATTS

The positive jaw clutch, when confined to its proper field and if well made, will perform its service effectively and with very little expense for upkeep. Unfortunately the advantage which may be gained by the use of the jaw clutch has in many instances been overlooked, and as a result it has been superseded to a considerable extent by more expensive types. However, for certain types of duty the positive jaw clutch is efficient, and owing to the simplicity of its design, should receive precedence over the more complicated types. The use of the positive clutch is limited by the fact that the shaft must either be stopped or must revolve very slowly when the clutch is being engaged, but after engagement it may be disengaged without trouble and when revolving at any speed. Although these facts are perhaps well known, it often happens that an expensive friction clutch, for instance, is installed where at much less expense the positive type could have been employed. The factor of expense concerns the installation as well as the upkeep costs. As an example of the type of work for which this clutch is particularly adapted, it may be stated that practically all the winches used on shipboard for unloading cargoes are



Various Types of Jaw Clutches. The Type shown at A illustrates the Effect of Wear on the Efficiency of the Clutch

equipped throughout with jaw clutches. The hoisting engines employed for this work are subjected to severe usage, and since the jaw clutch has proved successful for this particular work it is evident that it should be suitable for similar strenuous service.

The principal requirements for the successful operation of a jaw clutch are that the area of the faces of the jaws be sufficient to transmit the load; that the surfaces be machined so as to contact all over; and that the shaft be strong enough so as not to deflect under load and throw the clutch members out of alignment. If the jaws are not machined so as to give a true contact between the members of the clutch, the points of the jaws will wear and cause an axial thrust which will force the two members apart. This will develop, if allowed to continue, so that the clutch jaws cannot be kept in contact, since the leverage required on the shipper ring to counteract this thrust will be so great that the ring will become heated through friction. Perhaps the greatest difficulty experienced with this design of clutch is due to the fact that the teeth are not always machined, and as a result the load is concentrated on one jaw so that the sliding member is forced out of alignment, resulting in the jaw wearing away, as indicated in the accompanying illustration at *A*.

As this wear increases the axial force *R* also increases, the tendency being to force the sliding member out of contact, which eventually becomes so great as to destroy the usefulness of the clutch. The clutch will not wear itself down to a bearing surface, as might be supposed, for the tendency is for it to become more and more out of alignment, both on the jaws and in the fit on the shaft. Unless all the driving faces have an equal bearing, the sliding member of the clutch will twist out of line when under load and wear the jaws away still more from a plane parallel to the axis of the shaft. Even when the jaws are machined and are in contact, there is still the tendency, because of the projection of the jaws from the body of the casting, for the sliding member to be thrown out of alignment an amount determined by the degree of looseness of this part on the shaft. This is due to the turning moment having a certain amount of leverage. This tendency for the clutch to work out of alignment is cumulative. It is, in fact, upon this very point of machining the jaws so as to keep the two parts of the clutch in alignment, that the success of this type of clutch depends.

In order to prevent this tipping effect, the jaws should not project any more than is necessary to provide sufficient bearing area. The diameter may be made as large as desired. The shipper end member should be designed for two keys (except in clutches of the smallest sizes), which will practically eliminate this trouble and also will provide a greater surface area for resisting the wear which tends to throw the clutch out of alignment. Much less effort is required to operate the clutch when two keys are used.

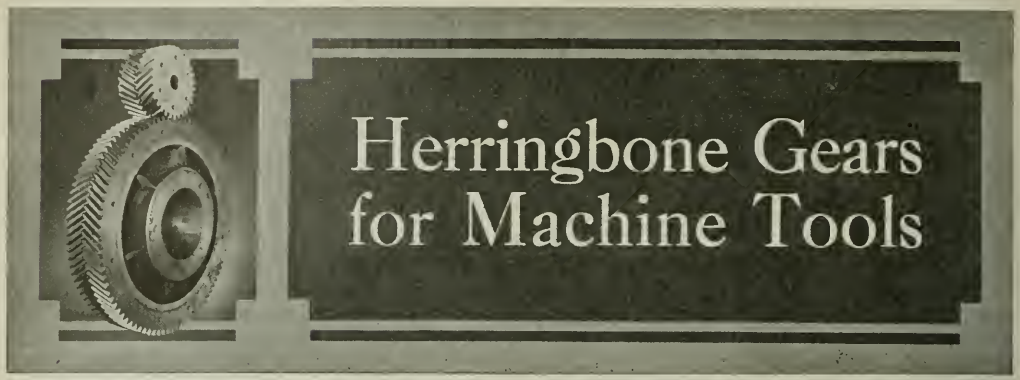
The bearing pressure on the jaw faces should not exceed 2800 pounds per square inch for clutches which are engaged and disengaged when not subjected to load. If the clutch is to be operated while the shaft is in motion, the pressure should not exceed 700 pounds per square inch, as otherwise the contacting surfaces are liable to be abraded. The jaws should have a sufficient area of contact to prevent shearing. The shearing stress should not exceed 2100 pounds per square inch if the load is applied gradually, and not more than 1400 pounds per square inch in cases where there is any possibility of shock. The depth of the groove in the shipper ring should be governed by the amount of bearing surface that is necessary to carry sufficient pressure to throw the clutch into and out of engagement. The pressure on the bearing surface should not exceed 50 pounds per square inch.

When the clutch is not operated under load, the force required to move the sliding member is that due to the friction between this part and the shaft and keys, and is equal to the weight of the sliding member multiplied by the coefficient of friction, which will not be greater than 0.20. When the clutch is operated under load, it will be necessary to add to this product the friction between the jaws due to the load, which will equal the pressure on the jaws multiplied by 0.20. In establishing the diameter of the pin on the shipper ring, allowance should be made for the fact that as the clutch is operated usually by a hand-lever, there is always the possibility for an operator to exert a much greater pressure on the clutch than the above calculations provide for, or more than is necessary.

In the illustration there are shown three of the types of positive clutches in use, of which there are many variations. The type shown at *A* is used when the direction of rotation may be reversed, and contains a variable number of jaws, according to conditions. When the direction of rotation is not to be reversed, the type shown at *B* is commonly used, and this has the advantage of more easily engaging when rotating than the first type. The clutch shown at *C* is self-locking, and is intended for heavy loads, such as winding and hoisting engines, for which type of service it is particularly satisfactory.

* * *

Statistics published by the Canadian Government, covering foundries and machine shops in Canada during 1918, show that the country has 667 establishments in this industry with a total invested capital of over $84,000,000. Ontario is the leading province in this line, more than one-half of the number of plants and nearly two-thirds of the capital invested being represented by this state. Quebec follows with nearly one-fifth of the total number of plants in Canada and with nearly one-fifth of the total capital investment. Most of the remainder of the industry is located in British Columbia. The total value of the manufactured products was over $82,000,000, of which about one-tenth, or $8,000,000, represented machinery of various kinds.



Herringbone Gears for Machine Tools

Advantages Gained by the Use of Herringbone Gears, and Methods Employed in Cutting Them

By NIKOLA TRBOJEVICH, Designing Engineer, Illinois Tool Works, Chicago, Ill.

In this article the author discusses the advantages derived from the application of herringbone drive for transmitting motion uniformly, deals with the satisfactory cutting of one-piece gears, and compares spur and spiral gear action from the standpoint of pressure angles, tooth form and depth, lines of contact, wear, and smooth operation. The conclusion drawn from the author's treatment of the subject of specific pressure is that spiral gears should be calculated on the basis of specific pressure rather than by means of the Lewis formula. The use of single-threaded hobs is advocated, and a detailed examination of the factors entering into the selection of the tools for cutting the threads or teeth in hobs for producing gears is made.

IT has been found in the case of machine tools, especially those which employ comparatively long trains of gears or which are used for precision work, that spur gears can be advantageously replaced by spiral gears. The reason for this is that the action of spiral gears is considerably smoother and more free from vibration than that of spur gears. Mathematically, this feature would be explained in the following way:

A spur gear transmits motion uniformly from one shaft to the other by means of its tooth curve, while the spiral gear transmits the motion principally through the pitch helix, the other parts of the tooth curve being of secondary importance. This means, in the first case, that uniformity of motion depends on the accuracy of the tooth curve, while in the case of a spiral gear it is the accuracy of the pitch helix that counts. It is well known that it is much easier to produce a helix accurately than an involute curve according to the present machining methods. A helix is simply a product of a rotation and a translation, and almost any machine tool will produce it with accuracy, provided a few ordinary precautions are taken. The involute, on the other hand, is copied or generated from a gear-cutting tool, and extreme accuracy is difficult to obtain; the slightest deviation from the theoretical curve is magnified in its effect sufficiently to cause vibration and noise in the gearing. Actual measurements have shown that an error of only 0.0002 inch in the involute curve is detectable when the gears are run at a high velocity. Theoretically, if an absolutely correct curve could be produced on a spur gear, it would run just as smoothly as a "correct" spiral gear, but to attain this in practice is out of the question.

Wearing Qualities of Spiral Gears

An important advantage of the spiral gear over the spur gear lies in its wearing qualities. When a tooth curve rolls with its conjugate curve, there is a pure rolling action on the pitch line, on both spurs and spirals carried on parallel shafts. There is also a combined sliding and rolling action on the points situated above and below the pitch line. This sliding component increases very rapidly as the distance increases between the point of the tooth and the pitch line. The sliding or rubbing action causes the points on the tops and bottoms of the teeth to wear out much more rapidly than in the neighborhood of the pitch line. In fact, the points in the neighborhood of the pitch line will hardly wear at all, due to the pure rolling contact occurring there, which may be considered for all practical purposes as frictionless, provided, of course, that the teeth are correctly spaced. The consequence is, in the case of either spur or spiral gears, that after they have worn out, the pitch line stands out prominently and remains uninjured, while the other parts of the tooth curve are practically destroyed, at least for the purpose of contact. After the spur gears have been worn out to such a degree, they become practically useless, as they cannot transmit motion uniformly, due to the absence of the necessary tooth curves and consequently to the loss of continuity of contact. The motion is transmitted then, intermittently, mostly through shocks imparted by the points of the pitch line. The spiral gears, on the other hand, can be used even in such a worn-out condition, because the pitch helix usually remains intact throughout its entire length. If the face of a spiral gear is sufficiently wide to permit the overlapping of two consecutive teeth, the contact will always remain a smooth and continuous one. Of course, the unit pressure on the tooth surface will gradually increase as the teeth wear out, but if the load is not too great and if it does not crush the metal on the pitch line, such gears will function correctly for an almost indefinite time.

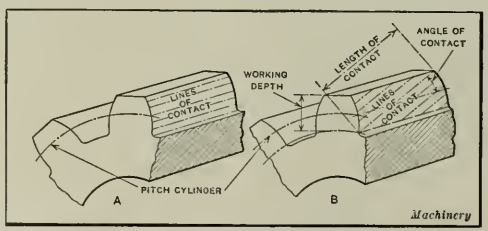


Fig. 1. Lines of Contact on Spur and Spiral Gears compared

Width of Spiral and Herringbone Gears

The minimum width of face should be such that the amount of overlap between two consecutive teeth will equal the product of the circular pitch and the cotangent of the helix angle. For the customary helix angle of 23

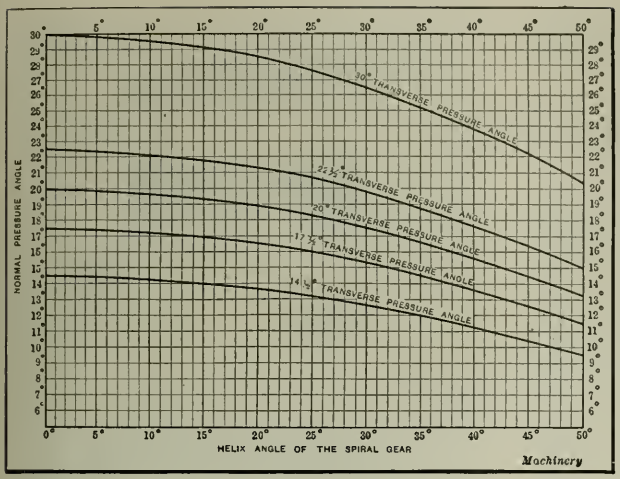


Fig. 2. Relation between the Normal and the Transverse Pressure Angles of a Spiral Gear

degrees, the minimum width on each side should be about 2½ times the circular pitch, this width being about 6 per cent greater than the theoretical minimum. Thus, a herringbone gear should have a total minimum width of 2½ times the circular pitch on each side of the central clearance space, plus from about 1 to 1½ times the pitch for width of groove or clearance space between the right- and left-hand sections. This gives a total width of from 6 to 6½ times the circular pitch for a one-piece herringbone gear.

Compound and One-piece Herringbone Gears

The custom is to make at least one gear in a herringbone drive of two sections, that is, two spiral gears fastened together. It is sometimes claimed that one-piece gears cannot be cut with sufficient accuracy to produce an even bearing in both sections of the gear. It is believed, however, that one-piece gears, both for driver and driven, can be made satisfactorily if the following points are observed.

(1) The right-hand section should be cut with a right-hand hob, and the left-hand section with a left-hand hob.

(2) Both hobs should be of the same make and tooth form and of very nearly the same diameter. The diameters of hobs should be held within 1/64 inch of each other.

(3) The angle of helix should be as accurate as possible. If the ratio of the two gears is 1 to 1, the same train of gears should be used on the hobbing machine, both for index and for feed, when cutting both sections of the teeth in each half of the gear. Under such conditions a slight error in the change-gear ratio is permissible, because the helix angle will then be uniformly affected throughout and the error will be fully compensated for.

(4) It is essential that pitch diameters be held the same on both sections within very close limits.

It is not necessary in the two-piece construction that the relative positions of the right- and left-hand helixes be very strictly kept. If the helixes are not exactly aligned on two herringbone gears, one of the gears can always be shifted lengthwise on the shaft to a position where they will align. For every 0.001 inch error in the helix alignment, the gear should be shifted lengthwise about 0.0025 inch.

Pressure Angle and Tooth Form

If the herringbone gears are hobbed and do not have to interchange with shaped gears, the matter of pressure angle is of little consequence. Under normal conditions about 20 degrees pressure angle gives satisfactory results, although one prominent concern is using 16½ degrees. The writer knows of a case in which 10 degrees normal pressure angle was used, producing a remarkably silent drive, although considerable rubbing action occurred at the tops and roots of the teeth. Although it seems to contradict the theory, it has been repeatedly observed in practice that while, in general, gears that have high pressure angles are more efficient and run more smoothly, they produce more noise than gears with low pressure angles. Thus, the absence of noise is not necessarily a proof of high mechanical efficiency.

Depth of Teeth

The whole depth of herringbone gear teeth should not be quite as great as on spur gears. The principal difference between the spur and spiral gear systems has already been pointed out, for the purpose of showing that the main advantage of the spiral gear system over the spur gear system lies in its correctly formed helix at the pitch line and vicinity.

The present practice regarding depth of tooth is to use about 0.8 of the standard depth. In the opinion of the writer, even that is too much, and it is also believed that herringbone teeth will soon be made to closely resemble helical splines. It should be borne in mind that a deep form weakens the tooth materially. When the strength of a gear tooth is figured, the entire tangential load is assumed to be concentrated on the top of a single tooth, so that if breakage results it will occur at the root of the tooth. Hence, to increase the depth means to increase the leverage of the load, and vice versa. The increase of pressure angle also strengthens the tooth, as the root of a 20-degree pressure angle tooth is, of course, thicker than that of a 14½-degree tooth, for instance.

It is sometimes necessary to know the relation between the normal pressure angle and the transverse pressure angle of a spiral gear. A case of that kind arises when it is desired to find the pressure angle of a hob which would interchange with a helical gear-shaper cutter. These cutters are usually made to an even transverse pressure angle (that is, the pressure angle relative to the section perpendicular to the gear shaft), while the hob is made to correspond to the normal pressure angle of the gear. The geometrical relation



Fig. 3. Single-thread Herringbone Gear Hob

which exists between the two pressure angles may be expressed as follows: *The tangent of normal pressure angle equals the tangent of transverse pressure angle multiplied by the cosine of helix angle.* On the chart, Fig. 2, the curves representing various transverse pressure angles have been plotted from this formula. It will be noted that for small helix angles the two pressure angles are of practically the same magnitude.

The Specific Pressure

From the point of view of specific pressure, spiral gears are at a disadvantage as compared with spur gears. On spur gears the line of contact is equal in length to the width of the gear, and runs parallel to its axis as at *A* in Fig. 1. On involute spiral gears the tooth surfaces are involute helicoids, that is, ruled and developable surfaces, on which the generating straight line forms a constant angle with the pitch helix, as Figs. 5 and 6 show. The angle which the generator includes with the pitch helix depends on both the helix angle and on the pressure angle of the gear. In a representative case, for a 23-degree helix angle and a 20-degree normal pressure angle, that angle is approximately 30 degrees. That the contact is along the generators can best be seen from the paper model illustration, Fig. 5. When the surfaces are rotated at the required ratio of velocities, the corresponding generators on the two helicoids will successively cover one another along their entire length. Hence, the length of contact between the two engaging teeth of a helical drive (see *B* Fig. 1) will be approximately equal to the continued product of the cosecant of the angle formed by the generators and the pitch helix, the working depth of the tooth, and the secant of the normal pressure angle. If we assume that the depth of herringbone gears is equal to about 0.8 of the standard depth for spur gears, the total length of contact of the drive in question will be cosec 30 degrees $\times$ 0.8 $\times$ 0.637 circular pitch $\times$ sec 20 degrees = 1.08 circular pitch.

This length of contact would be realized if the teeth were of a true involute shape from top to bottom. In practice, it is safer to estimate that length, however, to be exactly equal to the circular pitch. Hence, a spiral gear having a width of 2½ times the circular pitch has, roughly, only about 40 per cent of the length of contact which a spur gear of similar dimensions has. There are, however, two more important factors which should be considered when comparing the helical with the straight-tooth type.

First, there is the curvature of the surfaces. On spiral gears the radius of curvature is much longer than in the case of similar spur gears, and the tooth surface lies nearer to its tangent plane. This, naturally, will reduce the surface pressure, owing to the elasticity of the metal employed. A similar phenomenon to that found on bevel gears exists, due

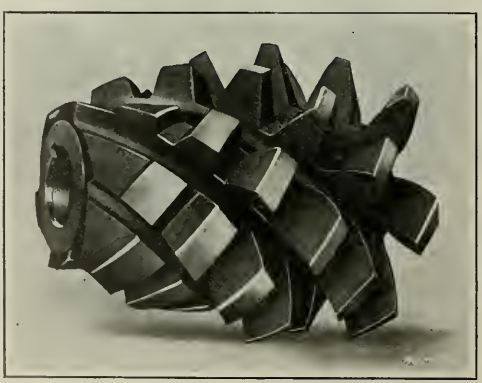


Fig. 4. Multiple-thread Hob for cutting Spiral Gears

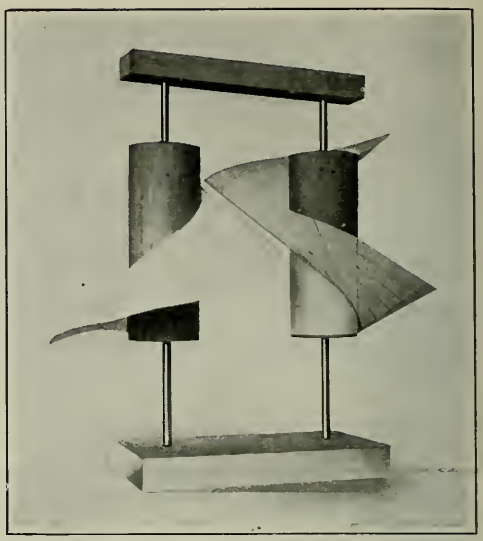


Fig. 5. Paper Model illustrating Action of Involute Spiral Gearing when the Shafts are Parallel

to the increased radius of curvature of the normal sections of teeth; the gears appear to have, so far as their rolling qualities are concerned, a greater number of teeth than is actually the case. This "ideal" or equivalent number of threads or teeth, so called, is on spiral gears equal to the original number of threads multiplied by the third power of the secant of the helix angle. For 23 degrees this increase equals 28 per cent.

The other factor to be considered is that there is generally less friction in a spiral gear than in a spur gear of similar dimensions. This is due to the fact that the spiral gears, as a rule, are shallower and have a greater transverse pressure angle. The friction is further reduced and the mechanical efficiency of the drive increased because, owing to the helical action, the vibration is practically eliminated.

As previously shown, the specific pressure is about 2½ times greater on spiral than on spur gears for the same load. However, even this increased pressure is not sufficient to offset the advantages of the spiral type in other respects, such as freedom from vibration and excessive friction. One of the most efficient mechanisms in use is the ball bearing, in which the surface pressures are enormous. If, in a mechanism, the material has sufficient tensile strength, a great surface pressure in itself is not a very objectionable feature. It is much more important that friction be avoided even under a moderate pressure, as a combination of excessive pressure and friction is detrimental to any machine part. From this point of view herringbone gears can stand any comparison with spur gears, especially if the depth of tooth of the former be still further reduced.

Hobs for Cutting Herringbone Gears

The hobbing method is well adapted for cutting spiral and herringbone gears. It has been shown that the main strength of that type of gearing lies, first, in the correctly formed pitch helixes and adjacent parts of the tooth surface, and principally, in the correct spacing of the teeth. There is no other known method of gear cutting in which indexing and its attendant errors are so completely eliminated as in hobbing gears with single-threaded hobs; for errors of indexing can only be completely eliminated when the gear-cutting machine operates on a continuous or generating principle, and the cutting tool itself is also made on that principle. A multiple-threaded hob, or a gear-shaper cutter, however, consists of a

number of independent threads or teeth which cannot be manufactured without using some sort of indexing apparatus.

The elimination of this difficulty is a very important point in favor of single-threaded hobs. In fact, this property of single-threaded hobs is being rapidly recognized and taken advantage of by engineers, when trying to cut gears having the greatest possible accuracy.

The cutting of herringbone gears with multiple-threaded or Wuest hobs has been advocated by many, and there is no doubt that the method possesses some advantages. On Wuest hobs the number of threads and the diameter of hob are selected so that the thread angle is the same as the helix angle of the gear to be cut. This feature permits of placing the hobs horizontally on the hobbing machine, in a perpendicular position with respect to the shaft of the gear. The fact that formed hobs are now made to produce ordinary spur gears without the need of tilting the head of the hobbing machines (Zimmermann's "right-angle" hobs), is an indication that of which is equal to the base radius of the transverse lamina of the spiral gear. The lead and the hand of the base helix are the same as those of the gear.

The Involute Hob

A hob is merely a spiral gear provided with suitable cutting edges. In order that a hob may produce correct involute spiral gears (or spur gears), it must be a correct involute spiral gear itself. Hobs are generally made with perfectly straight cutting edges on the normal section. This is not quite correct, theoretically, but for single-thread hobs, the error is practically negligible. The error, however, rapidly increases as the number of threads, or what amounts to the same thing, the angle of thread is increased; for the normal tooth curve of a spiral gear is approximately the same as that of a spur gear having as many teeth as the "ideal" number of teeth in a hob of a spiral gear. On the other hand, the ideal number of teeth is equal to the cosecant

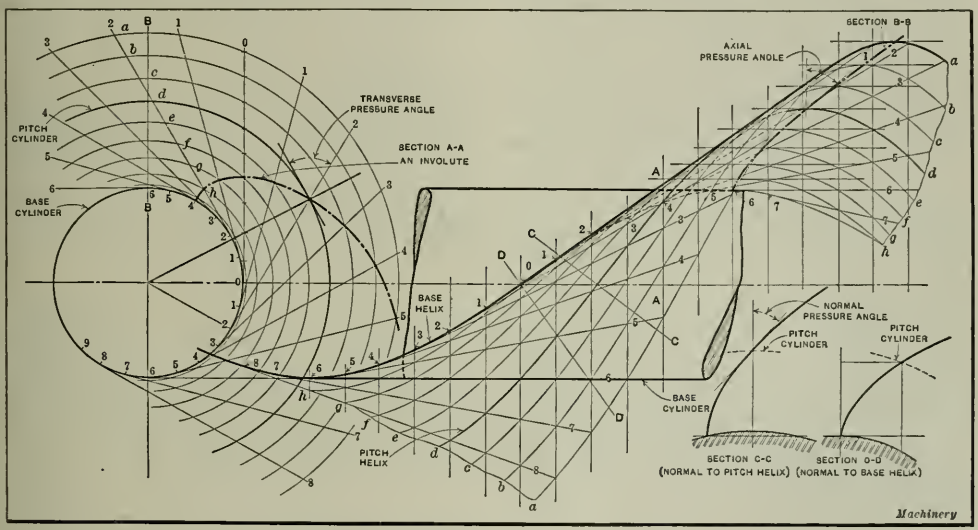


Fig. 6. Involute Helical Surface and its Principal Sections

both spur and spiral gears can be hobbed without swiveling the head of the machine. In addition to this, the Wuest hobs, owing to their horizontal position while cutting, require a slightly narrower clearance space between the right- and left-hand gear sections. The "over-travel" is also less than for single-thread hobs.

In spite of all these apparently important advantages, the writer is strongly in favor of single-threaded hobs, ground in the thread after hardening. In order that this point of view may be more clearly seen, we shall review in what follows a few of the principles of the theory of hobbing involute spiral gears.

Principles of Hobbing Spiral Gears

The involute tooth surface can be produced by uniformly twisting a spur gear. In the course of this transformation the straight line generators of the spur gear become helixes while the involutes remain unchanged. Hence, a correct spiral tooth surface has only one section which is involute, and that is the transverse (perpendicular to the shaft) section. It can be shown by actual calculation (see page 429, January, 1919, MACHINERY) that the involute surface can also be swept by a straight line rolling on a helix. The spiral involute surface is a ruled and developable surface, in which the straight line elements are so arranged as to be always tangent to a helix, the so-called base helix (see Figs. 5 and 6). This base helix is wound on the base cylinder, the radius cubed of the thread angle, multiplied by the number of threads or teeth. The term "thread angle" is used here to denote the angle of hob helix with a plane perpendicular to the hob axis, and is therefore complementary to the gear helix angle. The smaller the thread angle, the greater the ideal number of teeth will become, because the cosecant increases with the decrease in magnitude of the angle. For example, a single-thread hob of 4 pitch and 3.845 inches pitch diameter, having a thread angle of 3 degrees 43 minutes, has an ideal number of teeth of 3652, because the cosecant of that angle is 15.4 and its cube is 3652. Evidently a spur gear having 3652 teeth would be practically a rack, and its tooth outline would be straight lines, in the involute system of gearing. In this case the actual error in normal tooth curve for a 14½-degree pressure angle is less than 0.0003 inch, whereas a hob of the same normal pitch and diameter, having six threads and a thread angle of 23 degrees, has an ideal number of teeth of 101, and a corresponding error of nearly 0.01 inch. This is a thirty-six fold increase in error, and in order to maintain the involute system, the cutting edges of the hob would be pronounced curves, the exact equation for which cannot be arrived at except by very complicated calculation. The ideal number of teeth is the index number showing how closely a hob approximates a rack.

In principle, the use of multiple-threaded hobs for cutting spiral gears is correct; but with the present development

in machining methods it is almost impossible to produce sufficiently accurate multiple-threaded hobs. The relieving of the teeth and the problem of indexing the threads may be considered as even greater obstacles to the accuracy than the development of the correct tooth form itself. For instance, the tool with which the teeth of the multiple-threaded hobs are cut and relieved must be ground in a special fixture so that its top surface will be warped in approximately the same way as the gash of the hob is warped, as otherwise the cutting edges cannot be correctly relieved. For the same reason, flat gages cannot be used for inspecting such hobs. All tooth caliper dimensions must be corrected to allow for the curvature of different helixes and helicoids. When changing from one thread to the other on the relieving lathe, both the main spindle and the camshaft must be indexed. The indexing of the cam which governs the radial motion of the relieving tool is especially troublesome, as the angle to be indexed is a function of such quantities as lead of thread, lead of gash, number of threads, and number of gashes—that is, an irrational quantity. In the majority of cases the accuracy obtained, in spite of greatest efforts, is inadequate for the purpose, and hardly comparable with the accuracy usually found in ordinary commercial single-threaded hobs.

TABLE 1. INCREASE OF THREAD ANGLE ON 4-PITCH HOBS, AFTER ¼-INCH REDUCTION CAUSED BY REPEATED GRINDING

Number of Threads	Pitch Diameter of Hob, Inches		Thread Angle of Hob, Degrees and Minutes		
	Original	After Grinding	Original	After Grinding	Increase
1	3.845	3.595	3–43	3–58	0–15
2	3.845	3.595	7–28	7–59	0–31
3	3.845	3.595	10–27	11–9	0–42
4	3.845	3.595	15–4	16–4	1–0
5	3.845	3.595	18–58	20–11	1–13
6	3.845	3.595	23–0	24–25	1–25

Machinery

Thread Angle and Normal Pitch as Functions of Diameter

The thread angle of a hob changes when the diameter of the hob is reduced. This, of course, affects the accuracy, because the diameter must be reduced through repeated sharpening. Now, the error from this source is practically infinitesimal for hobs having a small thread angle, but it becomes quite noticeable and even prohibitive for large angles, which of course, means for multiple-threaded hobs. The rate at which the error increases for various thread angles, and the amount of error can readily be determined. In the following equations,

l = lead of hob;
α = thread angle;
D = pitch diameter of hob;
p = normal circular pitch;
n = number of threads.

$$\text{Tan } \alpha = \frac{l}{D\pi} \qquad (1)$$

Therefore

$$D = \frac{l}{\pi} \text{ cotan } \alpha$$

But

$$l = \frac{np}{\cos \alpha} \qquad (2)$$

For a given hob the lead remains constant while the diameter of hob is being reduced through repeated sharpening. Hence, in Equation, (1) α and D are the variables. Differentiating with respect to D, the rate of variation is found, thus:

$$dD = -\frac{l}{\pi} \times \frac{d\alpha}{\sin^2 \alpha}$$

or

$$d\alpha = -\frac{\pi}{l} \sin^2 \alpha \, dD \qquad (3)$$

That is, the error increases with the square of the sine of the thread angle.

Table 1 shows the change in thread angle on 4-pitch hobs, having one to six threads, 4 7/16 inches outside diameter, when the diameters of hobs are reduced ¼ inch through repeated sharpening. The resulting change of the thread angle is about six times greater for a six-thread, than it is for a single-thread hob.

The variation of the diameter also affects the length of the normal circular pitch of the hob. This follows from the fact that the normal circular pitch is a function of the lead, the diameter, and the number of threads of the hob. On a certain hob, the number of threads and the lead are necessarily constant, while the diameter is gradually reduced through repeated sharpening, as already stated. This error, while not nearly as serious on hobs as it is, for instance, on gear-shaper cutters, may amount to considerable inaccuracy on multiple-threaded hobs. From Equation (2)

$$p = \frac{l}{n} \cos \alpha \qquad (4)$$

and

$$\text{Tan } \alpha = \frac{l}{D\pi} \qquad (5)$$

Differentiating Equations (4) and (5) with respect to p, D and α, and considering the last-named variable as a parameter:

$$\frac{dp}{dD} = -\frac{l}{n} \sin \alpha \frac{d\alpha}{dD}$$

$$\frac{d\alpha}{dD} = -\frac{\pi}{l} \sin^2 \alpha$$

After eliminating the derivative of α with respect to D from the above system, we have

$$dp = \frac{\pi}{n} \sin^2 \alpha \, dD \qquad (6)$$

Equation (6) shows that the length of the normal pitch of a given hob decreases with the third power of the sine of the original thread angle, when the diameter is decreased. It is interesting to note that Formulas (1) to (6) also apply to gear-shaper cutters, as a helical gear-shaper cutter is essentially a multiple-threaded hob of, for example, 67 degrees thread angle, used for cutting 23-degree helix angle gears; while a spur-gear-shaper cutter is equivalent to a multiple-threaded hob of 90 degrees thread angle and an infinite lead. Table 2 compares the single-thread hob, the six-thread hob and the helical-gear-shaper cutter, as regards the change in

TABLE 2. CHANGE IN THREAD ANGLE AND PITCH OF GEARS WHEN DIAMETER OF CUTTING TOOLS IS REDUCED BY GRINDING

Name of Cutter	Diametral Pitch	Number of Threads	Pitch Diameter, Inches		Thread Angle Increase, Degrees and Minutes			Normal Circular Pitch Decrease, Inches		
			Before	After	From	To	Increase	From	To	Decrease
Single Thread...	4	1	3.845	3.720	3–43	3–51	0–8	0.7854	0.7852	0.0002
Six Threads.....	4	6	3.845	3.720	23–0	23–46	0–46	0.7854	0.7813	0.0041
Helical Gear Shaper.....	4	14	3.845	3.675	67–0	72–15	5–15	0.7854	0.7682	0.0172

Machinery

their respective thread angles and normal circular pitches when the diameter is reduced by repeated sharpening. It will be seen that the tabulated diameters and amounts of reduction for each are such as to permit comparisons to be readily made. These comparisons show the amount of superiority of the single-thread hob over the other two gear generating tools, so far as keeping the correct tooth form after sharpening is concerned.

The angular and pitch errors of the cutting tools are not, however, transmitted to the helix angle and the lead of the spiral gears, as one might think at first glance, because these elements are determined by the way the hobbing or gear-shaping machine is geared or set up, and not by the shape of the cutting tool. The errors in thread angle and pitch of the cutting tool will show themselves in the changed form, pressure angle, and thickness of teeth of the spiral gear. Thus, gears cut by a worn-out hob or by a gear-shaper cutter will not, strictly speaking, be the same as those cut by a new cutter. For single-thread hobs, however, the error from this source is hardly detectable, even for the finest class of work.

Conclusions

From the above observations we may draw the following conclusions:

(1) If silent operation is required, spiral gears are more likely to possess that feature than spur gears.

(2) The specific pressure on spiral gears is greater than on spur gears. For this reason spiral gears should be calculated on the basis of specific pressure rather than according to the commonly used Lewis formula for strength of gear teeth.

(3) On spiral gears, all features which decrease the friction as a rule increase the specific pressures. The pressure angle and the helix angle are somehow related as common agents in reducing the friction and increasing the surface pressure. When either of them is increased, the friction is reduced, but at the same time the line of contact is shortened. However, the pressure and helix angles distribute the pressure in a different manner. A great pressure angle has a tendency to throw the load toward the journal, while a great helix angle will divert that load mainly in the axial direction.

(4) The logical tool to cut herringbone gears is the single-thread hob, for the following reasons: First, it has a straight-line cutting edge for the involute system of gearing; second, it can be made accurately and can be ground in the thread after hardening; third, it keeps the form of tooth and the pitch after repeated sharpening; fourth, it is free from errors of indexing.

* * *

Steel plate of large size has been cut by the oxy-acetylene process at Sandy Hook by the Oxweld Acetylene Co. under a government contract for cutting 4000 tons of armor plate into sections of suitable size for furnace charging. In carrying out this work, plates 9 feet by 13 feet by 3 inches thick, weighing between 7 and 8 tons each, were readily cut into sections 13 inches by 25 inches, weighing about 300 pounds. This is believed to be one of the largest jobs of the kind that has ever been undertaken, and the oxy-acetylene process is undoubtedly the only one by which salvage work of this nature can be satisfactorily handled.

HIGH-SPEED DRILLING

All previous records for drilling in machine steel and cast iron are said to have been broken by the performance of milled high-speed drills, made by the Cleveland Twist Drill Co. and taken from stock, at several demonstrations at the convention of the American Railroad Association at Atlantic City. In these tests, 1- and 1¼-inch drills penetrated through cast iron at the rate of 72 inches per minute, a 1-inch drill cut through machine steel at the rate of 30 inches per minute, and a 1¼-inch drill cut through machine steel at the rate of 20 inches per minute. The data resulting from these tests, which were performed on a Foote-Burt heavy-duty drilling machine, are conveniently arranged for reference in the accompanying table.

While these demonstrations indicate the very great amount of reserve in modern milled high-speed drills, it is not recommended that the high rates of speeds and feeds at which the drills were operated in these tests be used in ordinary shop practice. For instance, it will be observed that when drilling cast iron, the 1-inch drill was run at the rate of 720 revolutions per minute, with a feed of 0.100 inch per revolution. If this drill were operated according to what is considered good practice, the speed would not be greater than 267 revolutions per minute and the feed approximately 0.015 inch per revolution. The same is true concerning the feeds and speeds used in the drilling of machine steel.

DATA OF DRILLING TESTS

Material	Size of Drill, Inches	R.P.M. of Drill	Feed per Revolution, Inch	Peripheral Speed per Min., Feet	Number of Inches Drilled	Penetration per Min., Inches	Amount of Metal Removed, Cubic Inches	Weight of Metal Removed, Pounds
Cast Iron	1	720	0.100	188	9	72	56.55	14.70
Machine Steel	1	600	0.050	157	3	30	23.56	6.64
Cast Iron	1¼	720	0.100	236	15	72	88.36	22.97
Machine Steel	1¼	500	0.040	164	3	20	24.54	6.91

Machinery

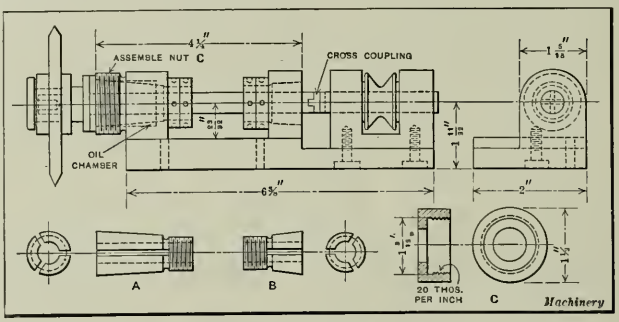
COOPERATIVE COURSE IN ELECTRICAL ENGINEERING

For the past year an interesting experiment in cooperative engineering education has been conducted by the Massachusetts Institute of Technology, Cambridge, Mass., and the General Electric Co., at Lynn, Mass. While the cooperative scheme in itself is not new, several departures from the usual plan were introduced, which are said to have produced highly satisfactory results. The course covers a period of five years, the first two years being identical with the regular course in electrical engineering at the institute, and the last three being divided between instruction in theory at the institute and instruction in practice at the Lynn works. The class was limited to thirty students, who were chosen entirely upon the records which they had made in the first two years' work of the electrical engineering course. Included in this group were graduates from Yale, Harvard, Dartmouth, Princeton, the Naval Academy, besides men who had completed their first and second years solely at the Massachusetts Institute of Technology. The year is divided into four three-month periods, the students spending alternately thirteen weeks at the Lynn works of the General Electric Co., and eleven weeks at the institute followed by a two weeks' vacation. No break is made in the major studies when the students are at Lynn, courses being conducted at the works in principles of electrical engineering and in general studies. The progress of the students through the plant is regulated not by the production needs of the various departments, but by the advantage which the experience in each department is to the student. The result of this year's work has been so gratifying to the originators of the plan that the General Electric Co. has increased the number of men who can be enrolled in this year's class to sixty, and has secured a new club house in order to furnish rooming accommodations for them.

PRECISION THREAD GRINDER

The high degree of accuracy demanded in modern thread gage manufacture has led to the development of various types of thread grinding attachments. By employing grinding as a means of correcting distortion, caused by hardening, a thread can be produced which will be accurate in lead to less than 0.0001 inch. The practice of grinding hardened thread gages represents the highest attainment reached in the manufacture of precision thread gages.

A thread grinding machine of the bench lathe type, has recently been designed by H. Wiederhold, of the Diehold Mfg. Co., Brooklyn, N. Y. This machine is simple in construction, and it is claimed that it will produce an accurate lead to within 0.0001 inch. The machine will handle both external and internal work, and may be set for grinding gages up to and including 6 inches in diameter. A special slide-rest is mounted on the base of the thread grinder to which is fitted an auxiliary slide in which there are three parallel T-slots. These slots are used for locating on this auxiliary slide the grinding wheel and its mounting, as well as the attachment for truing the wheel. The design of the mounting for the wheel-spindle is shown in the accompanying illustration. A cast-iron base is bored out in the pulley-end bearing to fit the diameter of the shaft, and in the other two bearings to fit special bushings *A* and *B*. These bushings are made of high-carbon steel and are tapered and threaded on the outside to receive adjusting nuts. The bushings, as well as the high-carbon steel shaft, are hardened, ground, and lapped to an accurate fit. This construction allows adjustment to compensate for wear, and in addition it permits the end-thrust to be taken in both directions.



Grinding Wheel Housing Design for Thread Grinding Machine, in which Special Provision is made to prevent Vibration of Wheel

The grinding wheel is secured to the shaft as shown, its center bushing accurately fitting the lapped end of the shaft. Between the wheel end of the shaft and the pulley end provision is made to overcome vibration caused by the belt hook by constructing the shaft in two pieces, coupled together by means of a "cross." This coupling resembles an Oldham design, but its purpose is not so much to enable correction for misalignment, as to provide a means whereby the motion produced by the lateral thrust will be lost. There is a slight lateral movement permissible between the two connected shafts and the lugs of the cross to which they fit, which absorbs the vibration that otherwise would be transmitted to the wheel. With this arrangement, however, and proper adjustment by the means provided, the wheel will operate without the slightest amount of lateral play. Between the phosphor-bronze thrust bearing nut *C* and the adjacent bearing, a phosphor-bronze check-nut is employed.

This grinding wheel unit is attached to an angle-plate which is located on the auxiliary slide previously mentioned. The spindle is mounted at the correct helix angle of the screw thread on the vertical side of the angle-plate, and a tongue is provided on the seat of the plate to fit into one of the T-slots in the auxiliary slide. The button method or the use of a sine bar will enable this location to be accurately determined. The spindle bearing casting is drilled to receive a bolt, and a radial slot is provided in the angle-plate so that the desired location can be readily secured. Having established the correct angle for the wheel location, the depth of cut and the relation of the wheel to the flanks of the thread may be easily obtained by means of the graduated operating screws in the slide-rest.

The gage to be ground is mounted on a suitable spindle, which is in reality a combination spindle and master lead-screw. This tool-steel member is mounted in two bearings in the headstock, the front one of which is a split bronze bearing in which the spindle end fits. The lead-screw end of the spindle is carried in a babbitted bearing at the rear end of the headstock. The front bearing is provided with a cap which enables the spindle to be removed when it is desired to install a spindle having a lead-screw of different pitch. It is, of course, necessary to repour the babbitted bearing when changing the master lead-screw.

The end of the lead-screw is ground down to receive the driving pulley which is mounted on it and belted to suitable pulleys carried on an auxiliary shaft, located at the front of the machine. There are three pulleys carried on this auxiliary shaft, two fixed ones belted open and crossed, and one idler. By this means, the gage may be traversed back and forth over the grinding wheel until the desired limits have been attained. Ordinarily from 0.0010 to 0.0012 inch is left for grinding so that several traverses over the wheel are required.

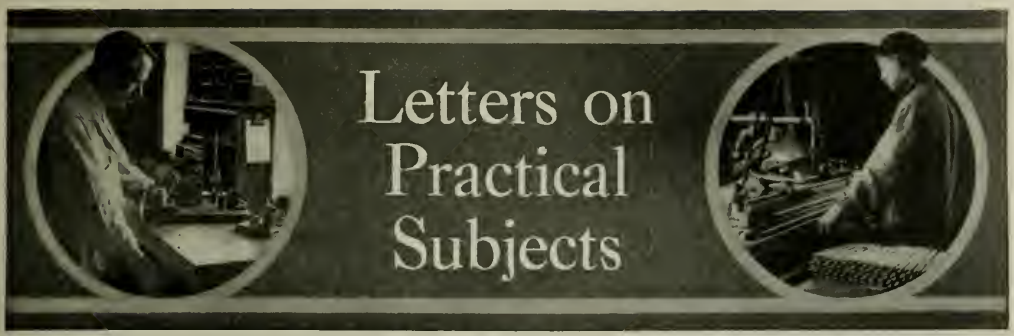
The grinding wheel may be driven by a suitable motor mounted above the machine, which is belted to transmit to the wheel a speed of from 7000 to 10,000 revolutions per minute. A felt washer is employed between the gage on the spindle and the front bearing so as to exclude all grit and foreign substances; the bronze bearing nut *C* serves the same purpose for the wheel-spindle. The provision of parallel T-slots on the auxiliary slide previously referred to enables a diamond truing attachment to be mounted on it for the purpose of maintaining the correct thread angle when dressing the wheel. This attachment is mounted in relation to the grinding surfaces of the wheel either by means of buttons or by employing a sine bar, as in the case of mounting the wheel at the correct helix angle. When the work is to be held between centers, a special tailstock is provided.

* * *

COUNCIL OF A. S. M. E. ADOPTS RESOLUTION REGARDING METRIC SYSTEM

Recently a number of articles have appeared in various publications stating in effect that the American Society of Mechanical Engineers had placed itself on record as being opposed to the metric system. This matter was presented to the council of the society and the following resolution was adopted: Resolved, that this society, as a society, does not and has not taken any stand in favor of or against the metric system, that notice to this effect be published in the journal of the society, *Mechanical Engineering*, and that this fact be given such further publicity as may be approved by the president.

It was the unanimous opinion of the members of the council, both at the meeting in Baltimore on February 27 and at the March 19 meeting, that while members of the society and of the council might properly and would naturally hold various opinions regarding the metric system and its introduction here, it was not advisable nor desirable that the society place itself on record either for or against the system or its introduction.



AIR CHUCK ATTACHMENT FOR THREADING STUDS

The set-up shown in the accompanying illustration was used on a Garvin screw machine for the purpose of rapidly threading one end of plain studs, which had previously been threaded on the opposite end and cut off to length. This attachment is not only quick-acting, but it has also been found to give the highest degree of satisfaction on this and similar kinds of work.

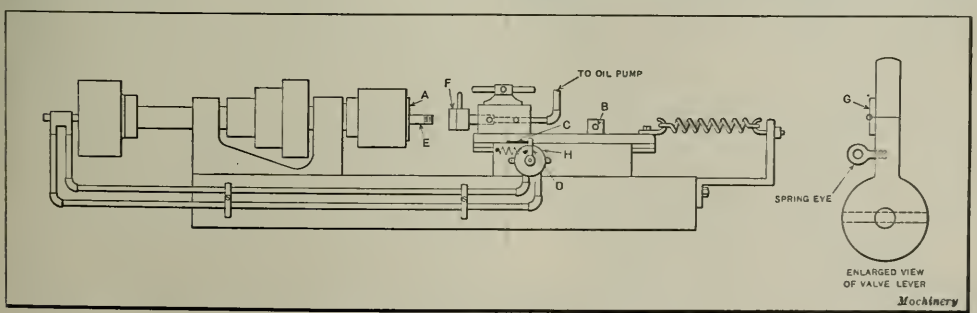
The chuck employed for the job is of the common air-operated type, equipped with threaded pads to suit the thread of the stud, by means of which the stud is held. These pads are made from tool steel, and are nicely fitted in the chuck and matched so that their sides close tightly together. The pads are then drilled out and tapped, a recess at the bottom of the hole being made so that the studs may be screwed in and bottomed in the hole. The pads should be hardened and tempered, and numbered to correspond with the numbers of the chuck jaws, so as to facilitate the work of putting the pads back into their respective positions, should the occasion require. A bracket made from cold-drawn steel is attached to the end of the machine and carries a hook to which a coil spring is attached. The purpose of this spring is to draw the carriage of the machine back as soon as the operating lever *B* is released. After the operating lever has been manipulated and the carriage traversed away from the chuck, a suitable dog or cam *C* attached to the carriage will contact with the valve lever *D*, pushing it back and thereby operating the air-valve *H*. This valve is constructed so as to allow the air to pass into the air cylinder and thence to the chuck jaws. As soon as the chuck has been opened and the stud *E* permitted to drop out, the cam *C* will have passed over the air-valve lever *D*, which will then be pulled back into its original position by means of a light coil spring. This automatically closes the air chuck, enabling the operator to insert another stud in the chuck with the machine still in motion, draw up the carriage by operating lever *B*, and by means of the self-opening die-head *F*, cut the thread to the desired length.

The construction of the valve lever *D* is shown enlarged at the right-hand side of the illustration, from which it will be seen that the lever consists of two parts, fastened together by means of the spring hinge *G*, the purpose of which is to enable the end of the lever to snap back as soon as the cam *C* on the carriage has passed over it on the forward movement, thus instantly closing the chuck jaws preparatory to threading another stud. It will be seen that the cutting oil is delivered to the work by means of a small iron pipe passing through the turret of the machine and into the shank of the die-head. A suitable valve is used to regulate the flow of the oil. This system of oiling not only delivers the cutting oil directly to the work, but also washes away the chips from the die-head. On a machine equipped with the arrangement illustrated, an average hourly output of 900 studs, ¼-20 by 1 inch, was obtained.

Cicero, Ill. JOHN J. BORKENHAGEN

DIES FOR DRAWING A DIFFERENTIAL GEAR CASE

The first operation performed in drawing the differential gear case illustrated consists of cutting out the blank from stock 5/32 inch thick. The diameter of this blank is 9 inches, and for the performance of the second operation, the blank is placed between the two steel rings *H* and *C*, Fig. 1, for the purpose of forming it to the shape shown at *A*, Fig. 2. These rings are fastened to the blank-holder casting *L* and to the die-block *B* to which they are fitted by means of annular tongues and grooves, and secured by means of machine screws. The locating ring *R* on the outside of the die ring *C* locates the blank concentrically with the die. In the operation of this die which is of the double-action type, the blank-holder *L* descends before the punch *F*, and holds the blank on the surface of the die ring while the punch descends and performs the drawing operation. At the end of the stroke of the press, the punch ascends in advance of the blank-holder so that, if the shell should stick on the punch, the blank-holder ring would strip it from the punch as the latter



Set-up of Garvin Screw Machine for threading Plain Studs. A suitably Regulated Air Chuck is employed to hold the Work

travels upward through it. The third operation reduces the shell to the final body diameter as indicated at *B*, Fig. 2. The knock-out *K*, Fig. 1, employed in the punch is set in as shown, thus permitting a larger bearing surface on the bottom of the shell for ejecting it from the punch. For producing heavy shells of large diameter, such as the one shown, this construction is advisable. The die ring *C* is inserted in the die-holder *B* and is held in place by ring *A*, which acts as a gage ring for locating the shell.

The die used in performing the fourth operation (see Fig. 1), is provided with two knock-outs *E* and *K*, located as shown in the punch and die, respectively. It will be noted that the punch does not entirely fill the shell, it being necessary for it to enter only the small diameter, as the operation is confined to this end of the shell. The three succeeding operations are not illustrated, for the reason that they consist merely of changing the shape, step by step, and reducing the small end preparatory to performing the final operation. The shape of the shell after the final, or eighth, operation has been completed, is shown at *D*, Fig. 2, and the dies employed are shown in the lower right-hand corner of Fig. 1. The operation consists of flattening the flange and of finishing both the large and small diameters. In this operation, the small end of the shell is reduced 1/32 inch while it is being sized. The die consists of two steel rings *C*, the smaller of which reduces the small diameter and is located within the larger ring which is employed in the flattening of the flange. This ring is held down by the gage ring *A*. Attention is directed to the fact that the punch-holder is employed to shape the flange against the larger die ring as the press ram completes its downward stroke. The entire arrangement and construction of the dies provides adequate rigidity. Like all other dies of this kind in which heavy work is performed, the holders should be built up strongly, so as to withstand the strain exerted upon them during the drawing operation.

The dies used on this job are all hardened and ground to a taper of 1½ degrees and are carefully fitted in the die-blocks. The methods employed in drawing this shell demonstrate the fact that, in drawing flanged shells, the flanges should not be formed first, unless it is absolutely necessary; it is a comparatively easy matter to form the flange after the rest of the shell has been drawn. In some cases, however, it may be necessary to form the flange first and make all the reductions and drawing operations afterward.

Toledo, Ohio J. BINGHAM

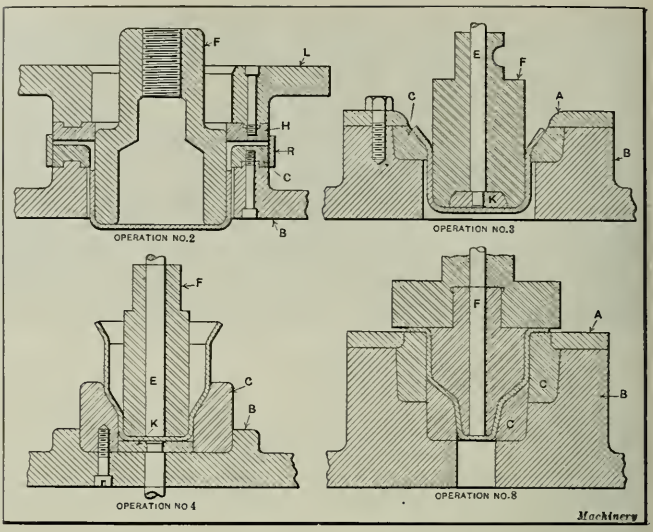


Fig. 1. Principal Dies employed in drawing a Differential Gear Case

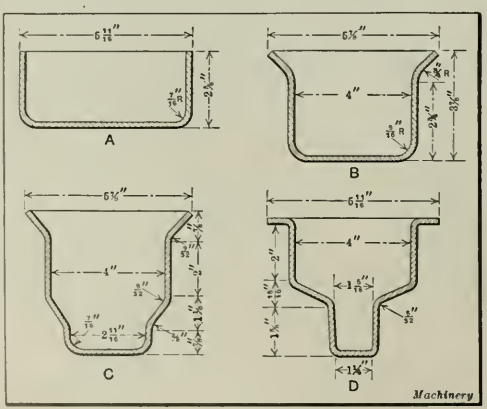
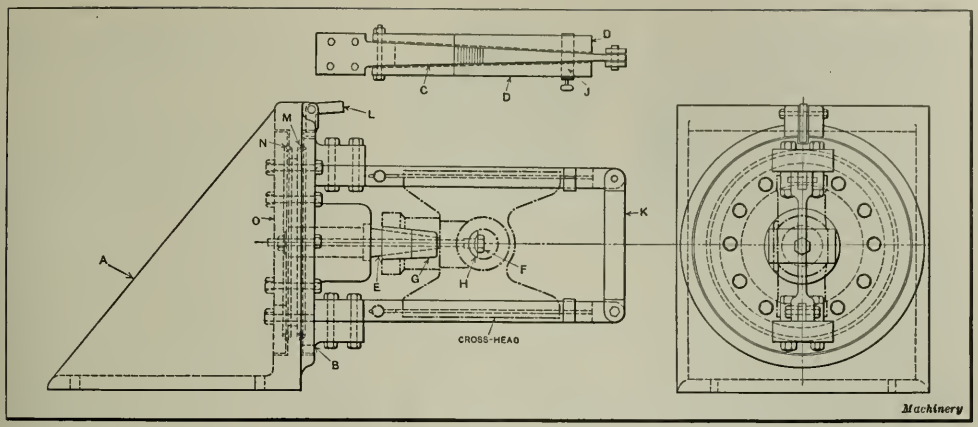


Fig. 2. Appearance of the Case after the Second, Third, Fourth and Eighth Operations

INDEXING JIG FOR BABBITTING LOCOMOTIVE CROSS-HEADS

An indexing jig that was designed to facilitate the babbitting of the surfaces of locomotive cross-heads that bear against the cross-head guides, is shown in the accompanying illustration. By its use it is unnecessary to machine these bearing surfaces after they have been babbitted. This feature makes the babbitting of cross-heads by the use of this jig an economical method, because it considerably reduces the time and labor required in the operation. It will be noted that the principal parts of the jig are the base *A*, the indexing head *B*, the fixed guide bars *C*, and the adjustable guide bars *D*. The indexing head is provided at the center with a boss which is bored to receive a steel mandrel *E*. This mandrel has a 1¼-inch hole running its entire length to receive bolt *F*, and its projecting end is machined to suit the tapered hole in the expanding bushing *G*. The three sections of this bushing are held together by a spring band.

When placing a cross-head on the jig, the expanding bushing is inserted in the hole provided in the cross-head for the end of the piston-rod. The rounded plate *H*, which has a square hole in it to suit bolt *F*, is then placed through the wrist-pin holes, after which bolt *F* is inserted in the holes in plate *H* and mandrel *E*. The nut on bolt *F* at the opposite end of the mandrel is then tightened, thus drawing the cross-head and expanding bushing up on the tapered surface of mandrel *E* and causing the bushing to expand. This action secures the cross-head so well in place that it is prevented from turning about the bushing. Bars *C* and *D* are made to occupy the same amount of space on the upper and lower sides of the cross-head, as is taken up by the guides on the locomotive. After bars *D* have been adjusted until the width across the two bars is the same as the width of the guide on the particular cross-head being babbitted, they are clamped in this position. The babbitting metal is then poured between these bars and the cross-head casting, the babbitt filling all the space between them, so that the cross-head may be mounted on the locomotive without requiring the babbitted surfaces to be machined. The adjustment of bars *D* is such that a sufficient amount of play between the cross-head and the guides is allowed.



Jig of the Indexing Type used when babbitting the Surfaces of Cross-heads which bear against the Cross-head Guides

It will be seen that the fixed bars *C* are bolted to lugs on the indexing head. The adjustable bars *D* are provided with grooves that fit corresponding tongues on bars *C*. Graduation lines are scribed on the fixed bars and an index line is scribed on each adjustable bar to facilitate setting to the proper width. After the adjustment has been made, the nuts on the bolts at the left-hand end of the adjustable bars are tightened, while the opposite ends of the bars are held together by means of the clamps *J*. The ends of bars *C* farthest from the indexing head are tied together by means of link *K* after the cross-head has been placed on the jig. The indexing head may be revolved through a complete circle, there being two slots cut 180 degrees apart on the periphery of the flange for the purpose of locating the head for babbitting either the upper or the lower bearing surface of the cross-head. One end of the locking lever *L* is placed in either of these slots in order to hold the indexing head in the desired position.

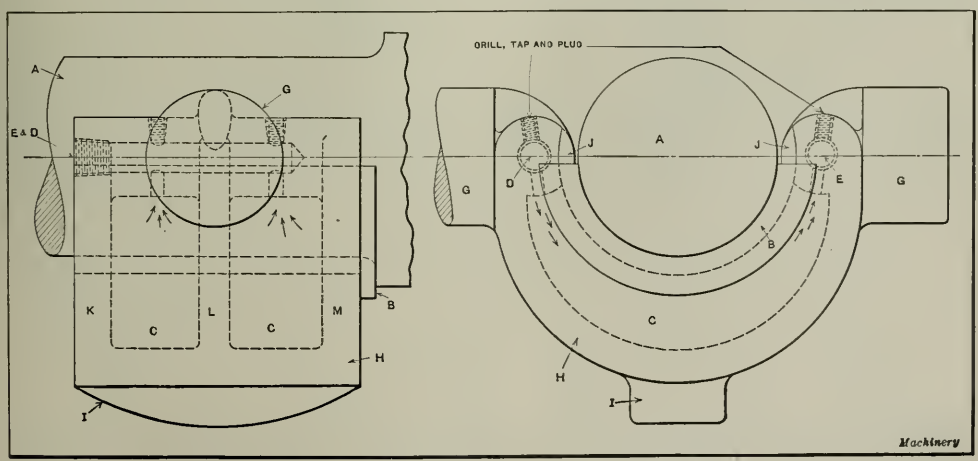
A ball bearing race *M* having 123 balls, ¾ inch in diameter, is provided between the indexing head and base *A* while a similar race *N* is situated between the base and the retaining plate *O*. These ball races make the rotating of the indexing head a comparatively easy matter. Expansion bushings of five different diameters are provided to suit the piston-rod hole in the five various sizes of cross-heads that can be accommodated in this jig. The base *A* should be bolted to a firm concrete foundation near the furnace used for melting the babbitt, and should be placed at such a height above the floor level that the workman need not stoop when pouring the metal.

NORMAN MCCLEOD

IMPROVED DESIGN FOR WATER-COOLED JOURNAL BOXES

A common design for water-cooled journal boxes employs a cored water pocket. There are some objections to this design particularly in regard to the molding proposition, because no matter how carefully the cores are made and set in the mold a certain amount of uncertainty exists in regard to the condition of the cored pocket. This may be readily understood when it is stated that there are two or three stud cores employed in the drag to support and secure a somewhat heavy and overbalanced core in the mold, as well as a like number of stud cores in the cope for centering and setting the core. There is no way of examining the casting to ascertain the condition of the pocket, and even though water may run freely through it, this does not indicate that the water passages and pockets are free from all obstruction. This design also makes it inconvenient to remove the core and core-rods from the castings when cleaning them.

As an illustration of the difficulties encountered in this design, an instance is cited in which considerable trouble was experienced by the journal heating. A careful examina-



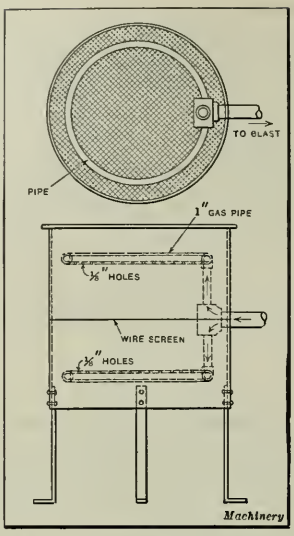
Water-cooled Journal Boxes designed to avoid Difficulties in Molding

tion did not disclose anything wrong in the water passages or pockets of the journal bearing. The suspicion that the bearing casting was responsible arose from the fact that the core-rods could not be removed in cleaning the casting. Later when the casting was broken it was found that the metal had run into the joint in the core and had thus formed a wall across the water passage with an opening around the core-rods merely large enough to allow the water to leak through.

Knowing faults of this nature to exist and the reason for them, the writer designed a water-cooled box which is radically different from the usual design. It will be seen from the illustration that the box is of the rocking type, that is, it is provided with trunnions *G* by means of which it is mounted in the copper rolling machine for which it was designed. It is evident that the shaft *A* bears in the brass liner *B*, which is a press fit in the casting, being supported by the three ribs *K*, *L*, and *M* and locked in place by means of four lips located between these ribs and projecting out over the brass liner as shown at *J*. The liner may be made in the form of a ring and then split, since the lips *J* extend below the center line ⅛ inch, or enough to allow for the width of the saw.

It will thus be seen that for molding purposes the water chambers *C* are open and exposed to view, so that no doubt exists as to their condition. The lips for locking the press liner in place form part of the body *H* of the casting, but do not interfere in any way with finishing the seats for the brass liner which, of course, must be done in order to make the pockets water-tight. The casting is drilled and tapped for water pipe connections at *D* and *E*, and these two holes are connected by two other holes with the water chambers. Holes *D* and *E* are tapped and plugged at the top, as shown in the illustration. The drilling of the holes in the casting does not weaken it to any noticeable degree. The water enters at *D* and from this inlet passes through the chamber and then through the outlet at *E*. By this means the water has a more direct effect as a coolant than would be possible in the more common type of bearing. The bottom of the casting is designed with a seat *I*, as shown.

Kenosha, Wis. M. E. Duggan



Air Box with Coils of Pipe having Hole through which Air is blown

AIR-COOLER FOR HARDENING HIGH-SPEED STEEL

Considerable difficulty is often experienced when hardening air-cooled steel, owing to the arrangement of the air blasts for uniformly cooling the work. Many contrivances have been devised to overcome this difficulty. The arrangement shown in the accompanying illustration has been used by one of the leading small tool manufacturers with satisfactory results. This arrangement allows the air to come in contact with the work at every side so that all sections may be hardened at the same time.

The device consists of a cylindrical sheet-iron hood riveted to four strap-iron legs, within which coils of 1-inch gas pipe are arranged as shown with suitable connections to the blast. These coils of pipe are perforated with ⅛-inch holes, spaced 1 inch apart, and so located on the pipe that the blast of air will be directed at an angle toward the center of the box. Between these two coils a ½-inch mesh wire screen is provided on which the work is supported. By this simple arrangement the desired results are attained. The air may be furnished from a blast pipe, or the coils may be connected to a compressed air pipe, according to which one may be handier. The air blast, however, is the better one to use, as the air is drier and therefore is not so liable to cause checks in the surface of the steel. R. F. M.

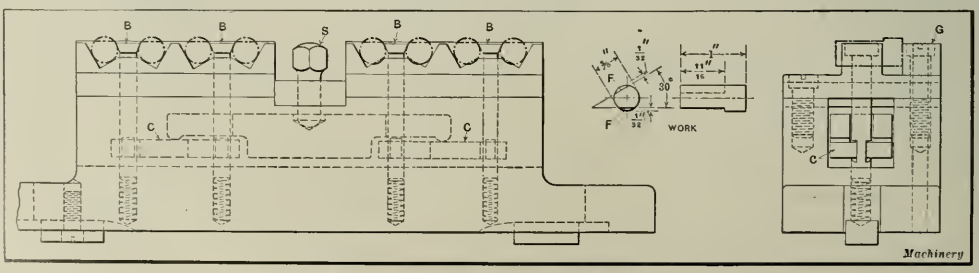
MAKING TABLES ON TRACINGS

When titles and tabular matter have to be changed, as is often the case in drawing-room work, the lines of the table usually become erased, as well as the data. The extra amount of work involved is needless and can be avoided by following the method here recommended. If the lines forming the table in which the data are entered are placed on the back of the tracing, erasures may be made without danger of impairing the appearance of the table on the blueprint. Obviously much time will be saved by following this simple idea. The appearance of the drawing will also be preserved, for the patching up of partly erased lines usually spoils their appearance. The writer has found this practice of value and thinks that it will doubtless be useful to other draftsmen who have not previously been familiar with it.

Philadelphia, Pa. John Kloster

MILLING FIXTURE

The milling fixture here described and illustrated was used for holding the work shown in the illustration while milling the two flats *F* at a 30-degree included angle. Each block on which the work is held has double vees machined in it, between each pair of which there is a bolt with a wedge-shaped head that clamps the work. These bolts are spring-actuated, and linked together so as to be operated by one screw *S*. Links *C* are slotted at each end, and in these slots



Special Milling Fixture and Type of Work for which it is used

the slabbed portion of each bolt fits. This arrangement is more clearly shown in the end view. The left-hand side of the fixture carries four pieces of work during the first milling operation, while at the right-hand side the remaining flats are milled, the work being located from the previously milled surfaces. In machining the vees in the right-hand side of the fixture to bring all cuts in line, the surfaces against which the flats bear had to be made a little higher than the surfaces of the vees contained in the left-hand side of the fixture. The work abuts against strip *G*, which serves not only as a stop for the work but also as a gage for the depth of cut.

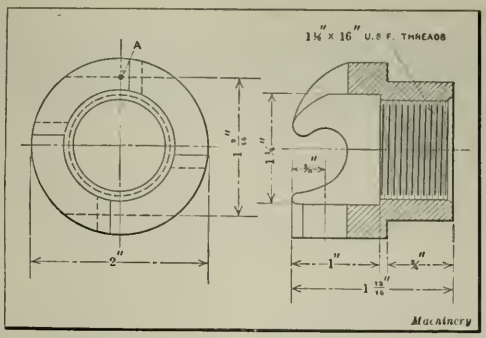


Fig. 1. Crankshaft Gear Nut in which Four Notches are milled

Richmond Hill, N. Y. J. PLASTARAS

MILLING CLAW NOTCHES

For the purpose of milling four claw notches in the crankshaft gear nut shown in Fig. 1, a special milling fixture was designed. This fixture is illustrated in Fig. 2, which also shows the work in place and its relation to the cutter when performing the operation. The nuts are made of cold-rolled steel, cyanide hardened. The preliminary operations consist of drilling, reaming, counterboring, and tapping. Two flats are then milled on opposite sides, after which the piece is ready to be machined in the special milling fixture. The base of the fixture contains a slot 1¼ inches wide by means of which it is located on the milling machine table at an angle of 45 degrees. The fixture is secured to the table by means of bolts engaging the T-slots. The cutter shank *B* is driven into the machine spindle, and the form cutter *A* screwed on, both members being held in the spindle by means of a ¾-inch draw-bolt. The crankshaft gear nut is screwed on the threaded end *C* of the fixture spindle, the wrench being applied to the flats previously milled in the sides of the work. After the work has been thus firmly screwed in place, a lever *D* is inserted in the end of the work-spindle for the purpose of rotating the work through an arc of 90 degrees. As the rotation occurs, cam *E* advances the work against the force of coil spring *G* so that it is brought into contact with the revolving cutter.

This operation is done manually, and at the termination of the travel the claw is milled to the correct shape. After each groove has been milled the index-pin *F* is removed and the spindle indexed 90 degrees before taking the next cut. It is obvious that the action of spring *G* will force the spindle back from the cutter immediately after the operator releases the lever *D*. Care must be exercised when setting the fixture on the machine so that the correct distance from the spindle will be obtained, and the center line of the machine spindle should lie in the same plane as the center line of the work-spindle and be set so that the cutter will be brought into contact with the work at point *A*, Fig. 1. It is necessary that this relation between the work and the cutter be obtained, as otherwise the cutter may cut into the lower side of the work.

This fixture was originally used on a small horizontal milling machine, the production rate being five minutes per piece from floor to floor. Although the fixture is hand-operated, it has been used for machining various sizes of these nuts and has given entire satisfaction. The degree of accuracy that is obtainable by the use of this fixture depends principally upon the accuracy of the cam slot. Obviously a new cam slot must be designed for each new nut in order to take care of the clearances between the cutter and the work, which are very small.

Pittsburg, Pa. W. OWEN

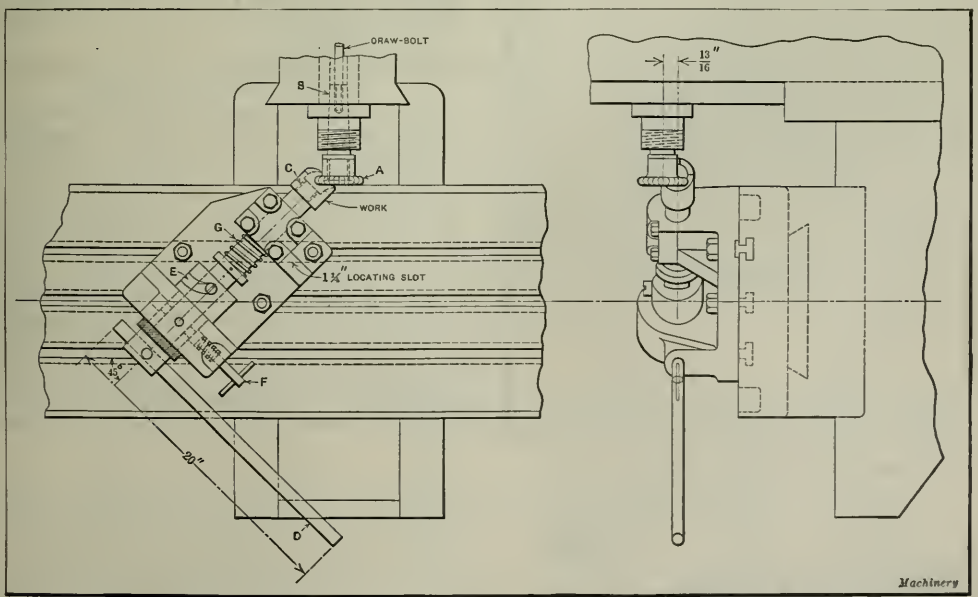


Fig. 2. Special Milling Fixture used in machining Claw Notches in a Crankshaft Gear Nut

FINDING THE RADIUS OF A SMALL DISK

The accompanying diagram illustrates a method for determining the radius r of a disk or cylinder by means of a depth micrometer used in connection with a V-block and a ground disk of known diameter. Measure the distance H from the top of the standard disk to the top of the piece that is to be tested, using a depth micrometer, and calculate r from the following formula, in which R represents the radius of the standard disk.

$$r = R - H \ (2.41422)$$

The derivation of the formula is as follows: In the triangle CDE,

$$b = 45 \text{ degrees} = \frac{a}{2}; \ CD = R + H; \text{ and } CE + X = R.$$

But

$$CE = (R + H) \cos b$$

and

$$X = r - r \sin b = r (1 - \sin b)$$

Therefore, substituting for CE and X,

$$(R + H) \cos b + r (1 - \sin b) = R$$

$$r (1 - \sin b) = R - (R + H) \cos b$$

$$= R (1 - \cos b) - H \cos b$$

$$r = \frac{R (1 - \cos b) - H \cos b}{1 - \sin b}$$

$$r = R \frac{1 - \cos b}{1 - \sin b} - H \frac{\cos b}{1 - \sin b}$$

But

$$\frac{\cos b}{1 - \sin b} = \frac{\cos b}{\text{vers cos } b} = \sec b + \tan b$$

Therefore

$$r = R \frac{1 - \cos b}{1 - \sin b} - H (\sec b + \tan b)$$

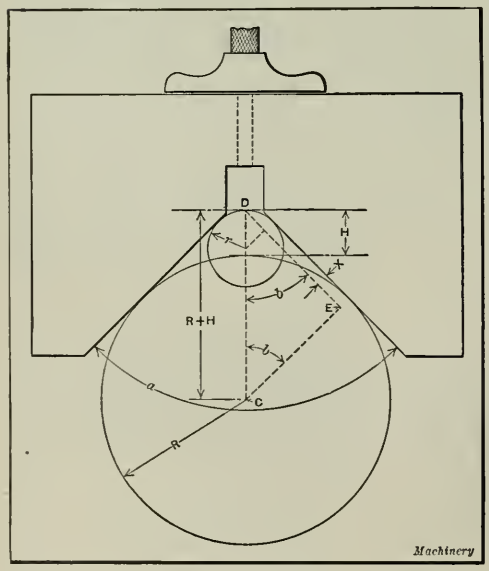


Diagram illustrating Method of determining Radius of a Ground Disk or Cylindrical Part

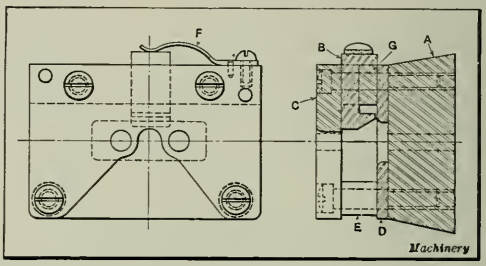
Now since angle b equals 45 degrees, $\frac{1 - \cos 45 \text{ degrees}}{1 - \sin 45 \text{ degrees}} = 1$; and sec 45 degrees + tan 45 degrees = 2.41422

$$r = R - H \ (2.41422)$$

Richmond College, Va. V. E. AYRE

AUTOMATIC EJECTOR FOR PIERCING DIES

The device here described may be applied to almost any piercing die and will save a great deal of time by ejecting the work after it has been stripped from the punch without the necessity of removing it from the nest by hand. This ejector is positive in action and can be readily applied for ejecting almost any type of small work. After the work has been pierced and while it still sticks to the punch, it travels up with the punch and bears against the inclined face of the ejector B, forcing this member back against the tension of the leaf spring F. As soon as the work has been stripped,



Device for ejecting Work from Punch Press

the spring immediately snaps the ejector forward and knocks the work clear of the die, so that if a deflector plate or other suitable arrangement is employed, the part can be deposited by means of a chute into a suitable receptacle. When applying this ejector, the riser or separator strip G must be made slightly higher than in the conventional construction, so as to allow it to be slotted for the reception of the ejector B. The stripper is supported at the front of the machine by means of bushings E. It is well, if practicable, to cut away the stripper in front, as shown in the illustration, to facilitate loading. If the production is large enough to warrant it, a magazine and automatic feed may be advantageously used, and for such a combination this ejector adapts itself admirably. If so desired, the attachment may be applied on either side of the die instead of at the back as shown.

Montclair, N. J. ROY V. TERRY

* * *

MOTOR MANUFACTURERS ADOPT RESOLUTION AGAINST METRIC SYSTEM

The Motor and Accessories Manufacturers' Association, at its spring meeting in Atlantic City, adopted a resolution to the effect that the members of the association had formally registered their opposition to the adoption of the metric system on the grounds that it is uneconomic, and that the disadvantages of the metric system are not offset by the advantages. The association expressed its belief that the benefits of the metric system do not justify the enormous expense which would be entailed through the necessary changes in sizes of product and equipment, and through the education of employes and customers. The association went on record as being in opposition to any legislative action which would make the metric system of weights and measures obligatory, and commended to the members of the association the work of the American Institute of Weights and Measures in opposing the compulsory adoption of the metric system.

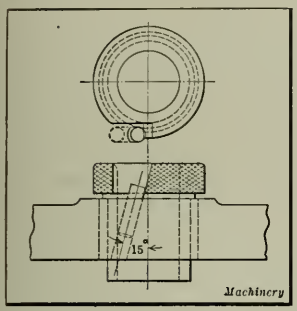
* * *

It has been estimated that the total available water power in the British Isles is about 1,500,000 horsepower, and that the United Kingdom possesses only 1 per cent of the water power and 2½ per cent of the total coal resources of the world. On the other hand, the blast furnaces of Great Britain are said to waste annually 1,000,000 horsepower through not making full use of the waste blast furnace gases.

SHOP AND DRAFTING-ROOM KINKS

SLIP BUSHING FOR DRILL JIG

The slip bushing shown in the accompanying illustration will be seen to be of very simple design. It has a portion milled out at an angle of 15 degrees from the vertical in its outside circumference. In the body of the jig a small dowel-pin hole is drilled at the same angle, so that when the dowel-pin is driven in, it will align with the milled portion of the bushing and prevent it from turning. On account of its angular position the pin also keeps the bushing from working out of the jig when the drill is at work and when the tendency of the accumulated chips is to force the bushing from the jig. In other respects, the bushing is of the standard type with the usual knurled head.

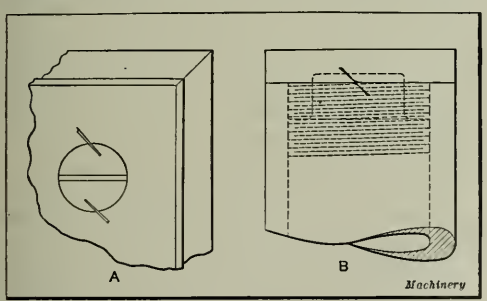


Drill Bushing with Dowel-pin for preventing it from revolving

B. S.

PREVENTING THE LOOSENING OF THREADED FITS

In assembling, it is frequently necessary to guard against excessive vibration when the parts are fastened by means of screws or when they are screwed together. The peening action produced by vibration is liable to develop looseness. The simple means described here has been used extensively on this kind of work and although simple chisel cuts are used to lock the parts together, these cuts will not mar the appearance of the work if they are neatly and symmetrically placed. A sharp pointed chisel should be employed and the chisel marks should be located as shown at *A* if a round-head screw is employed to hold the parts together. These cuts raise burrs which by their interlocking and overlapping position, will prevent to a considerable degree the loosening of the parts by vibration. The chisel should be held at the proper angle and the cut should be made in the direction indicated; otherwise a cut will be produced which will not give the desired results. The view at *B* shows a cap screwed on a sleeve, the two parts being held together by the same method. In this case the chisel cut is placed diagonally across the joint.

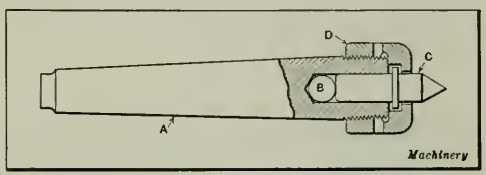


Chisel Cuts, if made with care, may be employed to prevent Parts assembled by Screws from coming loose

Allentown, Pa. JOE V. ROMIG

REVOLVING LATHE CENTER

The accompanying illustration shows a revolving lathe center designed by the writer, which has proved very satisfactory in supporting both light and heavy work. The center consists of a machine-steel shank *A*, a tool-steel ball *B*, a tool-steel center *C*, and a machine-steel cap *D*. Ball *B* and the shank of center *C*, which is ground to size, are inserted into the drilled and reamed hole in the end of shank *A*, after which cap *D* is screwed on the shank by means of a spanner wrench. Center *C* revolves freely when the work in the lathe is rotated, ball *B* taking up the thrust produced on the center. Some means should be provided for occasionally furnishing lubricant to the ball. When center *C* becomes so worn that it can no longer be reground to the proper shape, it is easy to make a new one.



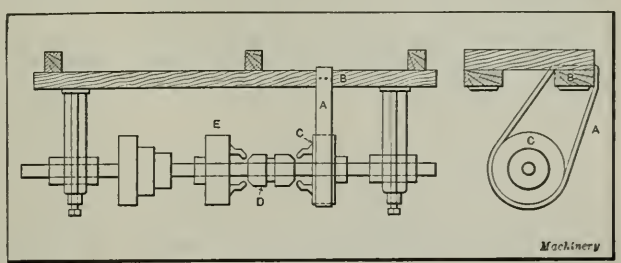
Design of Lathe Center in which the Center rotates freely with the Work

Bridgeport, Conn. GUSTAVE F. BAHR

BELT BRAKE FOR COUNTERSHAFT

In many shops, belts will be found so placed over the cone pulleys of lathe heads that they can be used as hand-brakes, thus enabling the operator to stop the rotation of the lathe spindle quickly. While this arrangement is effective, it is not as good as one the writer noticed recently. A leather brake-band *A* was fitted over pulley *C* on the countershaft and fastened to the hanger boards *B* with lag screws and washers. By throwing the shifter lever over so as to disengage the cone *D* from the open belt pulley *E* and engage it directly with the clutch of the reverse pulley *C*, the machine can be brought to a dead stop instantly, thus allowing the operator to remove and replace the finished work in the chuck without loss of time.

Cicero, Ill. J. J. BORKENHAGEN



Countershaft equipped with Brake-band

Slippage Factor in Belt Design

THE great variety of belt applications makes the problem of determining the transmitting power of belting difficult without reference to the many variables that enter into the consideration of any drive. In machine shops, for instance, some of the belts operating near the ceilings are apt to be dry, while others are saturated with oil. On woodworking and textile machinery, belts are often run at very high speeds and over small pulleys, and are constantly surrounded by a fine dust which greatly affects their adhesion to the pulleys. The desirability of being able to determine the proper size of belt for a given transmission becomes more and more important as the cost of belting increases, and although this subject has received much consideration, there is still a great deal to be known before it can be considered as adequately understood. In an article recently published in the *Sibley Journal of Engineering*, by W. N. Sawdon, a review is made of many experiments on the belting problem in the past and of tests made by the writer himself in endeavoring to determine the effect of belt speed upon the coefficient of friction and slip.

Results of Experiments Made by Wilfred Lewis

The first experiments made under conditions corresponding to practical operating conditions were made by Wilfred Lewis for William Sellers & Co., and reported in 1886. The machine designed for the purpose was provided with a dynamometer; a tension weighing mechanism by which the tension in the belt could be measured while the machine was operating as well as when at rest; a slip meter by which the sum of the slips on the pulleys could be accurately measured; and a prony brake for absorbing and measuring the power delivered by the driving pulley. The belt could be tightened or loosened by moving the carriage on which the driven pulley was mounted, in the proper direction. Previous to this time it had been universally assumed that the sum of the tensions in the two sides of a belt remain constant for a given initial or standing tension. The experiments made by Mr. Lewis, however, showed that this is not even approximately true, but that this sum may increase indefinitely. He obtained values of the coefficient of friction varying from 0.251 for a dry oak-tanned belt to 1.38 for a rawhide belt.

The results of the experiments were summed up as follows: (1) The coefficient of friction may vary under practical conditions from 25 to 100 per cent. (2) Its value depends upon the nature and condition of the leather, the velocity of sliding, the temperature, and the pressure. (3) A velocity of sliding equal to 1 per cent of the belt speed is not excessive. (4) With horizontal belts, the sum of the tensions in the two sides of the belt may increase indefinitely as far as the breaking strength of the belt. (5) The economy of belt transmission depends principally upon journal friction and slip. (6) Belt speeds should be as high as possible within the limits of 5000 to 6000 feet per minute. Mr. Lewis also found that the slip due to the extension of the belt is from 1½ to 2 per cent, and therefore 2 per cent slip may be considered allowable and proper.

Effect of Pulley Surface on Belt Slip

In 1909, Carl Barth published a mathematical analysis of the experiments of Mr. Lewis, in which he presented an equation for finding the coefficient of friction. From this equation another was derived to represent the horsepower which a belt would be expected to transmit. Charts and tables for conveniently solving belt problems were also constructed by Mr. Barth. This is considered the most authentic work on this subject up to the present time, but the fundamental assumptions are based upon experiments with one kind of pulley surface, and could not be expected to apply to surfaces in general.

The tests made by Mr. Sawdon were performed in 1910 upon the same machine as used by Mr. Lewis. This machine had been rebuilt but, with the exception of the dynamometer, its operation was precisely the same as when used by its designer. The pulleys used were made of cast iron, and in the preliminary tests it was discovered that the carrying capacity was low, and that as soon as the slip exceeded about 2 per cent, it was impossible to keep the belt on the pulleys. Upon inspection it was found that the pulley surfaces still bore tool marks and were slightly rough, so they were dressed down with emery cloth and oil until all traces of the tool marks were removed and the faces had a smooth polished appearance. With the pulleys in this condition it was found that the slip for small loads was materially increased, but that the belt could be kept on the pulleys without difficulty with slips as high as 10 per cent, and the carrying capacity of the pulleys was greatly increased.

Variation of Belt Slip During Experiment

Another difficulty then developed, and this was the inability to get slip observations which would check from day to day when the speed, tension, and power transmitted were the same. This led to taking continuous slip observations for long intervals of time with the tension fixed and the speed and load constant. It was found that, in general, the slip was high when the load was first applied and that it gradually decreased to what appeared a normal condition, at which time the percentage of slip was very low. It usually required from a few minutes to as much as twenty minutes for this condition to be reached. Changes of slip, however, occurred at any time, during which the slip would increase to an amount even greater than the initial slip and then would gradually decrease as before. The tests were made at a belt speed of 2200 feet per minute and with different conditions of tension and load.

Relative Slip on Pulleys Made from Different Materials

A comparison was also made between the action of cast iron, paper, wood, and cast-iron pulleys with cork inserts. The variation in slip was much less marked with the other pulleys than with cast iron. The following results were obtained in comparing the carrying capacities when the tension was approximately 170 pounds per square inch of belt section, the speed 2200 feet per minute, and the slip 1 and 2 per cent, respectively. Taking cast iron as unity, the comparison made with a slip of 1 per cent was as follows: Cast-iron pulleys, 1; wood pulleys, 1.55; cast-iron cork-inserted pulleys, 1.69; and paper pulleys, 2.40. When the slip was 2 per cent, the results were as follows: Cast-iron pulleys, 1; wood pulleys, 1.14; cast-iron cork-inserted pulleys, 1.34; and paper pulleys, 2.53.

Recent experiments tend to show that the creep is very nearly proportional to the load; that it amounts to 1 or 2 per cent, depending upon the kind of pulleys used and the tension; and that if the load is increased beyond the point where true slipping occurs, the slip increases very much more rapidly than the load, and an unstable condition is soon reached. It would then seem that the point at which real slipping commences should be to the belt designer what the elastic limit of steel is to the bridge designer, and that drives should not be designed to operate beyond the limit of creep.

Activities of the American Engineering Standards Committee

THE Swiss Standards Association has addressed a communication to the national engineering standardizing bodies of various countries, proposing the international standardization of the widths across flats of nuts and bolt heads. The proposal covers bolts ranging from ¼ inch to 3 inches (6 to 80 millimeters) in diameter. The numerical values proposed are a compromise between the U. S. standard, the British or Whitworth, and the metric "Systeme Internationale." This communication has been addressed to the standardizing bodies of America, Belgium, England, France, Germany, Holland, and Sweden.

The American Engineering Standards Committee has requested the American Society of Mechanical Engineers and the Society of Automotive Engineers to act as joint sponsors in the matter, leaving to their decision the question as to whether a new sectional committee shall be organized for the project, or whether the work shall be done by a sub-committee of the sectional committee on screw threads, for which the same two societies are acting as joint sponsors.

Standardization of Structural Shapes

On the entrance of the United States into the war there came a demand for an immediate increase in ship construction which, in turn, meant an increased production by the steel mills. To increase production to the maximum and to simplify the practice followed in ordering structural shapes, a conference of steel makers was held in Washington July 2, 1917, at which American standards for structural steel for ships were adpoted.

Later it appeared that the British standard sections of ship channels and shipbuilding bulb angles were better adapted to economical manufacture than the American standard sections, and as the new rolls which had been turned in recent years to produce such sections conformed in general to British standards, it was decided at another conference of steel makers held in Philadelphia on November 19, 1918, that thereafter American standard sections should be discontinued. Rolls not then coinciding with British standards were to be redressed at as early a date as possible to correspond to British standards. It was believed that the adoption of British standard sections would enable American mills to compete on an even basis for ship steel wherever it is utilized in shipyards, either at home or overseas.

It was subsequently discovered that a revision of the British standards by the British Engineering Standards Association had been in process in 1913, and that this had been interrupted by the war activities. This association advised American steel manufacturers of the situation and expressed its desire to have them cooperate in the formulation of common Anglo-American standards for steel shapes. At the instance of the Association of American Steel Manufacturers, a sectional committee on steel shapes was organized under the auspices of the American Engineering Standards Committee for this purpose. This sectional committee gave very careful consideration to the entire routine of structural practice in the United States, not only as it affects the profiles of structural shapes themselves, but also as regards methods of ordering shapes, and the calculation and publication of weights, areas, and properties, etc., with the idea of insuring as far as possible a complete accord between makers and users wherever the sections rolled in English-speaking lands were used. At its meeting held on April 27, 1920, it formulated its recommendations for submission to its sponsor organizations, to the American Engineering Standards Committee and to the British Engineering Standards Association as a basis for common Anglo-American standards, and its conclusions are now to go before these organizations for further discussion and endorsement. The essential features of these recommendations may be obtained by addressing the American Engineering Standards Committee, 29 W. 39th St., New York City.

Standardization of Pipe Flanges and Fittings

The American Society of Mechanical Engineers has been requested by the American Engineering Standards Committee to assume sponsorship for the standardization of pipe flanges and fittings. In 1914, this society issued a report covering a schedule of pipe flanges and fittings from 1 to 100 inches in diameter for 125 pounds pressure; and from 1 to 48 inches in diameter for extra heavy pipe for 250 pounds pressure. In 1918 a supplementary report was published for working pressures of 50, 800, 1200, and 3000 pounds.

Standardization of Shafting

The American Society of Mechanical Engineers has also been invited to act as sponsor for the standardization of shafting. This society has already done a considerable amount of work on a set of standard diameters for transmission and machinery shafting. It is proposed that the work shall be broadened to include the standardization of the method of determining what diameters of transmission shafting should be used for given loads, the dimensions of shafting keys and keyways, and the setting of dimensional tolerances.

Standardization of Plain Limit Gages

A sectional committee of the American Engineering Standards Committee has been organized to undertake the standardization of plain cylindrical gages for general engineering work, also under the sponsorship of the American Society of Mechanical Engineers. The immediate occasion for undertaking this work was a request by the British Engineering Standards Association for cooperation on the subject. It is understood that this committee will recommend that the scope of the work be broadened to cover all plain limit gages for general engineering work.

Standardization of Safety Codes

Definite arrangements have been made by the American Engineering Standards Committee for the formulation of a considerable number of safety codes. The subjects of the codes for which arrangements have been completed, together with the organizations which will act as sponsors, are as follows: Abrasive wheels, the Grinding Wheel Manufacturers of the United States and Canada, and the International Association of Industrial Accident Boards and Commissions; explosives, the Institute of Makers of Explosives; foundries, the American Foundrymen's Association and the National Founders Association; gas, the United States Bureau of Standards and the American Gas Association; head and eye protection, the United States Bureau of Standards: paper and pulp mills, the National Safety Council; power presses, the National Safety Council; pressure vessels, non-fired, the American Society of Mechanical Engineers; refrigeration, mechanical, the American Society of Refrigerating Engineers; and woodworking machinery, the International Association of Industrial Accident Boards and Commissions,

and the National Workmen's Compensation Service Bureau. A large representative advisory committee of specialists organized by the National Safety Council, the National Workmen's Compensation Service Bureau, and the Bureau of Standards is to decide what additional codes are urgently required and what organizations are in the best position to undertake sponsorship for such codes.

Ball Bearing Standards

In order to cooperate with the Swiss Standards Association in standardizing ball bearings, the committee requested the American Society of Mechanical Engineers and the Society of Automotive Engineers to act as joint sponsors for the project. These societies have accepted and are now organizing a committee that will be thoroughly representative of all the interests involved and be responsible for the detailed formulation of the standards.

There are national standardizing bodies in Belgium, England, France, Germany, Holland, Sweden, and Switzerland, while one is in process of organization in Italy. The American Engineering Standards Committee is in active cooperation with some of these international bodies, the most important project at the present time being that of standardizing steel sections.

* * *

CLEVELAND MANUFACTURERS REPORT ON THE METRIC SYSTEM

One of the most complete reports in opposition to the compulsory adoption of the metric system that has so far been published is that of the Committee on Industrial Development of the Cleveland Chamber of Commerce, upon which committee some of the most prominent members in the machine tool and small tool industry in Cleveland served. This report goes into considerable detail in regard to the points of opposition to the metric system, and contains a detailed statement of the estimated cost of installing the metric system in the office, selling, and administrative departments of a large Cleveland manufacturing establishment. According to the report, the total cost for this entire plant would be $473,965. The report is quite concise and clear, and is of especial value because it goes into details rather than dealing with generalities. The strongest claims made are doubtless those that point out that the English system is already overwhelmingly used in the industrial field. It is mentioned, for example, that the United States makes more than one-half of the screw products of the world and that the system already in use is, therefore, the most interchangeable of any systems which are in use at the present time. It is further pointed out that about 50 per cent of all machine tools manufactured in the world are made in the United States and that 82 per cent of the total business in the machine tool field originates in the United States and in Great Britain, both of which use the English system.

In conclusion the report states: "A great majority of manufacturers are on record as opposing the adoption of the metric system under one of the three heads: (1) It offers no advantage over the present system of inch measurements. (2) It is a very expensive procedure to introduce it. (3) It will produce great complications during the period of transition."

The committee, after consideration of its investigation and of the facts that have come to its attention, earnestly urges the Chamber of Commerce to go on record as being absolutely opposed to the compulsory adoption of the metric system of weights and measures in this country, and strongly recommends that the Chamber of Commerce direct communications to the members of the Committee on Coinage, Weights, and Measures of the Congress of the United States, and to all of the representatives of Ohio in the Congress of the United States, opposing a legislation which will, in their opinion, be disastrous to all of us. The report may be obtained upon application to the Cleveland Chamber of Commerce.

AUTOMOTIVE ENGINEERS PASS RESOLUTION AGAINST METRIC SYSTEM

At the meeting of the Society of Automotive Engineers at Ottowa Beach, Mich., June 22, the members present passed a resolution to the effect that the society is opposed to the compulsory adoption of the metric system. It was further decided to send copies of the resolution to the members of the House and Senate Committees on Weights and Measures. At an earlier meeting the Aeronautic Division of the Society of Automotive Engineers recommended that the English system of measurements be used, except in isolated cases. This decision was unanimously adopted, not only by the Division of Standards, but by the society.

In order to ascertain the views of members of the society many of whom did not attend the convention, a questionnaire was sent out by *Automobile Topics*, and the results published in the June 26 number under the heading "Metrics Not in Favor," the results being that out of 967 votes, 250 favored the compulsory adoption of the metric system in this country and 717 were opposed to its adoption. In answer to the question of preference for personal use, 295 expressed a preference for the metric system for commercial reasons, while 546 preferred our present system. For scientific reasons 410 favored the metric system and 364 were opposed. It is interesting to note that while 659 indicated that they had used the metric system to some extent, only 250 voted in favor of legislation to bring about its adoption in this country.

The statements above are given on the authority of the publicity service of the American Institute of Weights and Measures, 115 Broadway, New York City.

* * *

PROPOSED SIX-YEAR ENGINEERING COURSES

There is considerable discussion at the present time as to the advisability of a longer and more thorough education of engineers, and some of the engineering societies have placed themselves on record as favoring a six-year engineering course beyond the high school. At Columbia University, New York City, the engineering course in the engineering school is only three years, but not less than three years of college training, including special preparation in mathematics, chemistry, and physics, is required for admission. Besides the Columbia course, the only other engineering course that definitely requires six years is the mining engineering course at Leland Stanford University. Six years is a long period of training after high school, and before it becomes general, it is to be hoped that a very thorough study will be made of the actual requirements in engineering work, and that such studies as are found to be of only secondary value be eliminated before the courses are extended. Furthermore, full use should be made of the time available during the year, for the college year, as a rule, makes use of but a part of the actual time available. A few engineering schools have set a fine example in this respect in that the students are at work practically throughout the entire year, with little or no more vacation than is granted in ordinary commercial work.

* * *

THE GERMAN MACHINE TOOL INDUSTRY

At the annual meeting of the Society of German Machine Tool Manufacturers in Dresden, June 14, Mr. Reinecker reviewed the present conditions in the machine tool industry in Germany. He called attention to the fact that the industry had suffered considerably from the disturbances in the labor market and from the high prices of raw materials. Six hundred firms are now members of the society and plans are made for an exposition of machine tools at Leipzig during the latter part of August and early in September.

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW AMERICAN METAL-WORKING MACHINERY

Diamond Heavy Face Grinder. Diamond Machine Co., 9 Codding St., Providence, R. I. 1181
Van Norman Bore Grinder. Van Norman Machine Co., Springfield, Mass. 1183
Ney Draw-in Chuck. J. M. Ney Co., Hartford, Conn. 1184
Rouillard Planer and Shaper Tool-holder. Rouillard Tool Corporation, 608 Chestnut St., Philadelphia, Pa. 1185
Wetmore Cylinder Reaming Sets. Wetmore Reamer Co., Milwaukee, Wis. 1185
Keller Dial Test Indicator. Atcheson Tool & Die Co., 609-611 N. 4th St., Columbus, Ohio 1186
Drilling Machine. Frontier Machine Tool Co., Inc., 128 Lakeview Ave., Buffalo, N. Y. 1186
Purves Drilling Attachment for Milling Machines. Purves Mfg. Co., 408 S. Franklin St., Syracuse, N. Y. 1186
Miller "Anyangl" Lighting Fixture. Miller Saw-Trimmer Co., Pittsburg, Pa. 1187
"Natco" Inverted Drilling Machine. National Automatic Tool Co., Richmond, Ind. 1187
Hasler Integrating Tachometer. C. H. Boulin, 82 Duane St., New York City 1187
J. C. Glenzer Interchangeable Counterbore. J. C. Glenzer Co., Detroit, Mich. 1188
R. G. Smith Radius Tool. R. G. Smith Tool Works, 315 Market St., Newark, N. J. 1188
Ross Centrifugal Lubricant Pump. Ross Mfg. Co., 3160 W. 106th St., Cleveland, Ohio 1189
Newton Special Milling Machine. Newton Machine Tool Works, Inc., Philadelphia, Pa. 1189
Bryant Chucking Grinder. Bryant Chucking Grinder Co., Springfield, Vt. 1190
Betts Continuous Milling Machine. Betts Machine Co., 400 Blossom Road, Rochester, N. Y. 1190
C. F. Davis Keyseater. C. F. Davis Machine Co., Inc., 133 Andrews St., Rochester, N. Y. 1191
Gardner Abrasive Disk. Gardner Machine Co., Beloit, Wis. 1191
Rickert-Shafer Chaser Grinder. Rickert-Shafer Co., 612 W. 12th St., Erie, Pa. 1191
Oliver Motor-driven Surface Planer. Oliver Machinery Co., Grand Rapids, Mich. 1192

Diamond Heavy-Duty Face Grinder

This grinding machine is intended for heavy work ordinarily performed on planers or large millers. The general features of the design are similar to those of face grinders of this company's manufacture equipped with ring-wheels up to 30 inches in diameter. The present machine has a sectional type of wheel 54 inches in diameter, and all other dimensions of the machine have been correspondingly increased to give the desired capacity for handling large pieces of work.

FOR several years the Diamond Machine Co., 9 Codding St., Providence, R. I., has been building machines known as heavy face grinders, which have found successful application in handling certain classes of work that are ordinarily done by planing or milling machines. Until recently these heavy face grinders have been built with ring-wheels up to 30 inches in diameter. Acting upon suggestions from manufacturers who believe they have work that could be economically ground on a machine of this general design but of larger capacity, a face grinder constructed along the same lines has been built with a sectional type of wheel 54 inches in diameter, and it will be used in a machine tool building plant for grinding the bases of multiple-spindle drilling machines. Although most of the original principles of design of Diamond face grinders have been retained, the machine has been entirely remodeled to afford increased capacity and to give it the necessary strength and rigidity for the heavier stresses encountered in handling larger pieces of work.

It is believed that this new Diamond 54-inch face grinder is one of the largest grinding machines which has ever been built, and this fact will be readily substantiated by reference to the following dimensions: As previously mentioned, the wheel is 54 inches in diameter, and it is carried by a 9-inch spindle supported in adjustable bronze-bushed radial bearings and ball thrust bearings. The table is 36 inches wide by 9 feet long, with a travel of 11 feet, and the distance from the table surface to the top of the wheel is 48 inches, which gives capacity for grinding work 47 inches high. From the floor to the center line of spindle, the distance is 55 inches.



Fig. 1. Fifty-four-inch Heavy-duty Face Grinder built by the Diamond Machine Co.

One of the features of the new Diamond grinder is the provision which has been made for handling water and the means provided for effectually protecting all slides and other rubbing surfaces from damage. Reference to the rear view of the machine will make it apparent that there is a tank arranged to hold the necessary volume of water in such a way that there is a large surface area and only a moderate depth. This arrangement is the means of facilitating the settling of sediment, so that clear water can be returned to the circulating system. Behind the table at each side of the machine, there is also a long trough that catches the water from the wheel; and in addition, there is a trough which extends around the two ends and front of the machine at the floor level, and communicates through by-passes with the main water tank. A system of troughs inside of the bed carries water from the long troughs behind the table back to the water tank. It will be apparent from the illustration that water is carried up to the grinding wheel and the work by means of a belt-driven pump.

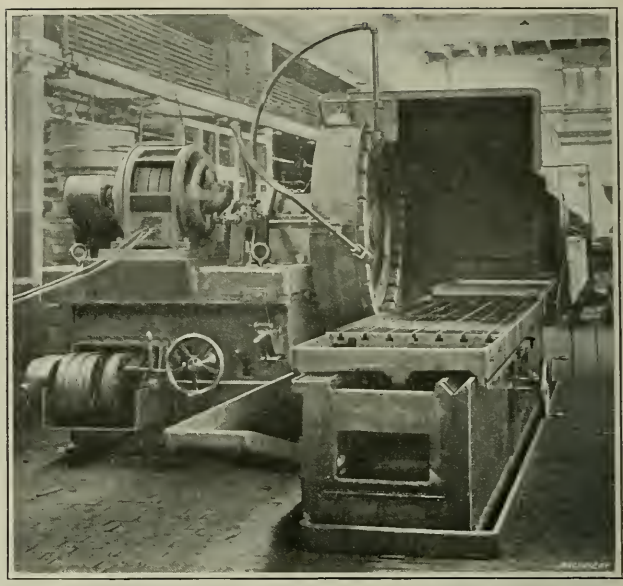


Fig. 3. End View of Diamond Face Grinder, showing Control Mechaniam

To those who are not familiar with the features of previous models of Diamond face grinders, it will be apparent from the illustrations that the present machine is arranged with a table that provides for reciprocating the work past the grinding wheel, and the wheel-head is mounted on a transverse slide to enable the wheel to be fed inward for grinding to the required depth. The maximum transverse feed movement is 5 inches and provision is made for moving the wheel-head either automatically or by hand. One of the new features of the present machine is an automatic feed-stop which may be set to provide for tripping the power feed when the grinding wheel has removed the desired depth of stock from the work.

In operating this grinder, the normal position for the attendant is as shown in Fig. 1, where he is able to observe the cutting action of the grinding wheel. However, it may happen that the operator wishes to go to the opposite side of the table while the machine is running, and it is desirable for him to have the machine under control while in that position. Consequently, two centralized sets of control wheels and levers have been provided, one of which is within reach of the normal operating position and one is at the front of the bed. The control mechanism at the front of the grinder includes a knob for manipulating the power-feed clutch, a lever for operating the table feed, another lever for manipulating the table reverse, and a handwheel for providing a hand-feed movement to the table; also, there is a lever governing the clutch on the main driving shaft. Located at what has been designated as the normal operating position, there are a feed-clutch lever, a table reverse lever, a wheel for obtaining hand feed for the grinding wheel head, an automatic depth stop for the table feed, and means for stopping the table travel at either end of its stroke.

Normally, a grinding machine of this type will be operated for considerable periods of time on a single class of work, and it is not necessary to change the rate at which the work is reciprocated past the grinding wheel, but provision has been made by the designers for obtaining four rates of table travel. This is accomplished by having a pair of change-gears contained in a case at the back of the machine, which can be removed from their studs to allow a new pair of gears to be substituted. By making such changes, speeds of 12, 17.33, 22.66, and 28 feet per minute are obtainable. The grinding wheel head feeds into the work at each reversal of the table, that is to say, there are two feed movements of the wheel-head for each complete forward and return movement of the table. This feeding of the wheel-head is accomplished by means of a cam-actuated pawl which engages the teeth of a ratchet wheel mounted on the feed-screw. The handwheel which adjusts this feed mechanism to govern the amount of feed that is imparted to the grinding wheel at each reversal of the direction of table travel is furnished with two graduated dials, one of which indicates the amount of feed that will be obtained for any given position of the adjusting wheel, while the other dial shows the total amount of metal removed from the work for any given position of the grinding wheel head. The feed mechanism furnished on the machine provides for obtaining feeds of from 0.002 to 0.020 inch per stroke of the table.

In conclusion, attention is called to the arrangement of guards at either end of the table, which project out far enough so that the ways are always covered regardless of the position of the table. Consequently, it is highly improbable that water, grit, or other foreign material will find its way into the bearings and cause them to become scored or rapidly worn. Another important feature of this grinder, from an operating standpoint, is

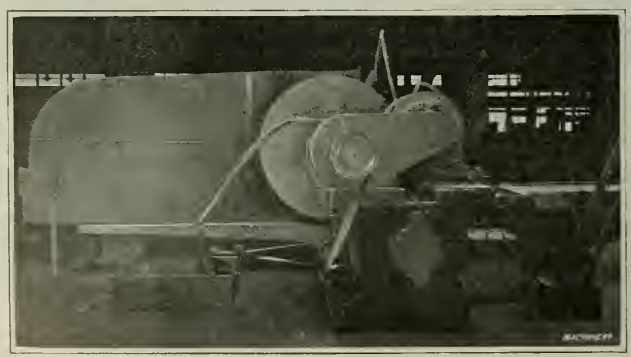


Fig. 2. Rear View of the Diamond Heavy-duty Face Grinder, showing Water Troughs, Motor Drive, etc.

the provision of conveniently located oil-holes around the frame of the machine, which are covered by pivoted plates conspicuously marked with the word "oil." From each of these holes an individual tube leads to one of the important bearings of the grinder; and with such an arrangement as this, it is so simple for the operator to oil the bearings on his machine that there would appear to be very little excuse for overlooking any of the parts of the mechanism that require the supply of lubricant to be replenished at specified intervals. Power for driving the machine is furnished by a 40-horse-power electric motor.

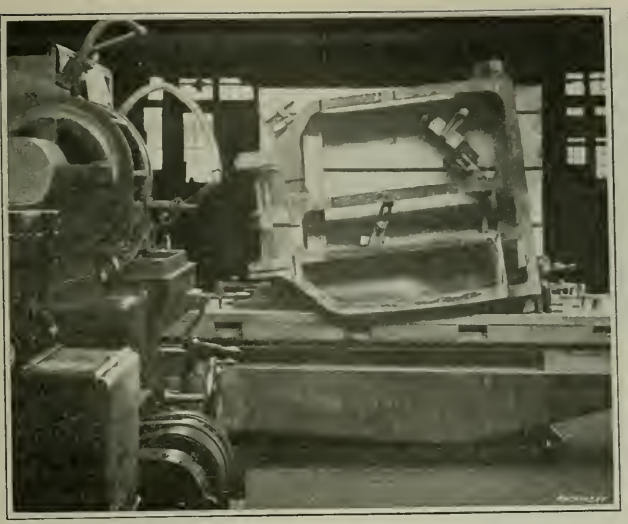


Fig. 4. Close-up View of a Casting set up on the Machine for grinding

VAN NORMAN BORE GRINDER

The Van Norman Machine Co., Springfield, Mass., has recently placed on the market a No. 9 bore grinding machine which is adapted both for small work and for larger work up to 20 inches swing; that is, a work-holding fixture of 20 inches diameter may be used with the head set to hold the work in alignment with the grinding wheel quill. The machine is equipped with the standard Van Norman type of sliding head, and resembles somewhat the No. 34 machine of this company's make. The provision for grinding large-diameter work includes a deep gap in the machine body. Reference to Fig. 1, which is a front view of the bore grinder, will enable this feature in the construction of the frame to be seen, while Fig. 3 illustrates the capacity of the machine for large-diameter work. This underslung construction of the frame of the machine, together with its compactness and rigidity, are noteworthy features of construction. The design of the base offers a unique method of motor installation; the motor is housed in the frame and is enclosed by a door in front. The advantage of this location for the motor will be apparent by inspecting Fig. 2, which shows a rear view of the machine and the short direct belting used in the drive. This arrangement reduces the space required and adds to the compactness of the machine.

The Work-spindle Head and the Grinding-wheel Quill

The construction of the work-head is illustrated in Fig. 4. The spindle is mounted in double sets of ball bearings, each pair being separated by a spacing collar which enables the correct adjustment to be obtained when mounting the spindle in the head. This is accomplished by grinding the face of the outer collar to take up the end play of the spindle. The rear bearings are floating in the work-head, and the inner raceways are held in a fixed position relative to the front bearings by a sleeve which runs in oil, distributing it from wipers *A* to the rear pair of ball bearings by an oil-tube, and to the other pair from the deep oil-groove *B*. The oil-well in which the spindle sleeve runs is provided with a window so that the supply of oil can be instantly seen.

The construction of the grinding-wheel quill is illustrated in Fig. 5, from which it will be seen that it is mounted on ball bearings similar to the mounting of the work-spindle. As in the case of the work-head, an oil reservoir with sight window provides a plentiful lubricant supply for the bearings of the quill spindle. It will be noted, in both the spindle head design and in the quill mounting, that the cap which encloses the ball bearings is provided with dirt grooves to safeguard the running condition of the ball bearings.

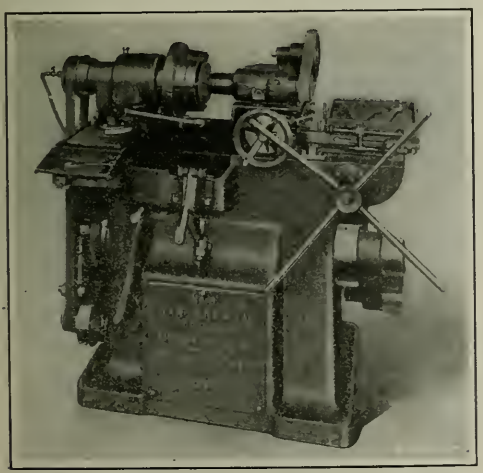


Fig. 1. Front View of Van Norman No. 9 Bore Grinder

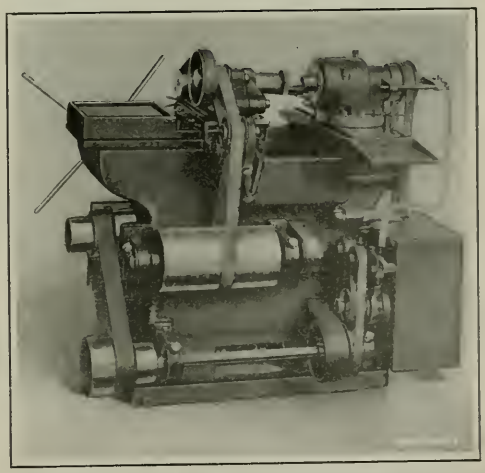


Fig. 2. Rear View, showing Pulleys belted through Frame

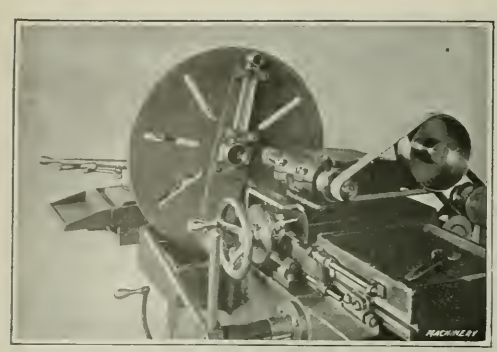


Fig. 3. Work-spindle in Offset Position carrying Large-diameter Work-holding Fixture

Operating Features of Machine

The No. 9 bore grinder is a hand-operated machine as regards traverse of the wheel-slide, but is provided with automatic cross-feed with graduated dial. The regular Van Norman work-spindle slide is operated by a hand-lever shown in Fig. 1, which permits the head to be slid out of alignment with the wheel-spindle when removing or gaging the work, the grinding wheel only having to be withdrawn a short distance from the end of the work. A self-acting brake mechanism stops the rotation of the work-spindle when the slide is drawn into an offset position. All operating levers have been arranged so that it is not necessary for the grinder to change his position during the grinding operation. The safety from physical injury with which the operator can test or remove the work when the head is in the offset position is a notable feature.

There is a sector-shaped plate carried on the work-head slide which has a T-slot in which a stop is fastened for the purpose of enabling the operator to bring the center line of the work-head in line with that of the grinding wheel. By employing two of these stops in the T-slot, to limit the swing of the operating lever in either direction, the grinding of work having two diameters of holes and an interior shoulder may be greatly facilitated. In grinding work of this kind, where it is desired to face-grind either the interior shoulder or outside edge of the work, a cup-wheel is used. One slide stop is then set, locating the work-head transversely for grinding the small-diameter hole, and the wheel-carriage stop is set to bring the end of the grinding wheel into position for facing the interior surface, when the carriage is brought back against the stop. Then by employing a second stop in the T-slot of the work-head slide, and by throwing stop *A* up out of engagement, the operating lever of the slide may be swung into engagement with the second stop, thus locating the work in the proper position for grinding the large-diameter hole. It will be seen that by locating the second stop to bring the work into the position necessary for grinding the larger diameter, the three interior surfaces will be ground at one setting.

The wheel dresser is attached to the box section on the frame as shown in Fig. 1 so as not to interfere with the operator, and can be swung into position when desired. Fig. 2 shows the position of the coolant supply tank and its connection to the spindle, and to the drip box from which the fluid drains into the supply box. A centrifugal pump is shown attached to the coolant box for pumping the liquid to the work. The drum and pulley shafts are mounted in self-aligning ball bearings. The cone pulley provides three grinding wheel speeds, as determined by the size of quill pulley with which the machine is equipped. Quill pulleys of recommended size for the particular work being ground are furnished with the machine, if so desired.

When the machine is equipped with a wheel dresser, it has a capacity for grinding holes to a depth of 4½ inches; when the dresser is not attached, the depth of hole capacity is 6 inches. The maximum diameter of work-holding fixture permissible when the head is not set at an angle is 20 inches. The maximum forward movement of the work-slide is 8 inches. The work-head is graduated 30 degrees each side of the center for convenience in grinding tapered work. Six work-spindle speeds are provided, ranging from 72 to 431 revolutions per minute, in geometrical progression. The regular grinding spindle speeds, using quill spindles and pulleys of recommended size, range from 3400 to 19,000 revolutions per minute, depending upon the diameter of work being ground. The machine is belt-driven throughout, no gears or chains being used. The distance above the floor to the center of the head-spindle is 43 inches; the floor space required is 39 by 63 inches. A constant-speed 3-horsepower electric motor, running at 1200 revolutions per minute, is considered standard construction. Regular equipment includes one standard wheel quill to suit the work, and pump and water attachments for wet grinding. The net weight of the machine is 2950 pounds; boxed, 3500 pounds.

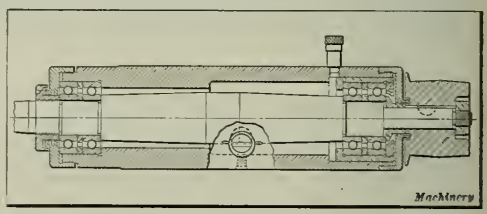


Fig. 5. Ball-bearing Mounted Quill Spindle for Van Norman No. 9 Grinder

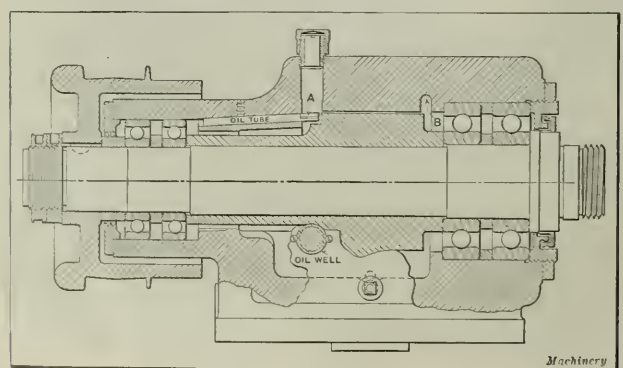


Fig. 4. Cross-section of Work-spindle, illustrating Spindle Mounting and Oiling System

NEY DRAW-IN CHUCK

The draw-in collet chuck shown in Fig. 1 has recently been placed on the market by the J. M. Ney Co., of Hartford, Conn. The long tube and handwheel which is ordinarily employed on a lathe spindle for operating a draw-in type of chuck is not used with these chucks. One of the outstanding features of this chuck is the fact that it is quite hollow and leaves the entire opening in a lathe spindle free from obstructions. When doing lathe work or performing milling operations on a long broach or similar work, it is possible to feed the work out of the chuck as the machining operation progresses. This feature makes the chuck well adapted for performing certain operations on both hand and automatic screw machines.

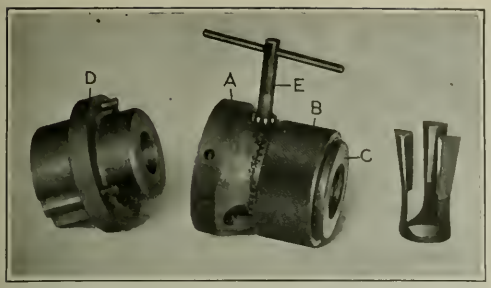


Fig. 1. Draw-in Chuck made by the J. M. Ney Co., and Collets of Various Sizes used in the Chuck

It is claimed that the chuck is equally well adapted for use on milling machines, grinders, or drilling machines. Its regular adaptation to the lathe is illustrated in Fig. 2. Each chuck is furnished with six collets ranging in size from ⅜ to 1 inch, and each collet may be used on work 1/32 inch over or under the nominal size. Referring to Fig. 1, the chuck consists of a body *A*, a knurled sleeve *B*, a nose-piece *C*, an adapter *D*, and a pinion key *E*. The nose-piece is threaded on the outside to fit the internal threads of the sleeve. By turning the sleeve, a longitudinal movement of the nose-piece is obtained, the nose-piece being prevented from rotating by a key located in the body. This longitudinal travel brings the nose-piece against the collet, causing it to draw in by being forced into the round cone-shaped opening within the body, which fits a similar conical shape on the outside of the collet. With this arrangement, adequate tightening pressure is obtained through the gear teeth on the sleeve and the pinion key *E*.

The longitudinal thrust which is imparted to the sleeve is taken up by a row of twenty-six ball bearings which insure easy operation of the chuck at all times. The collets are readily accessible, and can be changed by turning the sleeve until the nose-piece can be removed. The body and other members are made of machine steel, pack-hardened and accurately ground on all working surfaces. The collets are made of tool steel and are accurately ground. The adapter *D*, which is of cast iron, is furnished in a semi-rough condition. It has three drilled and counterbored holes properly spaced to correspond with three tapped holes in body *A*. There are also three tapped holes in the rim of the adapter into which screws may be put if it becomes necessary to remove the adapter from the body.

The portion of the adapter which enters the body is purposely furnished considerably larger than the hole in the rear of the body to insure perfect concentricity of the chuck when it is fitted to the machine on which it is to be used. In adapting the chuck for use on a lathe, it is customary to place the adapter in a chuck and thread it to fit the spindle of the lathe. After this operation has been accomplished, it is only necessary to screw the adapter on the nose of the lathe and turn the front end to a snug fit for the hole in the body. An interesting test of the holding qualities and rigidity of the chuck is illustrated in Fig. 2, where a 1-inch cold-rolled bar protruding 5½ inches from the face of the chuck was reduced to ½ inch in diameter using a 1/32-inch feed, without apparent spring of the chuck or work.

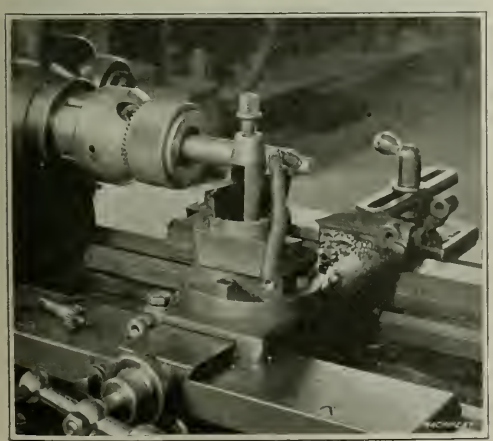
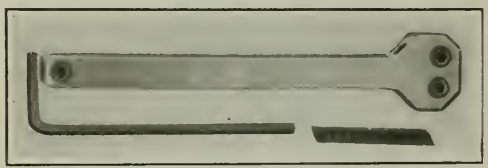


Fig. 2. Ney Draw-in Chuck mounted on Lathe

ROUILLARD PLANER AND SHAPER TOOL-HOLDER

The Rouillard Tool Corporation, 608 Chestnut St., Philadelphia, Pa., has recently brought out the double-ended tool-holder shown in the accompanying illustration. No rake angle is provided for the tools at either end of this holder. On one end the tool slot is parallel with the body of the holder, thus providing a suitable holder for use in planing flat surfaces. The other end has two slots at opposite angles with separate set-screws for each. With this arrangement of tool slots, it is possible to perform almost any kind of planing operation without removing the holder from the toolpost. These holders are furnished with one tool bit and a wrench for the headless set-screws, and they can be obtained in seven sizes. They are made of drop-forgings and are pack-hardened.



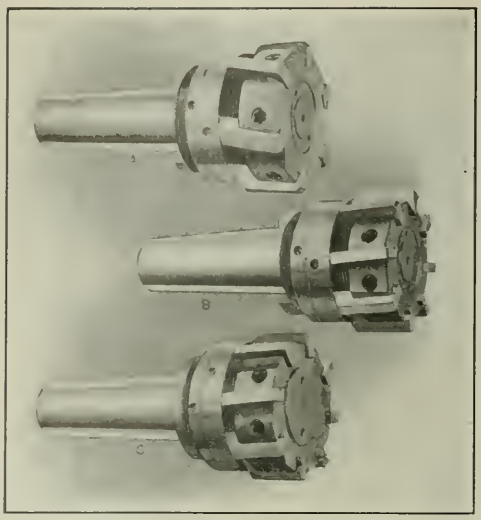
Double-ended Tool-holder made by the Rouillard Tool Corporation

WETMORE CYLINDER REAMING SETS

A new cylinder reaming set has been added to the line of reamers made by the Wetmore Reamer Co., Milwaukee, Wis. This set, which is shown in the accompanying illustration, consists of three tools: A roughing reamer, a semi-finishing reamer, and a floating finishing reamer. This set of tools has been designed for the purpose of producing as nearly as possible holes which are round, straight, and smooth. The roughing reamer shown at *A* is of heavy construction, and is intended to withstand the strains imposed by the initial reaming operation. It is equipped with adjustable blades set at a right-hand angle, and provision is made for replacing the blades when worn.

The semi-finishing tool shown at *B* has blades set at a left-hand angle, similar to the standard Wetmore floating reamer. The purpose of setting the blades in this manner is to eliminate the liability of digging in and chattering, so that a free, round hole that is not scored when backing out will be produced. It may be stated here that a modification of this reamer is made for line and pilot reaming.

The floating finishing reamer shown at *C* has the parts which give the reamer its floating action incorporated in the head of the tool at the point directly under the strain which the floating action is intended to counteract. It is claimed that this feature eliminates all tendency of the reamer to get out of parallel or to cramp. The floating action is obtained through the use of an improved type of Oldham coupling having rollers instead of sliding contacts to reduce friction. The floating mechanism is protected from dust and grit by a cap at the front of the tool and a washer which

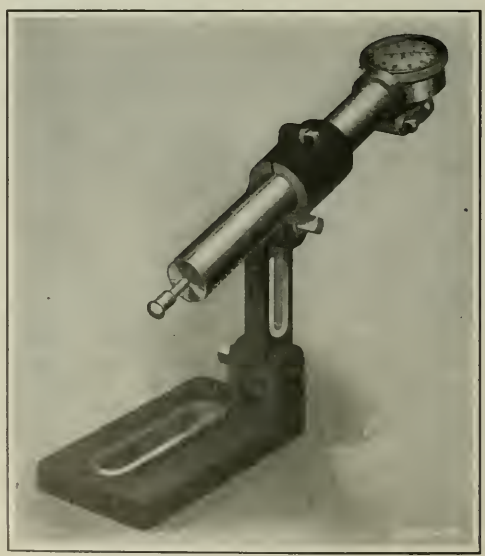


Set of Cylinder Reamers made by the Wetmore Reamer Co.

protects the back. Both the semi-finishing reamer and the finishing reamer can be adjusted to thousandths of an inch by means of a graduated micrometer lock-nut located at the rear of the blades. At present, these sets can be furnished in sizes varying from 2 7/16 to 5 9/16 inches in diameter.

KELLER DIAL TEST INDICATOR

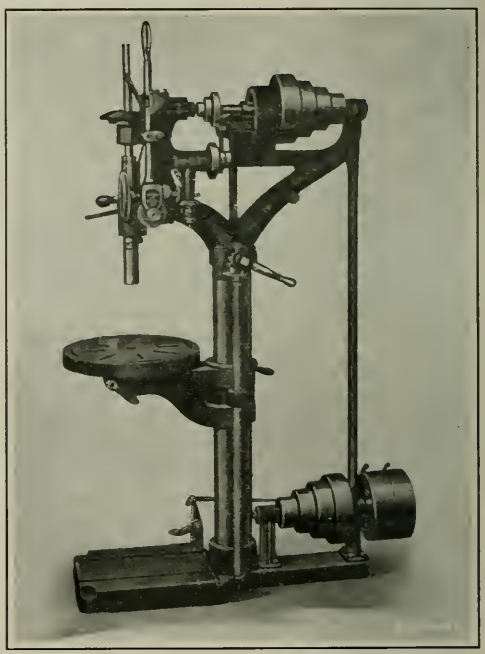
The indicator shown in the accompanying illustration is a recent product of the Atcheson Tool & Die Co., 609-611 N. 4th St., Columbus, Ohio. This indicator is designed to meet the requirements of a wide range of work, and is especially adapted for gaging cylindrical work while it is being rotated. Referring to the illustration, it will be seen that the dial indicator is mounted at the end of a mandrel fitted in a split bushing. The indicator pin extends through this mandrel and is provided with a hardened and polished tip which rests on the work. It will be seen that the split bushing is connected to a slotted base by an adjusting link, so that it is a simple matter to locate the indicator in any desired position. The dial is especially designed for easy reading, and is graduated in thousandths. Some of the advantages claimed for this indicator are that it requires no great skill to obtain the most accurate results, that it takes a wide range of work, eliminates the time lost in stopping the machine to measure the work and that the contact point is more sensitive than the human sense of touch.



Keller Indicator made by the Atcheson Tool & Die Co.

FRONTIER DRILLING MACHINE

The vertical drilling machine shown in the accompanying illustration is made by the Frontier Machine Tool Co., Inc., 128 Lakeview Ave., Buffalo, N. Y. This machine has been especially designed to meet the requirements of high-speed production. The most notable feature is the double column which is intended to resist the heavy pressure applied by the spindle. All controlling levers have been designed and located with a view to making the machine easy to operate.



Drilling Machine made by the Frontier Machine Tool Co.

PURVES DRILLING ATTACHMENT FOR MILLING MACHINES

The milling machine attachment shown in the accompanying illustration is made by the Purves Mfg. Co., 408 S. Franklin St., Syracuse, N. Y. With this attachment holes can be drilled at any angle varying from vertical to horizontal. In order to drill a hole at any desired angle, it is only necessary to place the work flat on the table, and throw the vertical head to the desired position; then attach the device and proceed as when drilling a vertical hole.

Practically the only difference in the drilling operation is that the drill is fed into the material with a small handlever which is part of the attachment. The feeding attachment is movable, so that it can be changed in case it interferes with any part of the work being drilled. The depth



Angle-drilling Attachment made by the Purves Mfg. Co., shown in Position on Milling Machine

of the holes can be controlled by a stop, which when once set, permits the drill to penetrate to the required depth but no further. Hence, the device enables the operator to drill a number of horizontal holes of the same depth.

MILLER "ANYANGL" LIGHTING FIXTURE

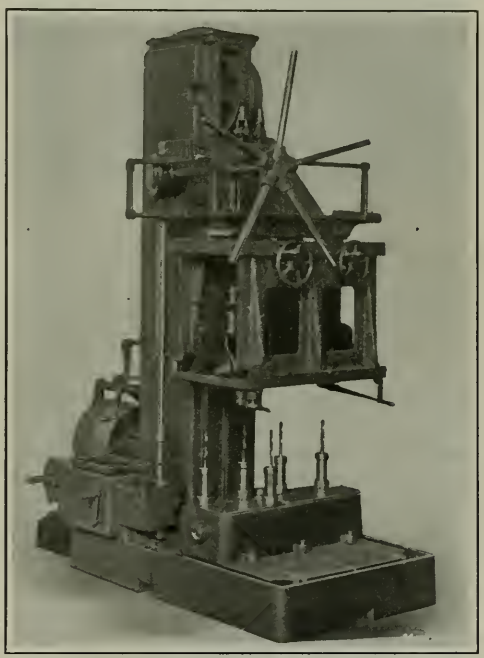
The "Anyangl" lighting fixture shown in the accompanying illustration is made by the Miller Saw-Trimmer Co., Pittsburg, Pa. This fixture is designed especially for attachment to lathes, planers, shapers, millers, and similar machines that require proper distribution of light in order to insure speed, accuracy, and safety of operation. The lamp with its reflector and protecting cage can be swung through a complete circle, either vertically or horizontally. This feature of universal adjustment permits the light to be projected in any direction or concentrated where needed. A simple twist of the thumb-screw at the joint which connects the extension arm to the supporting rod securely locks the lamp in position where it cannot be loosened by vibration.



"Anyangl" Lighting Fixture attached to Shaper

"NATCO" INVERTED DRILLING MACHINE

In the bottom of the Studebaker cylinder block, there are five holes to be drilled, which are 9/16 inch in diameter by 4¾ inches deep. Experience has shown that the drilling of such holes is likely to prove a troublesome operation, owing to the necessity of backing the drills out a number of times in order to clear the chips which have a tendency to clog in the drills. To overcome this difficulty and to provide for simultaneously drilling the five holes, the National Automatic Tool Co., Richmond, Ind., designed a No. 85 "Natco" inverted multiple-spindle drilling machine, which has the drills held in adjustable spindles located under the work. The cylinder block to be drilled is placed in a fixture supported on the table which feeds downward when the operation is performed. Under such conditions, the chips fall out of the holes by gravity, making it unnecessary to back the drills out of the holes until they have reached the desired



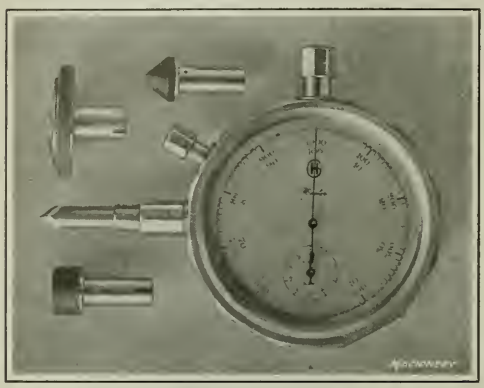
Inverted Multiple-spindle Drilling Machine built by the National Automatic Tool Co.

depth. The work is located in the fixture by means of two disappearing dowel-pins which are controlled by a lever at the bottom of the fixture. After being located, two handwheels at the top of the fixture are rotated to tighten up a clamping mechanism that forces the work down on a bushing plate at the bottom of the fixture.

HASLER INTEGRATING TACHOMETER

In the accompanying illustration there is shown an instrument known as the Hasler integrating tachometer, because it counts the speed over a period of three seconds and then "integrates" the result to give the desired information in terms of revolutions per minute or yards per minute. In using this instrument, no watch is needed, as the timing is obtained automatically. Attention is called to the fact that the danger of an error in using a watch is eliminated. In using this instrument, the operator is merely required to press a large button after connection has been made with the machine. This requires no mental concentration and en-

ables the operator to devote his undivided attention to maintaining contact between the instrument and the machine. Once the contact is made with a shaft, the spindle of the instrument runs freely until the large button is pressed down and released. This makes direct connection with the hands on the dial. After running for three seconds the spindle is automatically freed while the hands remain in the reading position; and after the reading has been taken, the



Hasler Integrating Tachometer for which C. H. Boulin has the Sales Agency

hands may be instantly brought back to zero by pushing a small button.

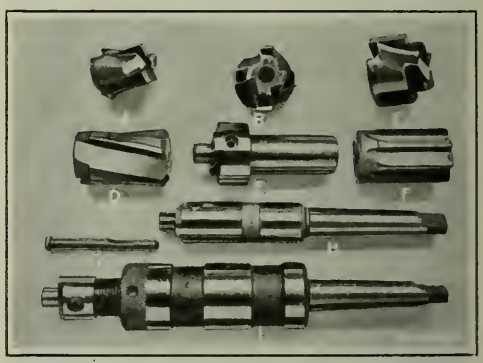
When it is required to take two or more readings, this may be done without pushing the small button, the last result being added to the first. If several measurements are taken in succession, the total result obtained automatically is divided by the number of readings to show the average speed. Naturally, such a practice would be followed only where the speeds of all machines are uniform. The operation of the instrument is entirely mechanical and it is not affected by magnetism, gravity, or centrifugal force. The clockwork is made by French and Swiss mechanics and is said to be entirely independent of temperature changes. The instrument is packed in a case, which also contains three different types of rubber connections, but which is small enough to be put in an ordinary pocket. The instrument is made of aluminum so that it weighs only 10 ounces. This tachometer can be operated in any position either vertical, horizontal, or at any angle, and it has a large speed range, namely from 1 to 10,000 revolutions per minute. The long hand indicates speeds from zero to 1000 revolutions per minute and the short hand, running over a separate dial, counts the number of thousands. By carefully noting the number of revolutions made by the small hand, speeds in excess of 10,000 revolutions per minute can be determined. Either revolutions per minute or yards per minute may be read directly on the dial without requiring any mathematical calculations, both the large and small dials having a second set of graduations in red to indicate speeds in yards per minute. This instrument is sold by C. H. Boulin, 82 Duane St., New York City.

J. C. GLENZER INTERCHANGEABLE COUNTERBORE

The interchangeable counterbores shown in the accompanying illustration are manufactured by the J. C. Glenzer Co., Detroit, Mich., and are sold by C. H. Westerberg & Co., Inc., 9-11 West Broadway, New York City. With the exception of the tool shown at *H*, which is similar to one described in the May, 1918, number of MACHINERY, these tools represent entirely new developments of the J. C. Glenzer Co. Referring to the illustration, it will be seen that the construction of these interchangeable tools is simple. A complete tool consists of only four separate parts, the pilot (which is not shown), a pin, cutter, and holder. The parts were designed to give as nearly as possible the strength of a solid tool with the advantages of the interchangeable feature.

The pilot is of cold-rolled steel, hardened and ground, and made in the form of a bushing with notches at one end into which the teeth of the cutter fit, insuring a positive drive. The pilot is brought down to fit over the cutter teeth and below the cutting edge of the cutter, thus preventing burring in the hole—a condition which usually causes the pilot to stick or break. The pilot is self-centering with reference to the cutter teeth, and is made 0.005 inch under size up to sizes ¾ inch in diameter, and 0.008 inch under size for diameters over ¾ inch. When cored holes are to be counterbored, a core drill, driven in the same manner as the pilot, may be substituted for the pilot, thus eliminating one operation, as both core-drilling and counterboring will be accomplished simultaneously. The pins, one of which is shown at *G*, are made of 3.5 per cent nickel steel, and are accurately ground. The tapered flat at one side forms a bearing for the set-screw and serves to tighten the parts. The pins carry no strain and simply hold the parts together. The cutters are made of the highest grade high-speed steel, and are ground, hardened, relieved, and slotted to receive the lug in the holder, which gives a positive drive. The regrinding of a cutter is a simple operation, and may be repeated until the cutter is nearly all used.

The cutter shown in the accompanying illustration at *A* is designed to counterbore and countersink a valve set at one operation. The cutter shown at *B* is employed in making dies for bottle caps, and that shown at *C* is designed to face, groove, countersink, and counterbore nuts at one operation. The holder shown at *E* is designed for screw machine work, and is adapted for holding any of the various cutters shown in the illustration. At *I* is shown a holder



"Utility" Interchangeable Cutters and Cutter-holders manufactured by the J. C. Glenzer Co.

for a multiple-spindle drilling machine. This is especially designed for use on machines which have no spindle adjustment to compensate for uneven wear of the tools; for instance, it permits a new cutter to be used on a multiple-spindle press in conjunction with ground down cutters. This holder is threaded on an outer sleeve to provide for adjustment, the position being fixed by a lock-nut. The reamer and core drill shown at *F* and *D*, respectively, are interchangeable and are typical examples of the type of tools generally used with the holders.

R. G. SMITH RADIUS TOOL

To meet the requirements of shops which desire to perform concave and convex radius turning operations in a lathe, shaper, or planer, the R. G. Smith Tool Works, 315 Market St., Newark, N. J., has developed a tool-holder that is regularly furnished with a set of cutters made in sizes



Fig. 1. Tool-holder made by the R. G. Smith Tool Works for performing Radius Work on a Lathe, Planer, or Shaper



Fig. 2. R. G. Smith Radius Tool-holder and the Complete Set of Convex and Concave Cutters, Thread Tool and Cutting-off Tool

for handling work on which the diameter of the circle, of which the radius forms a part, covers a range of from ⅛ to 1 inch in diameter by intervals of 1/16 inch. It will be seen that these cutting tools are of circular form with the cutting edge produced by removing a segment from the tool. There is a small shank on one side that enters an opening in the tool-holder, where it is clamped by a set-screw; both the upper and lower cutting edges are ground, so it is possible to enter the shank in the holder opening from either one side or the other, thus providing for the use of both of the cutting edges. In addition to the radius-turning tools, this tool-holder set is furnished with a cutting-off tool and a tool for turning 60-degree threads. Other special cutters or cutters ot other than the standard sizes could be furnished.

ROSS CENTRIFUGAL LUBRICANT PUMP

For delivering the lubricant or coolant to the cutting tools and work on various types of machine tools, the Ross Mfg. Co., 3160 W. 106th St., Cleveland, Ohio, has developed a centrifugal pump which is here illustrated and described. Fig. 1 shows the pump mechanism in detail, and in Fig. 2 the pump is shown set up on a machine ready for operation. From these illustrations it will be evident that driving is accomplished by a pulley which has an internal gear cut on the inside of its rim. This gear meshes with a pinion on the pump shaft. The arrangement of the intake and delivery pipes is apparent from the illustrations.

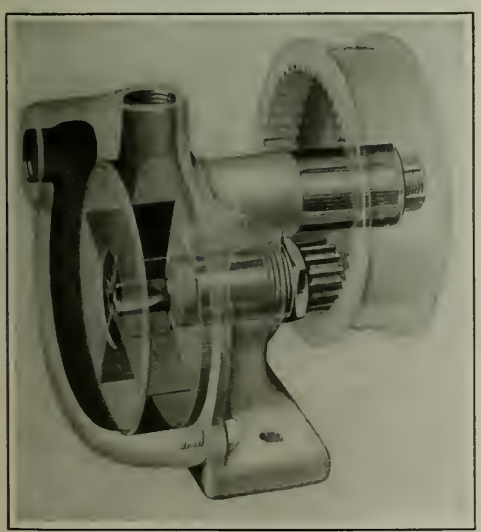


Fig. 1. Centrifugal Lubricant Pump made by the Ross Mfg. Co.

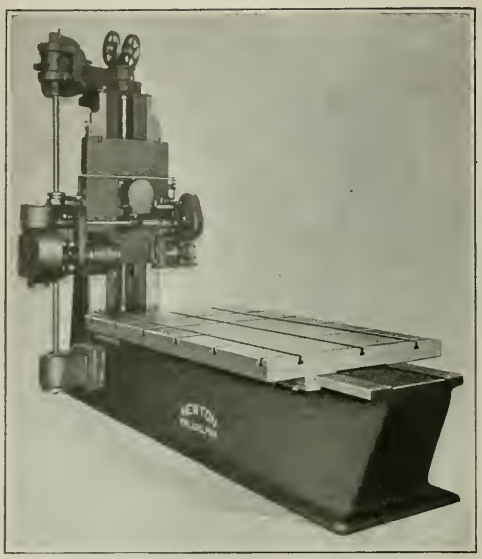
NEWTON SPECIAL MILLING MACHINE

The special milling machine shown in the accompanying illustration was designed and built by the Newton Machine Tool Works, Inc., Philadelphia, Pa., for use in the General Electric Co.'s plant at Fort Wayne, Ind. This machine was designed especially for milling the slots in motor rotors. The dimensions and specifications of the machine are: Diameter of spindle, 5 inches; vertical feed to spindle saddle, 24 inches; maximum distance from center of spindle to top of table, 28 inches; side adjustment to spindle, 2 inches; distance from center of spindle to face of upright slide, approximately 12 inches; size of table, 54 inches by 8 feet; and longitudinal adjustment of table obtained by hand feed, 24 inches.

The spindle of the machine is driven by a phosphor-bronze worm-wheel and hardened steel worm having roller end-thrust bearings. It is fully enclosed and runs in oil. An outboard support is pro-



Fig. 2. Application of the Ross Centrifugal Lubricant Pump

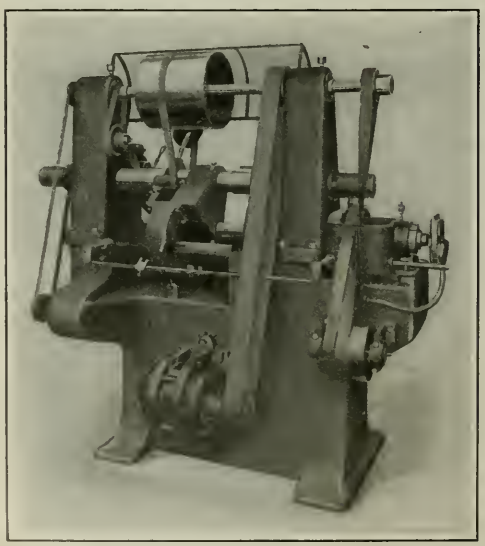


Special Milling Machine built by the Newton Machine Tool Works, Inc.

vided for the arbor, and the design is such that the arbor can be readily removed from the spindle. The spindle saddle has two vertical feeds operating through pick-off change-gears. An automatic stop is provided for the feed motion, which is so designed that the spindle stops rotating when the feed is thrown out. The spindle saddle is counterweighted and has power rapid traverse both up and down, a safety feed stop being provided to prevent damaging the cutters or work in case the rapid traverse gears are accidentally thrown in.

BRYANT CHUCKING GRINDER

The Bryant Chucking Grinder Co., Springfield, Vt., has recently brought out a self-contained grinder which is furnished in two types: A single-spindle hole grinder and a two-spindle hole and face grinder. These grinders are similar in design to the Bryant countershaft-driven machines with the exception that certain modifications have been made in their design which particularly adapts them for motor drive.



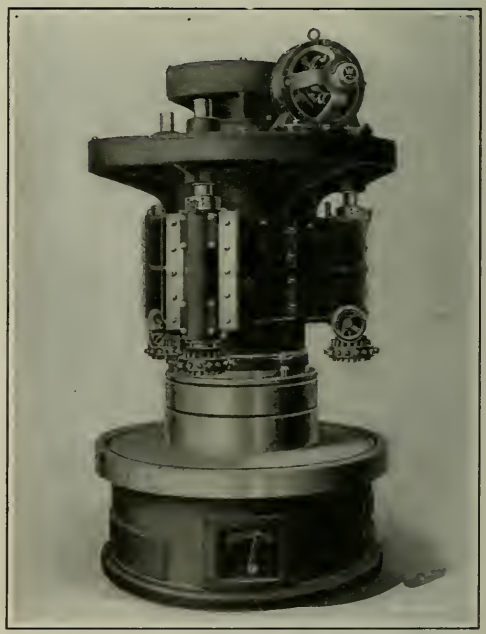
No. 15 Single-spindle Chucking Grinder made by the Bryant Chucking Grinder Co.

The No. 15 single-spindle grinder is shown in the accompanying illustration with the motor attached. This machine will swing work 12⅝ inches in diameter and has a wheel-slide traverse of 11¼ inches. The work-spindle is mounted in adjustable bronze bearings. The front bearing is 3 inches in diameter, the rear bearing 2½ inches, and the distance between the outer faces of these bearings is approximately 17 inches. There are two speeds for the work-spindle and two traverse speeds for the wheel-slide which are instantly obtainable by means of a lever. A graduated plate indicates angular adjustment for grinding tapers from zero up to a 30-degree included angle. The wheel-spindle drive shafts are mounted in ball bearings of the enclosed type. The water pump and piping are arranged to carry water to the work through the hollow work-spindle.

All pulleys and rotating members are given a dynamic balance at the speeds at which they are intended to run when in operation. A 3-horsepower motor having a speed of about 1720 revolutions per minute is recommended, and a 4½-inch diameter pulley is furnished with motors of this speed, which gives the main shaft the required speed of 1075 revolutions per minute. If slower speed motors are used, special sized drive pulleys must, of course, be provided.

BETTS CONTINUOUS MILLING MACHINE

The Betts Machine Co., 400 Blossom Road, Rochester, N.Y., is now building a multiple-spindle continuous vertical milling machine which is here illustrated and described. This equipment is usually provided with three spindles but it can be furnished with more spindles to meet the requirements of work where such a modification of the design is considered desirable. The machine is of simple and rigid construction and it is intended for heavy production milling on duplicate parts. The spindles are made of hammered steel and they are driven through long splines and spur gears.



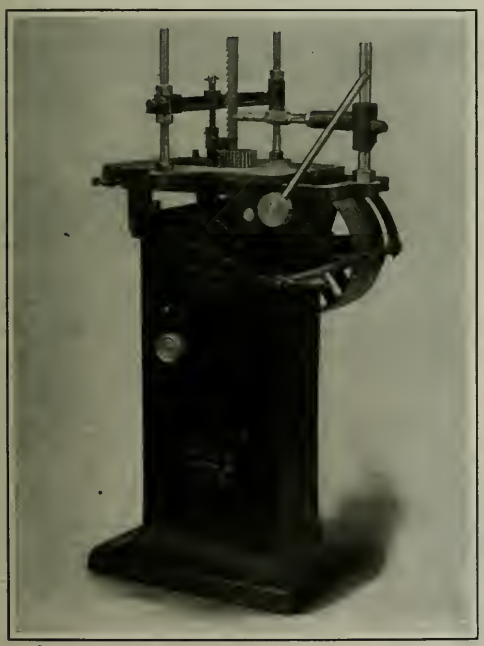
Continuous Milling Machine built by the Betts Machine Co.

Power for driving this miller is furnished by either a pulley or an individual electric motor at the top of the machine. Each of the spindles carries a milling cutter and may be adjusted vertically by hand.

A split tapered bushing provides for taking up wear in the bearing on which the table revolves about the column, in addition to which there is a flat bearing on the bed. The table is driven through a large internal gear, and four rates of continuous feed are obtained through sliding steel gears. All bearings are bronze bushed and all gears run in a bath of oil. None of the gears are ever in mesh except those that are actually transmitting power, so that there is no unnecessary wear. Obviously, the work-holding fixtures must be adapted to the pieces to be milled, and they are carried on a table that revolves continuously. No time is lost in chucking as the work is changed while the fixture is passing from one cutter to the next. It is stated that one of these machines will do as much work as can be handled by two men.

C. F. DAVIS KEYSEATER

The C. F. Davis Machine Co., Inc., 133 Andrews St., Rochester, N. Y., has recently brought out a No. A keyseater, which is shown in the accompanying illustration. This machine is designed to cut internal keyways in gear blanks, pulleys, crank handles, etc., and it can also be used for slotting and oil-grooving. The work is mounted on a bushing which is securely fastened to the table. The cutter is held in a saw block, having lateral adjustment, and travels in a vertical line. The cutter is backed up by an adjustable saw support, which is hinged to facilitate removing the work.



No. A Keyseater made by the C. F. Davis Machine Co.

The table carrying the work is fed against the cutter, thus assuring the keyway being cut the same depth at top and bottom. The proper depth of cut is insured by an adjustable stop located on the table. Keyways can be cut in tapered holes by tilting the table to the required angle. A slotting segment graduated to ⅛ inch taper per foot is located on the left-hand side of the table. This machine will cut keyways 1/16 to ½ inch in width in hubs 6½ inches long when the regular clamping stud is used. Special cutters can be made for cutting keyways up to 1 inch in width. The tight and loose pulleys are 12 inches in diameter by 3 inches face, and their recommended speed is 180 revolutions per minute. The table is 16¼ inches in diameter, and the machine weighs approximately 400 pounds.

GARDNER ABRASIVE DISK



"G. I. A." Abrasive Disk made by the Gardner Machine Co.

The abrasive disk shown in the accompanying illustration has been developed by the Gardner Machine Co., Beloit, Wis., for use on disk grinding machines. This product, which has been called the "G. I. A." (Gardner improved abrasive) disk is somewhat different from the ordinary type. A comparison of the construction of the "G. I. A." disk and the regular type will serve to show the principal difference. There are three ingredients which enter into the manufacture of an ordinary abrasive disk; the cloth backing, the bond, and the abrasive grains. The glue bond type of disk is made by first coating a sheet of cloth with hot glue into which is sprinkled the abrasive grains. After setting has taken place, the sheet is cut into circular forms of proper diameter. The approximate thickness of such a disk is a trifle over 1/16 inch, and a disk 18 inches in diameter with a 5-inch hole will weigh approximately 1 pound, 12 ounces. In the case of the "G. I. A." disk, however, the abrasive grains for the bond are first mixed together, and then applied to the cloth backing so as to produce a thickness of ¼ inch. While plastic, the surface of the disks is corrugated so as to tilt the grains into the best cutting position. The weight of a disk 18 inches diameter with a 5-inch hole is 5 pounds.

RICKERT-SHAFER CHASER GRINDER

The Rickert-Shafer Co., 612 W. 12th St., Erie, Pa., is adding to its line a machine for grinding chasers used in self-opening die-heads. This grinder has a throat grinding fixture



Fig. 1. Column Type Chaser Grinder made by the Rickert-Shafer Co.

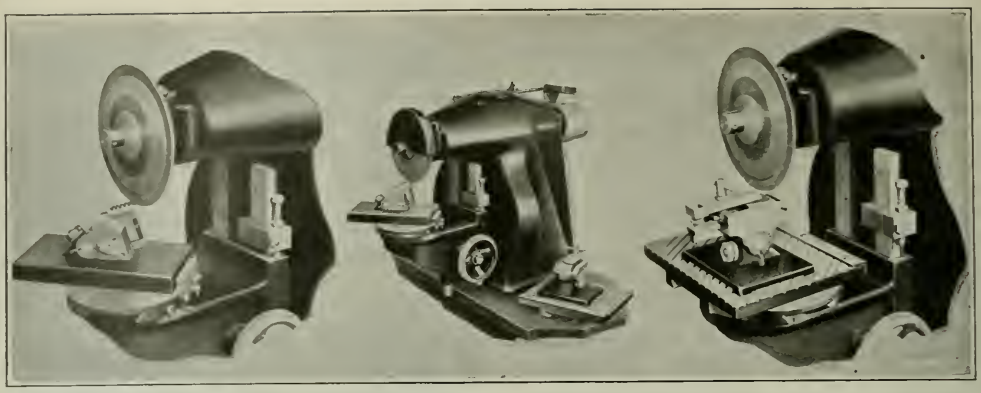
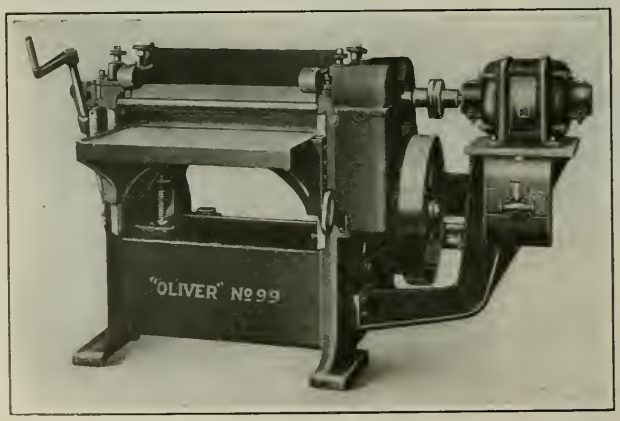


Fig. 2. Throat Grinding Fixture, Bench Type Chaser Grinder, and Face Grinding Fixture

and is equipped throughout with S K F ball bearings. The throat grinding fixture permits chasers for threading ⅛-inch diameter stock and any size up to those for cutting 6-inch stock to be ground by the 6-inch rubber corundum wheel furnished with the machine. To accomplish this, the fixture is arranged as shown at the left in Fig. 2 so that the chaser will be held in the right position to give the desired throat angle. Passing the chaser back and forth under the wheel gives it the radially ground throat which is essential to all hobbed or tapped chasers.

The required throat radius is obtained by adjusting the angle between the fixture slide and the axis of the wheel-spindle. The following will illustrate this more clearly: When the angle between the fixture slide and the axis of the wheel-spindle is zero, the radius ground will be equal to the radius of the wheel, or in this case 3 inches. When the angle is 90 degrees, the radius will be the same as that to which the ⅛-inch thick wheel is dressed or 1/16 inch. In order to grind a radius smaller than 1/16 inch, it is necessary to dress the wheel thinner. A table accompanying the grinder gives the required setting for any radius between 1/16 inch and 3 inches.

This arrangement for varying the radius saves time, as only one size of wheel is required to grind all sizes of chasers. A fixture for grinding the faces of chasers as illustrated at the right in Fig. 2 is also part of the grinder equipment. This fixture is adjustable and graduated so that any desired amount of rake or hook can be given the cutting face, thus adapting the chasers for cutting any material. These grinders are built in either bench or column type and for either motor or lineshaft drive.



Motor-driven Surface Planer made by the Oliver Machinery Co.

OLIVER MOTOR-DRIVEN SURFACE PLANER

The Oliver Machinery Co., Grand Rapids, Mich., has recently brought out the motor-driven surfacer or surface planer shown in the accompanying illustration. This machine is equipped with a self-contained motor drive in which no driving belts or driving pulleys are employed. The motor, which runs at 3600 revolutions per minute, is coupled directly to the cutting cylinder. Three high-speed knives are employed in the cutting head which gives the proper number of cuts per minute.

NEW MACHINERY AND TOOLS NOTES

Adjustable Wrench: Allan-Diffenbaugh Wrench & Tool Co., Baraboo, Wis. An adjustable wrench which automatically grips a nut when the handle is pulled. It is made in several sizes from drop-forged steel and has jaws that are machined and hardened.

Universal Clamps: Burwin Co., Inc., 87 Warren St., New York City. Tools known as the "Force" universal clamps, which are made by the Black Rock Mfg. Co., Bridgeport, Conn., in several styles adapted for holding irregular work on milling machine tables.

Friction Clutch: Link-Belt Co., Chicago, Ill. A friction clutch known as the "Twyncone," which is applicable to any transmission system. This clutch has one point adjustment, and is said to be perfectly balanced so that it will operate satisfactorily at very high speeds.

Steam or Air Engine: H. B. Underwood Corporation, Philadelphia, Pa. A vertical engine built in 3- and 5-horsepower sizes, especially designed for driving portable tools, such as boring-bars and drills. The engine runs at 250 revolutions per minute with 70 to 125 pounds air or steam pressure.

Planing Machine: Powell Machine Co., 245 Stafford St., Worcester, Mass. A 48-inch by 17-foot belt-driven planing machine of the "Hy-Speed-Cut" type. The noteworthy feature of this machine is the accelerating drive which overcomes many of the difficulties heretofore met with in designing planing machines of the heavy-duty type.

Oil Cooler: Griscom-Russell Co., 90 West St., New York City. A device known as the G-R "Multiwhirl" oil cooler, designed for cooling the oil used in the lubrication of turbine bearings and reduction gears, or the quenching oil used in the heat-treatment of steel. It is claimed that the oil can be maintained at the proper viscosity for efficient results.

Automatic Lifting and Tiering Truck: Automatic Transportation Co., 2935 Main St., Buffalo, N. Y. An electric-driven truck designed to pick up and elevate loads with its own power to suitable heights for placing ma-

terial in box cars, on trucks, wagons, etc. It is claimed that the truck will lift a load of 4000 pounds any distance from 1 inch to 6 feet at the rate of 1 foot in 15 seconds.

Starter for Induction Motors: General Electric Co., Schenectady, N. Y. An automatic starter for use with squirrel-cage induction motors driving lineshafts, pumps, compressors, and similar devices. The starter is operated by a push-button or by a float switch, pressure governor, or some similar automatic accessory.

Pneumatic Riveter: Baird Pneumatic Tool Co., Kansas City, Mo. The Baird type of riveter supported on a stand. This riveter is intended for use in riveting traction plates on the rims of pneumatic tires. It has a 10-inch reach and a 9-inch gap, and will deliver a maximum squeeze of 70 tons with 100 pounds air pressure.

Crankshaft Bearing and Flange Turning Lathe: Wickes Bros., Saginaw, Mich. A line of 20-inch lathes especially adapted for turning the line bearings and flanges on automotive crankshafts. They can be furnished for belt drive or with a motor mounted on the head casting. The main spindle has eight feeds ranging from 1/64 to ⅛ inch.

Drilling Machine: Holt Electric Co., 377 S. Pierce St., Milwaukee, Wis. A 20-inch vertical drilling machine having a square base provided with T-slots for clamping work, and a regular slotted table 18 inches in diameter. The spindle has a No. 3 Morse taper; it has vertical travel of 11¾ inches, and is driven by a 2-inch belt running on four-step cone pulleys.

Welding and Cutting Torches: K-G Welding & Cutting Co., Inc., 556 W. 34th St., New York City. Oxy-acetylene cutting and welding torches known as the K-G Model M. The heads, tips, and nuts that are exposed to the heat are made of monel metal, which is claimed to give the torches long life and permit them to be used contiuuously at high temperatures.

Drill Chuck: Scully-Jones & Co., 647 Railway Exchange Bldg., Chicago, Ill. A drill chuck or collet made with tapers to suit all standard drilling machine spindles, and with holes to fit all sizes of straight-shank drills. These chucks are of such construction that they permit drills on multiple-spindle drilling machines to be spaced much closer than if held in the ordinary type of drill chuck.

Sand-blasting Machine: Scully-Jones & Co., 647 Railway Exchange Bldg., Chicago, Ill. A self-contained sand-blasting machine combining a work chamber, sand pressure reservoir, and dust collector. An electric light inside the chamber and a window above the mouth of the machine enable the operator to observe the work at any time. The machine is 6 feet 6 inches in height by 1 foot 10 inches in diameter.

Piston-turning Machines: Foote-Burt Co., Cleveland, Ohio. Multiple-spindle piston-turning machines made in either two- or four-spindle types. The vertical spindles are mounted on a common base, and although all spindles are driven from the same power source, there is no timing connection between the different units other than the constant rate of drive, as their operating functions are all self-contained.

Universal Grinder and Die Grinder Attachment: Lafayette Tool & Equipment Co., 21 S. 12th St., Philadelphia, Pa. A motor-driven universal grinder and button die grinding attachment for grinding internal and external precision threads on gages, and which can be used for cylindrical and taper grinding, relieving taps, and similar work. A special attachment is provided for use in reclaiming button dies.

Electric Transformer: General Electric Co., Schenectady, N. Y. A line of General Electric MTQ auto transformers of 1 to 1 ratio in sizes 1, 3, 5, 7, 10, 15, 20, and 25 kva. output. The transformers are air-cooled and suitable for indoor or outdoor use on 220-volt circuits having frequencies between 50 and 140 cycles per second. They are designed for deriving three-phase current from two-phase, four-wire service and vice versa.

Grinding and Buffing Machines: Van Dorn Electric Tool Co., Cleveland, Ohio. A line of one-horsepower electric grinding and buffing machines of heavier types than those previously made by this company. The new line includes a floor grinder and a bench grinder with two guarded wheels; a floor grinder with one guarded wheel and a left-hand extension having a polishing brush; and a floor type machine with a buffer and a grinding extension.

Pyrometer Recording Instrument: Charles Engelhard, 30 Church St., New York City. A recording pyrometer having a 5½-inch scale, which is calibrated both in temperature and corresponding millivolt range. The charts are of the continuous-roll type, approximately 100 feet in length. The instrument is 11 inches high, 8½ inches wide, 8½ inches deep, and is made in two types, Type RL being a single-record type while Type RM is a multiple-record instrument.

Cylinder Grinder: Heald Machine Co., 16 New Bond St., Worcester, Mass. This company has made some changes in the design of its No. 65 cylinder grinder. The distance between the center line of the eccentric and of the table has been increased by 1⅝ inches, so that it is now 9½ inches instead of 7⅞ inches, as previously made. The location of the idler bracket has also been changed from the top of the main drive pulley guard to a position on the guard itself, thus bringing it near the base.

Drilling Machine: Fox Machine Co., 1812 W. Ganson St., Jackson, Mich. A D-12 multiple-spindle drilling machine having the table and column bolted to the base, which contains a reservoir for the coolant. The spindle change-gears and the feed gears are controlled by conveniently located levers. The feed is engaged by a quick-acting clutch, which can be operated either by a hand-lever or automatically by an adjustable stop on the column. The drilling head is provided with from ten to sixteen spindles, and has a travel of 15 inches. The machine weighs 2250 pounds and occupies a floor space of 28 by 36 inches.

* * *

THE BROWN & SHARPE APPRENTICE HOUSE

An unusual departure for taking care of their apprentice boys has been inaugurated by the Brown & Sharpe Mfg. Co., Providence, R. I. An institution known as the "Apprentice House" has been started. The apprentice house is a home for out-of-town boys who are taking courses of training in the Brown & Sharpe apprentice department. It consists of a well-built three-story house located in a good residential section of Providence, only a short distance from the works of the company. This house provides accommodation for twenty-seven boys.



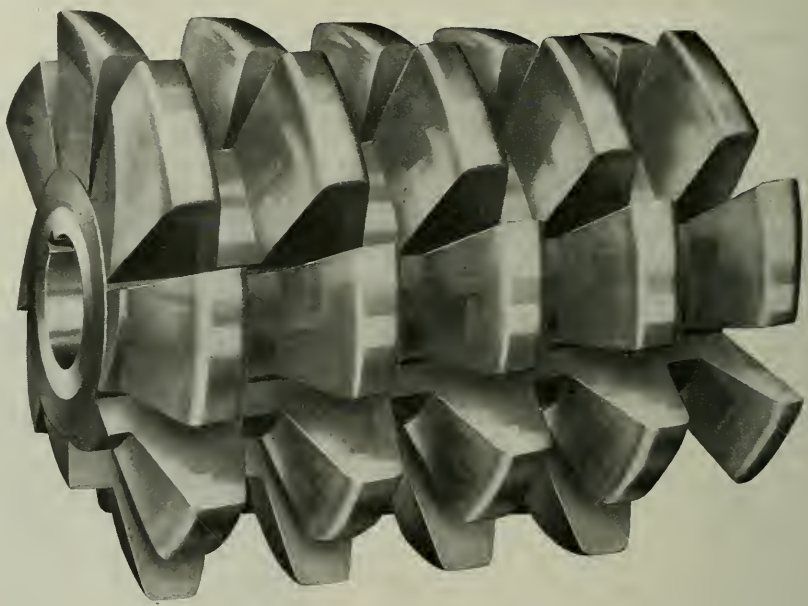
Fig. 1. Brown & Sharpe Apprentice House

The house is under the supervision of the apprentice department, but is directly conducted by a responsible housekeeper and an assistant. There are no set rules, the boys simply being asked when coming into the house to do as they would do in their own homes. The policy is to maintain a thoroughly homelike atmosphere and to avoid any of the institutional tendencies often found in places of this kind. No meals are served, but there are boarding places nearby where the boys obtain their board. The boys pay room-rent for the accommodation provided, but they deal with the housekeeper, and not the company.

When the boys make application for an apprenticeship they include an application for a room at the apprentice

PROMPT

BROWN & SHARPE



FOR INCREASED OUTPUT AND

BROWN & SHARPE MFG. CO.

DELIVERIES

CUTTERS AND HOBS

Quality in cutters cannot be determined by mere examination. It takes actual service to prove their real worth. Brown & Sharpe Cutters and Hobs are made to meet the most exacting requirements for accuracy, quality and length of service. They are made from the best material obtainable, designed to give free cutting action, scientifically heat-treated and subject to rigid inspection before shipment.

CUTTERS	*HOBS*
Regular Stock for	**Worm Wheel**
Milling and	**Spur Gear**
Gear Cutting	**Splined Shaft**
Special to Order	**and Special Purpose**

The methods and processes employed in manufacturing are the outgrowth of over a half century of experience. Modern methods, skilled workmanship and special improved machinery enable us to assure prompt deliveries.

LOWERED OPERATING COSTS

PROVIDENCE R.I.U.S.A.



Fig. 2. A View in the Living Room of the Brown & Sharpe Apprentice House

house, if this is desired. If there are no openings when the apprentice begins his course, his name is placed on a waiting list and he is helped to find a room for temporary use until a vacancy occurs. The apprentice house is provided with modern improvements in every way, electric light, steam heat, good sized halls, and a large living room furnished with an aim toward comfort and homelike environment and provided with the inevitable victrola. The bedrooms are furnished in an attractive and comfortable manner, and each room contains a study table and chair.

* * *

ORIGINATORS OF BROACHING MACHINES

In connection with the article published in the June number of MACHINERY entitled "Modern Broaching Practice," it is believed that a statement should be made as to the present connections of the men who were instrumental in developing the broaching trade and more especially some of the machines shown in this article.

J. N. Lapointe, mentioned in the article, is no longer actively engaged in the manufacture of broaching equipment of any kind. He is known as the originator of the Lapointe broaching system. The machines shown in the article were designed and patented by Francis J. Lapointe. Joseph N. Lapointe, who originally organized the J. N. Lapointe Co. of New London, Conn., sold out his controlling interest in this firm at the end of 1917, but agreed to remain one year in the employ of the company, after which period he agreed that for ten years he would not engage in or be interested in any plant making or selling broaching machines and equipment. Francis J. Lapointe, his son, is the patentee of the inventions made and sold by the J. N. Lapointe Co. up to 1918, having transferred his patents to it when it was controlled by his father, Joseph N. Lapointe. Francis J. Lapointe is now president of the American Broach & Machine Co., Ann Arbor, Mich., and is not connected with any other firm manufacturing a similar product.

AMERICAN BROACH & MACHINE CO.
Ann Arbor, Mich.

* * *

The exports of mining machinery from the United States, including oil well machinery, during May, 1920, amounted to $1,131,000. Of this, oil well machinery was represented by over $500,000.

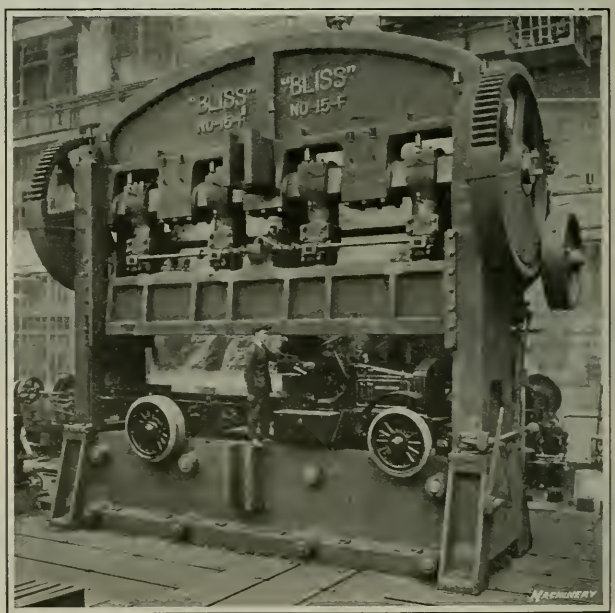
MEETING OF STEEL TREATING SOCIETIES

The American Steel Treaters' Society and the Steel Treating Research Society will hold their annual convention and exhibit at the Commercial Museum, Philadelphia, Pa., September 14 to 18. It is planned to make the exhibition the greatest of its kind ever held. Eighty thousand square feet of floor space at the Commercial Museum will be used for exhibiting heat-treating appliances and heat-treating products. In conjunction with the exhibition there will be a joint convention of the two societies, at which important papers on steel and its heat-treatment will be read. The sessions of the convention will be held in the same building as the exhibition. The secretary of the Steel Treating Research Society is L. S. Carrick, Box 834, Detroit, Mich., and the American Steel Treaters' Society may be addressed at 208 N. Wabash Ave., Chicago, Ill., where applications for space at the exhibition in Philadelphia should also be sent. It is planned to join the two societies mentioned into one society (as previously mentioned in the March number of MACHINERY, page 689) known as the American Society for Steel Treating, the new society coming into action immediately following the convention.

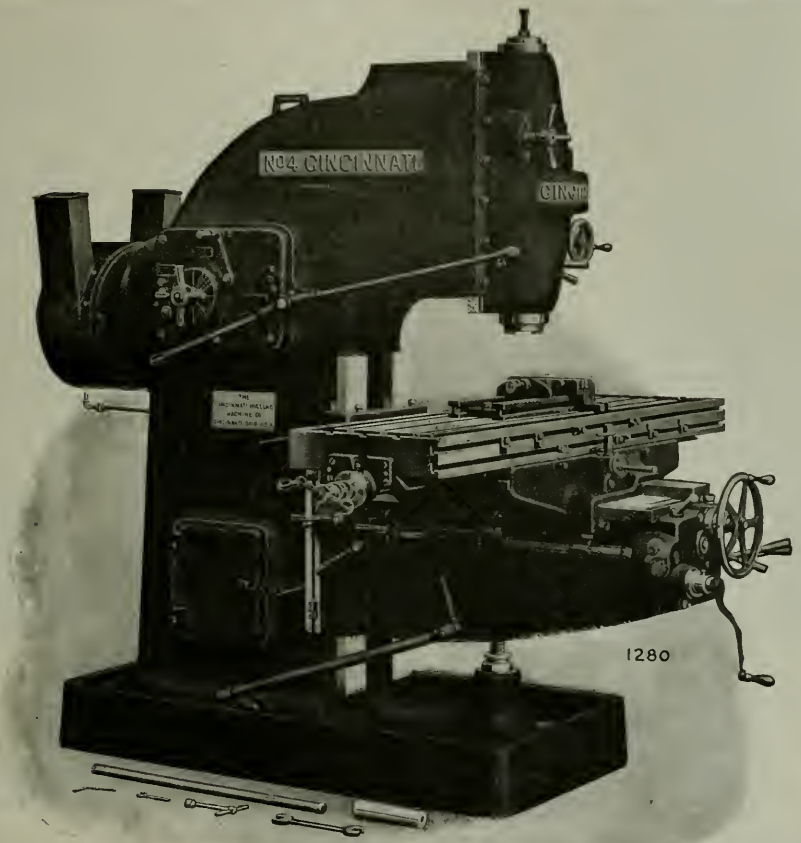
* * *

POWER PRESS OF UNUSUALLY LARGE SIZE

The primary use of the four-crank power press which is here illustrated and described is for the blanking and perforating of side rails for the largest sizes of motor truck frames. Of course it could be used for other purposes, including the performance of heavy forming operations. The Pierce Arrow motor truck chassis shown in the illustration was placed in the press for the purpose of emphasizing its unusual size, which will be further brought out by the following dimensions: Area of bed, 252 by 48 inches; area of slide face, 242 by 40 inches; number of strokes per minute, 5; and total height, 25 feet 9 inches. This machine is known as a No. 15-F four-crank press, and was recently built at the E. W. Bliss Co.'s plant in Brooklyn, N. Y.



No. 15-F Four-crank Power Press of Unusually Large Size built by the E. W. Bliss Co.



The New No. 4 Vertical Cincinnati Miller

(Patent Rights Fully Reserved)

Some of its big productive features are—

Intermittent Feed.
Power Quick Traverse in Both Directions.
Square Gibbing with Narrow Guides.
Feed Changes at Front of Knee.
Safety Couplings in Feed Transmissions.
Individual Feed Control Levers.
Automatic Lubrication.
Centralized Oiling.
Flooded Lubrication for Cutter and Work.
Hardened Sliding Gears Throughout.
Starting Lever at Front.
Automatic Brake.
Spindle Can Run in Either Direction.
Spindle Driven Through Spur Gears.
Face Gear of Large Diameter for Large Cutters at Slow Speeds.
Secondary Spindle Gear Provided for Small Cutters at Fast Speeds.
Spindle Gears Keyed to Sleeve, which is Keyed to Spindle at its lower end.
Back Gears Slide on Hardened Shaft having Four Integral Keys, and Automatically Maintain Proper Driving Relation for All Positions of Vertically Adjustable Spindle Head.

Ask for descriptive matter

THE CINCINNATI MILLING MACHINE CO., Cincinnati, Ohio

PERSONALS

FRANK J. FARRELL has been appointed eastern representative for the Precision & Thread Grinder Mfg. Co., Philadelphia, Pa., manufacturer of the multi-graduated precision grinder.

H. L. SCHMIEDER, for a number of years superintendent of the Advance Tool Co., Cincinnati, Ohio, is now representing the Langhaar Ball Bearing Co., Aurora, Ind., in Milwaukee and vicinity.

WILLIAM W. JOHNSON, formerly tool engineer with the American Axle plant of the Standard Parts Co., is now located with the George T. Trundle, Jr. Engineering Co., Cleveland, Ohio, in the capacity of chief engineer.

HENRY A. POTTING, for eleven years superintendent of the P. A. Geier Co., Cleveland, Ohio, has organized a company known as the Delta Machine & Tool Co., at 1265 W. 2nd St., Cleveland, Ohio, to make special tools, jigs, and machinery.

A. H. GRAYBURN, for the last four years assistant to the vice-president of the Norma Co. of America, Long Island City, N. Y., manufacturer of ball and roller bearings, has been made assistant secretary and assistant treasurer of the company.

C. N. LEO, for the last eight years in charge of the warehouse sales for the W. M. Pattison Supply Co., Cleveland, Ohio, is now associated with the Hess-Schenck Co., 221 St. Clair Ave., Cleveland, Ohio, in the capacity of sales representative.

C. R. SYME, formerly Dayton sales representative of the W. M. Pattison Supply Co., Cleveland, Ohio, will represent the Hess-Schenck Co. at 221 St. Clair Ave., Cleveland, in the southern Ohio and Indiana territory. Mr. Syme will be stationed at Dayton.

FRED A. BIGELOW has been elected president of the Carpenter Steel Co., Reading, Pa., succeeding W. B. Kunhardt, who becomes chairman of the board of directors. Mr. Bigelow has been connected with the company since 1904 in the capacity of salesman, sales manager, and general sales manager.

HARRY A. RASELEY, formely sales manager of C. E. Johansson, Inc., Poughkeepsie, N. Y., has become export sales manager for the Nordyke & Marmon Co., Indianapolis, Ind. Before joining the Johansson organization he represented the General Motors Corporation in the export field for several years.

ROBERT R. LASSITER, who was formerly mechanical superintendent of the Richmond Forgings Corporation, Richmond, Va., has become associated with the Dale-Brewster Machinery Co., Inc., 54 Lafayette St., New York City, as part owner, and will hold the position of assistant to the president, in charge of engineering sales.

THOMAS P. ORCHARD, previously secretary and sales manager of the Service Engineering Co., Inc., New York City, has been appointed director of sales with the Arthur Knapp Engineering Corporation, 19 W. 44th St., New York City. The company is engaged in the design and manufacture of machinery, tools, and equipment for quantity production and interchangeable manufacture.

F. M. RODGERS of London, England, has been appointed European manager of the Westinghouse Electric International Co., East Pittsburg, Pa. J. W. WHITE has been appointed manager for Cuba, and will have offices in the Royal Bank of Canada Bldg., Havana, Cuba. L. T. PECK has been appointed manager for Argentina, with headquarters at Bartolome Mitre 754, Buenos Aires.

E. D. MITCHELL has been appointed manager of the New York branch of Alfred Herbert Ltd., 54 Dey St., New York City, to take the place of W. J. Fuller. Mr. Mitchell first became connected with the company in 1906, and has had considerable experience in connection with the export end of the business, having visited the Far East, India, and Continental Europe. He is also a director in the Société Anonymé Alfred Herbert, Paris, France.

H. F. GRIFFITH has been appointed assistant to the general manager of the Westinghouse Electric International Co. at East Pittsburg, Pa. G. H. BUCHER has been appointed assistant to the general manager in New York City. A. B. COLE, assistant manager of the Department of Publicity of the Westinghouse Electric & Mfg. Co., of East Pittsburg, Pa., has been placed in charge of the advertising and promotion work for the Westinghouse Electric International Co.

NORMAN BELL has been made assistant sales manager of the Norma Co. of America, Long Island City, N. Y., manufacturer of ball and roller bearings. Mr. Bell has been connected with the concern for over three years as sales engineer. His training and experience in the mechanical and automotive fields include association with a leading British manufacturer of motor cars and four years' service in charge of the motor accessories department of the Lunkenheimer Co. of Cincinnati, Ohio.

A. J. STRONG, who was associated for a number of years with the Pratt & Whitney Co., Hartford, Conn., and later with the Motch & Merryweather Machinery Co., at Detroit, Mich., has been appointed sales manager of the Detroit branch of the Reed-Prentice Co., Becker Milling Machine Co., and Whitcomb-Blaisdell Machine Tool Co., whose sales and purchasing departments have recently been consolidated. W. D. CREIDER, formerly president of the Saxer-Creider Machinery Co., Erie, Pa., and for the last two years manager of the Modern Tool Co., in Cleveland, Ohio, has become sales manager of the Chicago branch of these three companies at 28 N. Clinton St.

LAWRENCE G. SPEALMAN, who has been the representative in Michigan of C. E. Johansson, Inc., Poughkeepsie, N. Y., for the last year and a half, has been made sales manager, with headquarters at Poughkeepsie. Mr. Spealman has had many years of experience as toolmaker and production engineer with the National Cash Register Co., Buick Motor Car Co. and Dayton Engineering Laboratories. The Michigan territory will be taken over by J. K. MURRAY, who is at present a member of the sales organization in Poughkeepsie, and he will make his headquarters in Detroit. Mr. Murray is familiar with the Michigan territory, having previously been connected with several automobile industries in that locality.

OBITUARIES

B. F. MECHLING, president of the Albro-Clem Elevator Co., Philadelphia, Pa., died July 2, at his home in Philadelphia, aged seventy-three years. Mr. Mechling had been president of the company for twenty-seven years. He was also president of the Elevator Safety Appliance Co. of Philadelphia and a director of Mechling Bros., Camden, N. J., manufacturers of heavy chemicals.

* * *

CONVENTION OF THE AMERICAN FOUNDRYMEN'S ASSOCIATION

The annual convention and exhibit of the American Foundrymen's Association will be held in Columbus, Ohio, during the week beginning October 4. Present indications point to the largest exhibit so far held by the association. There will be many new exhibitors this year of machine tools and shop equipment, it being recognized that many of the men interested in the foundrymen's association meetings also operate machine shops. Many of the machines exhibited will be shown in operation. The secretary's address is 140 S. Dearborn St., Chicago, Ill.

COMING EVENTS

September 14-18—Second annual convention and exhibit of the American Steel Treaters' Society of Chicago, Ill., and the Steel Treating Research Society of Detroit, Mich., in the Commercial Museum, Philadelphia, Pa. Department of Exhibits, 208 N. Wabash Ave., Chicago, Ill.

September 20-October 9—Sixteenth annual convention of the International Association of Machinists, at Rochester, N. Y.

October 4-9—Convention and exhibit of American Foundrymen's Association at Columbus, Ohio.

December 7-10—Annual meeting of the American Society of Mechanical Engineers at 29 W. 39th St., New York City.

SOCIETIES, SCHOOLS AND COLLEGES

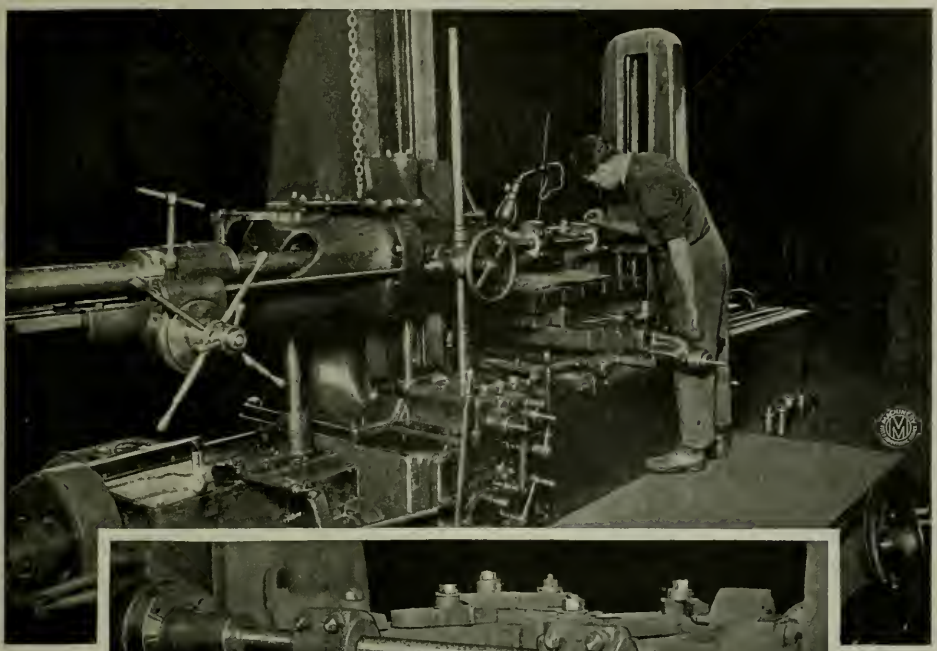
Beloit College, Beloit, Wis. General catalogue for 1919-1920, containing calendar, announcements, outline of courses, and general information.

Polytechnic Institute of Brooklyn, 85 Livingston St., Brooklyn, N. Y. Catalogue of the College of Engineering, containing calendar and courses of study for 1920-1921.

New Hampshire College of Agriculture and the Mechanic Arts, Durham, N. H. Catalogue containing calendar, announcements, and courses of study for 1920-1921.

University of Missouri, School of Mines and Metallurgy, Rolla, Mo. Catalogue for 1919-1920 containing calendar, courses of study, and other information relative to the university. Bulletin containing the war records of members of the school who were in the service of the Army or Navy during the war.

Columbia University—School of Mines, Engineering, and Chemistry, Morningside Heights, New York City. Bulletin of information, containing outline of professional courses in mining, metal-



Three Lucas "Precision" Horizontal Boring, Drilling and Milling Machines

Always Busy on Jigs and other Large Pieces Held to Close Limits

Photographs and data obtained at the Baird Machine Company's plant at Bridgeport, Conn., where these machines have seen several years of service.

THESE machines are used for milling, drilling and boring—the one in the foreground being engaged in boring shaft bearing holes in a slide for a wire forming machine. There are ten of these holes, not cored but bored from solid stock, and they must all be on the same center line—limits for alignment and diameters of the holes being plus and minus 0.001".

Faces of bearings and caps are first milled off and caps drilled and tapped in place; after which the bearing holes are drilled, bored and reamed. Diameters are $2\frac{3}{16}$" and the bearing on each one is $4\frac{1}{4}$" long.

Think this over and write for a description of the machine

LUCAS MACHINE TOOL CO. NOW AND ALWAYS OF CLEVELAND, OHIO, U.S.A.

FOREIGN AGENTS: Alfred Herbert, Ltd., Coventry. Societe Anonyme Belge, Alfred Herbert, Brussels. Allied Machinery Co., Turin, Barcelona, Zurich. Benson Bros., Sydney, Melbourne. V. Lowener, Copenhagen, Christiania, Stockholm. R. S. Stokvis & Zonen, Rotterdam. Andrews & George Co., Tokyo.

lurgy, civil engineering, sanitary engineering, electrical engineering, mechanical engineering, and chemical engineering for 1920-1921.

BOOKS AND PAMPHLETS

Reflecting Power of Monel Metal, Stellite, and Zinc. By W. W. Coblentz. 6 pages, 7 by 10 inches. Published by the Department of Commerce, Washington, D. C., as Scientific Paper No. 370 of the Bureau of Standards. Price, 5 cents.

Principles of Cylindrical Grinding. By Charles H. Norton. 47 pages, 5 by 7 inches. Published by the Norton Co., Worcester, Mass.

This book is a treatise on the principle of cylindrical grinding, based on the many years of experience of the company. The subjects treated are as follows: Relation between Speed of Work, Speed of Traverse, and Width of Wheel; Relation between Grade of Wheels and Speed of Work; Relation between Depth of Cut, Speed of Work, and Grade of Wheel; Wheel Speeds; Grade and Grain of Wheels; Depth of Cut; Width of Wheel Face; Finishing; Balance of Wheels; Traversing Worktable versus Traversing Wheel; Truing and Dressing of Wheels; Lubrication; and Wheel Service. The book has an appendix on the Grain Depth of Cut, which is a reprint of an article by George I. Alden, presented before the American Society of Mechanical Engineers, containing a mathematical analysis of the grain depth of cut, including a general equation for determining the proper depth.

Motor Boats and Boat Motors. By Victor W. Page and A. Clark Leitch. 524 pages, 6 by 9 inches; 372 illustrations. Published by Norman W. Henley Publishing Co., 2 W. 45th St., New York City. Price, $4.

This work is compiled to serve as a handbook for those interested in motor boats. It considers all the details of modern hulls and marine motors, and deals exhaustively with boat design and construction, design and installation of all types of marine engines, and boat and engine maintenance and repair. It is written in a non-technical style in order to be easily understood by motor-boat owners who are desirous of learning about the mechanical construction and operation of their engines, so that they can adjust and repair them intelligently. The first part of the work is devoted to the hull and fittings, and the second part to the power plant and its auxiliaries. The material of especial interest to readers of MACHINERY is that relating to the engine, which includes the chapters on Types and Operating Principles of Boat Motors; Typical Boat Motors; Power Plant Auxiliaries; Power Plant Installation; and Care and Repair of Motors.

Exporter's Gazetteer of Foreign Markets. Compiled and edited by Lloyd R. Morris. 808 pages, 6 by 9 inches. Published by the "American Exporter," 17 Battery Place, New York City. Price, $10.

This is the 1920 edition of a book which contains a condensed survey of the world's markets and industries, for the use of manufacturers, exporters, bankers, shipping and allied trades. In view of the present activity to develop trade with foreign countries, the information here presented should prove of interest to all concerned either actually or prospectively with foreign trade. The countries of the world have been grouped in alphabetical order by continents and other major geographical divisions so that adjoining markets are found together. Under each country will be found detailed information on area and population; commerce; production and industry; railroads; telegraphs and telephones; money; weights; measures; commercial language; local advertising mediums; principal shipping routes; customs tariffs; consular regulations and consular representatives; cable rates; mail time; postal rates, and regulations respecting parcel post, money orders and reply coupons. The section under each country dealing with commerce contains tables showing the value of the total foreign trade for a series of years; the value of imports and exports by commodities and countries; and the value of its imports from and exports to the United States for ten years or more. Under production and industry, a detailed survey is given of the various industries including agriculture, forest and mineral resources and manufactures, and in the majority of cases a table has been included showing the number of each kind of manufacturing enterprise together with the number of persons employed, the capitalization, the value of annual output, and the consumption of raw material. Tables are also given showing the world's production and consumption of principal necessities and materials, as well as the world's equipment of shipping, railroads, telegraphs, and automobiles. Comparative tables show the relative growth of the export and import trade in the United States, Great Britain, France, and Germany. Separate sections of the book are devoted to the new states, Czecho-Slovakia, Jugo-Slavia, Poland, Finland, Latvia, Lithuania, Esthonia, Ukrainia, Austria, and Hungary. The book contains a number of charts, a map of the world, a map of the new Europe, and line maps of each of the markets.

NEW CATALOGUES AND CIRCULARS

Green Engineering Co., East Chicago, Ind. Circular advertising the Green steam jet ash conveyor.

Gisholt Machine Co., 9 S. Baldwin St., Madison, Wis. Circular containing illustrations of the plant and views in Madison.

United States Blueprint Paper Co., 327 S. La Salle St., Chicago, Ill. Circular illustrating a set of drawing instruments.

Smith & Serrell, Central Ave. at Halsey St., Newark, N. J. Circular descriptive of "Pintite" rigid couplings for lineshafts.

General Fireproofing Co., Youngstown, Ohio. Circular advertising steel shelving for factories, offices and other industrial uses.

Queen-Gray Co., Philadelphia, Pa. Bulletin A-5 of precision levels for use in machine shops in erecting machine tools and other similar work.

Griscom-Russell Co., 90 West St., New York City. Bulletin 1130, descriptive of the Bundy oil separator, for removing oil from exhaust steam in power plants.

Hohart Bros. Co., Troy, Ohio. Bulletins 17 and 64, describing the H. B. battery charger, which is capable of charging from one to ten 6-volt batteries at one time.

Electric Controller & Mfg. Co., Cleveland, Ohio. Bulletin 1044, treating of Type ZB starting switches for small alternating-current motors of 7½-horsepower capacities.

Chapin & Baker Mfg. Co., Inc., Syracuse, N. Y. Catalogue illustrating the jigs and fixtures, counterboring and spot-facing tools, end-mills, gear blocking tools, and turning tools made by this company.

Electric Furnace Co., Alliance, Ohio. Circular entitled "The Crisis in Fuel Oil," suggesting the use of electricity as a solution of the problem, and giving data relating to the Baily type of resistance electric furnace.

H. H. Arnold Co., Rockland, Mass. Circular of "Economy" machine reamers, hand reamers, counterbores, and milling cutters, all of which are provided with high-speed steel blades held in low-carbon steel bodies.

Hyatt Roller Bearing Co., 6th Ave. and 41st St., New York City. Circular showing the application of Hyatt roller bearings in mine locomotives and cars, motor trucks and motor cars, textile machinery, and power farming machinery.

Stow Mfg. Co., Inc., Binghamton, N. Y. Bulletin 20, giving price lists, dimensions, horsepower transmitted, and other data relating to "Stow Binghamton" flexible shafting for motor, belt, or rope drive, which is made in portable, bench, pedestal, and suspended types.

Smalley-General Co., Inc., Bay City, Mich. Bulletin K, containing line illustrations showing details of construction of Smalley-General thread milling machines. Circular containing recommendations for motors and electrical equipment to be used in connection with Smalley-General thread milling machines.

Pennsylvania Pump & Compressor Co., Easton, Pa. Form 100, covering Pennsylvania Class 3A power-driven, single-stage, straight-line air compressors. The bulletin describes, among other features of design, a new type of ring plate valve and an oil float gage for determining the level of oil in the crank basin.

Alfred Herbert, Ltd., Coventry, England (New York City office 54 Dey St.). Section K2, illustrating and describing a microscopic measuring machine for measuring screw-thread tools, formed tools, gages, threaded work, and similar pieces. The construction is described in detail, and the dimensions, weight, etc., are given.

Westinghouse Electric & Mfg. Co., East Pittsburg, Pa. Miniature catalogue 5-A-1, containing a complete list of Westinghouse insulating materials and supplies, including mica, micarta, and bakelite micarta plates and tubing, treated and untreated cloths and papers, insulating and soldering compounds, insulating oils, and tapes.

Dunbar-Wood Engineering Co., Inc., E. 32nd St., Covington, Ky. Catalogue descriptive of the Dunbar variable-speed pulley, which can be used with any source of power—either lineshaft, engine, or motor—for driving any kind of machinery at varying speeds, without employing cones, shifting gears, or variable-speed motors or engines.

Van Keuren Co., 362 Cambridge St., Boston 34, Mass. Circular M 21 descriptive of the Van Keuren optical measuring equipment and its application in the shop to precision measurements of gages and tools by light-wave interference. Rules are given for the guidance of the mechanic, particularly with reference to the measurement of flat combination gage-blocks.

Canton Foundry & Machine Co., Canton, Ohio. Catalogue illustrating and giving specifications for the Canton line of portable floor cranes and hoists, for carrying work to parts of the shop that cannot be reached by overhead cranes. This apparatus combines the services of a crane, hoist, and truck, and is therefore useful in small shops not equipped with overhead systems.

Wetmore Reamer Co., Milwaukee, Wis., is distributing a new publication entitled "Reamings," which is published monthly in the interests of the Wetmore reamer salesmen and distributing houses. It contains news about the factory and salesmen, as well as talks on the various types of reamers produced by the company, matters of sales policies, comments on troubles and their remedy, and similar subjects.

Davis-Bournonville Co., Jersey City, N. J. Bulletin 550, illustrating and describing the Davis-Bournonville No. 1-A radiagraph, a mechanically operated cutting torch for use in shipyards, bridge works, boiler shops, locomotive shops, and other plants that need portable equipment for cutting and beveling plate and structural steel near the place of erection. The bulletin shows some examples of characteristic cutting done with the radiograph.

W. S. Rockwell Co., 50 Church St., New York City. Bulletin 217, containing a review of methods developed in recent years for the heat-treatment of metals, and a description of automatic and semi-automatic furnaces for continuously heating, hardening and tempering crankshafts, light bar stock, coil springs, light rod stock, tubes, billets, drop-forgings, dies, etc. A large number of installations of various types of furnaces used for this class of work are illustrated.

Whitman & Barnes Mfg. Co., Akron, Ohio. Catalogue 92, giving dimensions and price lists for W. & B. twist drills and reamers. Attention is called to the fact that this catalogue does not include screw and drop-forged wrenches presented in previous catalogues, as the company no longer makes these lines, its manufacturing facilities being devoted exclusively to twist drills and reamers. The catalogue also contains tables of tap drill sizes, decimal equivalents, cutting speeds and feeds, and other miscellaneous data.

Baldwin Chain & Mfg. Co., Worcester, Mass. General catalogue, edition F, covering the complete line of power transmission chains and sprockets, including roller chains, block chains and special chains, made by the company. The catalogue shows application of these chains for various classes of drives and gives data for selecting a roller chain drive, determining the length of a chain, tables of pitch line diameters, and information on lubrication and care of chains, as well as several pages of tables of sprocket dimensions.

South Bend Lathe Works, South Bend., Ind. Lathe Book 19, entitled "How to Run a Lathe." This is one of a number of instruction books brought out by the company, giving information on how to erect, care for, and operate a screw-cutting engine lathe. The book shows a lay-out of a small machine shop, and describes in considerable detail various parts of the lathe and the simpler operations performed on this machine. The book also shows various attachments, and contains, in addition, a considerable amount of information of educational value.

Vacuum Oil Co., 61 Broadway, New York City, is publishing a pamphlet, prepared by its technical department, containing a treatise on bearings and their lubrication. The subjects treated of are as follows: Construction; Bearing Types; Bearing Material; Workmanship; Operating Conditions; Oiling Systems—for Individual Bearings, for Group Bearings, and Special Methods of Lubrication; Oil Distribution; Lubrication; Fractional Heat; Bearing Oils—Physical Tests, Selection of an Oil, and Oil Qualities; Lubricating Greases; Bearing Troubles; and True Economy.

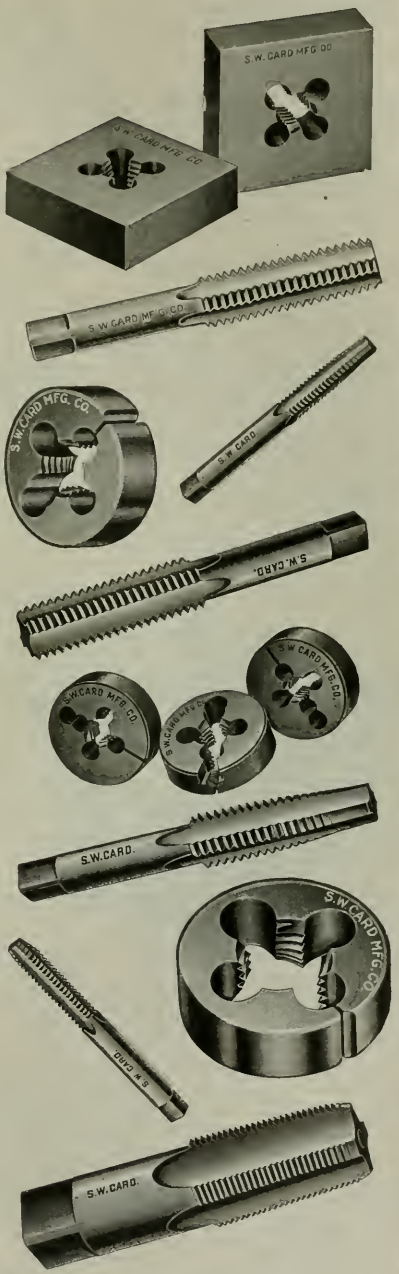
Liberty Tool Corporation, 1318-20 Munsey Bldg., Baltimore, Md. Catalogue covering the line of Liberty tools and equipment, which includes portable drilling machines made in three styles, namely, the double-cylinder, single-cylinder, and single-cylinder (close corner) types; rivet heaters; heating torches; holding-on bars or dolly bars; staybolt heading attachment; bottom riveting rigs; backing-out punches; and high-speed hot chisels. The catalogue contains a brief description of the different tools, as well as illustrations, and a list of the repair parts with the numbers by which they are designated.

Chicago Belting Co., 127 N. Green St., Chicago, Ill. Catalogue and belting reference book containing illustrations showing step by step the operations performed in the manufacture of belting, with brief descriptions of the processes. The various brands of belting and their specific applications are listed, and prices are given for belting of different widths. Information is included concerning methods of lacing, belting, rules for calculating the horsepower, width, length, and speed of belting, suggestions for belt users, and other useful information. One section of the catalogue is devoted to leather packings and specialties, and contains price lists, dimensions, etc.

Buffalo Forge Co., Buffalo, N. Y. Catalogue 700, treating of the Buffalo fan system of heating, ventilating, and humidifying. The book is a treatise on heating and ventilating, rather than an ordinary catalogue of products, much of the material having been taken from this company's handbook on heating and ventilating, entitled "Fan Engineering." It contains many charts and tables, such as a humidity chart, synthetic air chart, tables of pressure and velocity of air, friction of air, indoor temperatures, capacities of Buffalo fans and blowers, and other general data of use to the heating and ventilating engineer.

OVERCOME YOUR TAPPING TROUBLES BY SPECIFYING

CARD TAPS and DIES



Exact in size, uniform in temper, true to pitch and in every possible way High Grade.

Our stock is well assorted and we are prepared to quote lowest current prices.

Please let us figure with you.

HAMMACHER, SCHLEMMER & CO.

Hardware, Tools and Factory Supplies

NEW YORK (Since 1848) 4th Avenue and 13th Street

The book is divided into five sections, treating respectively, of the application of heating and ventilating systems in public buildings; application in industrial plants; Buffalo apparatus; and formulas and engineering data of use in designing heating and ventilating systems.

Cutler-Hammer Mfg. Co., Milwaukee, Wis. Publication 845, treating of machine tool control and describing Cutler-Hammer controllers. The first half of the pamphlet is devoted to machine tools of all kinds, and gives suggestions for the selection of motor and control apparatus for the different machines. The second half of the book illustrates and describes Cutler-Hammer controllers, both manual and automatic, and gives horsepower ratings for the different sizes. Circular 855, treating of Cutler-Hammer lifting magnets of the circular type and illustrating their application in foundries, steel mills, shipyards, and other plants throughout the country for speeding up production and reducing handling costs.

Edison Lamp Works of General Electric Co., Harrison, N. J., has issued a series of publications under the title "Lighting Data," which include Bulletins 101 to 114, treating respectively, of the following subjects: Maintenance of the Lighting System; Effect of Color of Walls and Ceilings on Resultant Illumination; the Lighting of Show Windows and Show Cases; Artificial Daylight for Merchandising and Industry; 110-vs. 220-volt Circuits from the Standpoint of Lighting Service; Illumination and Production; the Lighting of Office Buildings and Drafting-rooms; Lighting of Schools; Lighting of Textile Mills; Lighting of Piers and Warehouses; Light and Safety; Edison Miniature and Mazda Lamps—Standard vs. Special; Edison Mazda Lamps—Theory and Characteristics.

Hendey Machine Co., Torrington, Conn. Catalogue illustrating and describing in detail the construction of the Hendey line of engine lathes, and attachments for use with these lathes. Specifications are given for the various sizes of lathes, which are made in the cone-head and geared-head types. To meet the demand of the foreign trade, all sizes of these lathes are made with metric pitch lead-screw and special gearing to cut standard pitches of French and international standards, and dimensions and specifications are also given for the metric engine lathes. The spiral relieving attachment is illustrated and described, and a number of relieving operations on different classes of work are illustrated. Data are given on figuring gears for threads not given in the index, formula for thread cutting, etc. Illustrations are included showing the application of motor drive to Hendey lathes.

Golden Co., 405 Lexington Ave., New York City. Prospectus 257, covering the apparatus handled by this company for the Societe Genevoise d'Instruments de Physique of Geneva, Switzerland. These machines and appliances, which can be furnished either to English or metric measurements, include the following: Universal measuring machines for checking and controlling gages and standards of all kinds; high-precision micrometer with a range of from 0 to 4 inches, measuring to an accuracy of 0.000005 inch; comparator for gaging interchangeable parts, measuring to an accuracy of 0.00005 inch; thread gages; standard and reference gages; limit gages; adjustable limit snap gages; machines for adjusting the anvils of adjustable limit gages; laying-out-locating-drilling machine in four models; dividing engines for linear, circular, and cylindrical work; and high-precision standard certified scales and rules.

Crescent Belt Fastener Co., 381 Fourth Ave., New York City. Catalogue 203 containing service data on Crescent belt fasteners for transmission, elevating, and conveying belting. The book is conveniently arranged with a thumb-index, which makes it easy for the belt user to determine rapidly the size that will insure best results. Data are given for belt fasteners intended for high-speed light work on 2-inch or larger pulleys; for light work on 3-inch or larger pulleys with belting from ¾ to 4 inches wide; for general work on 6-inch or larger pulleys with belting 1½ to 8 inches wide; for general work on 9-inch or larger pulleys with belting from 2 to 12 inches; for heavy work on 12-inch or larger pulleys with belting from 6 to 36 inches wide; and extremely heavy work on large pulleys with belting up to 72 inches wide. The catalogue also describes how a Crescent joint is made and gives prices and weights of Crescent plates and rivets.

Peter A. Frasse & Co., Inc., 417 Canal St., New York City, has recently published a new 800-page general catalogue of tools, machine tools, and general machine shop supplies. This is the first large general catalogue that has been issued by the company. It contains complete specifications, including dimensions, prices, etc., for Frasse electric and open-hearth steels; Shelby seamless steel tubes; Reeold transmission chains; drill sockets; sleeves; lathe centers; twist drills; arbors; reamers; countersinks; milling cutters; gear-cutters; taps; dies; screw plates; die-stocks; pipe threading machines; vises; wrenches; pliers and nippers; files; screws; bolts; nuts; rivets; nails; micrometers; machinists' and draftsmen's tools; gages; chucks; tool-holders; saws; hammers; blowers; chisels; grinding wheels; oilstones; pulleys; tool stands; pumps; oil and grease cups; welding equipment; blowpipes; clamps; lathe dogs; punches; trucks, etc.; machine tools; air compressors; and woodworking machines. Stock list for July, 1920, covering Shelby cold-drawn seamless steel tubing in round, square and odd sizes.

Heald Machine Co., 16 New Bond St., Worcester, Mass. Instruction book and parts catalogue, explaining the operation and adjustment of the Heald No. 60 cylinder grinding machine. The purpose of the book is to aid users in acquiring a knowledge of these machines, and attention is called to points affecting the rate and quality of production, together with some of the fundamental difficulties that are likely to be encountered in operating. This is a new edition of the book, and a great many new features have been added. Diagrams of the floor plans of the machines, fan lay-outs, etc., are included, and instructions are given for adjusting the machines and for setting up. A section has been added on the selection of grinding wheels. Wet and dry grinding is treated of, as well as speeds and feeds, and the various size arms regularly furnished with these machines. The entire line of grinding machines is illustrated, and in the parts catalogue all the repair parts are shown, the method of presentation being to show a drawing of the entire machine with the various parts numbered, which is followed by line drawings of the separate parts.

TRADE NOTES

Duplex Mill & Mfg. Co., Springfield, Ohio, is building a brick addition to its plant, 50 by 100 feet.

Detroit Tool Co., Detroit, Mich., announces that it has changed its firm name to Detroit Machine Tool Co.

Cooper Hewitt Electric Co., Hoboken, N. J., has removed its St. Louis office to larger quarters in the Title Guaranty Building. A. H. Smith is the district sales manager.

Springfield Finished Castings Co., Springfield, Ohio, has recently been organized to specialize in finished casting work. The company is located in a two-story brick building, 75 by 150 feet.

Detroit Stamping Co., Detroit, Mich., announces that, owing to a renumbering of the Detroit streets, its address after August 1 will be 3445-3459 W. Fort St., instead of 951-957 W. Fort St.

Lay-Vall Brass Co., Orrville, Ohio, has constructed a new foundry building having a casting floor 30 by 50 feet, which will be devoted to jobbing work in brass, bronze, and aluminum castings.

American Production Machine Works, manufacturers of the American production grinder head and piston grinder, have moved to the Hayward Bldg., 965 Woodward Ave., Detroit, Mich. F. M. Ehehalt is the general manager.

Standard Shop Equipment Co., Inc., 1220 Sedgley Ave., Philadelphia, Pa., is moving to larger quarters at Hunting Park Ave. and Nicetown Lane. This change was found necessary owing to the increase of the company's business.

American Broach & Machine Co., Ann Arbor, Mich., is starting operation on the erection of a new machine plant, 200 feet long by 50 feet wide, of mill construction, which will be entirely devoted to the manufacture of broaching machines.

Thomas Spacing Machine Co., Pittsburg, Pa., has purchased the patents and business of the Hill Drill Co., and will manufacture the Hill multiple drilling machine at its plant in Pittsburg. Mr. Hill will supervise the manufacture of the drilling machine under the new arrangement.

Norton Co., Worcester, Mass., announces the opening of a Philadelphia office at 324 Bulletin Bldg., under the direction of Paul Hoffman, district manager. The establishment of this branch office will in no way affect the distribution of Norton grinding wheels, which will be handled as in the past by Powell, Clouds & Co., 602 Arch St., Philadelphia.

Federal Electric Co., 87th and State Sts., Chicago, Ill., announces that plans are in contemplation under which employes of the company will have a voice in the management. John F. Gilchrist, president, stated that the employes could purchase stock in the company on terms convenient to themselves, and that approximately 40 per cent of the employes were already stockholders.

Atlantic Elevator Co., has opened a New York office at 165 Broadway, under the charge of the sales manager, Harlan A. Pratt, formerly manager of the New York Industrial Sales Division of the Westinghouse Electric & Mfg. Co. The Atlantic Elevator Co. states that it has the exclusive right to install the Westinghouse gearless traction elevator equipment in the eastern part of the United States.

Air Reduction Sales Co., 120 Broadway, New York City, has recently completed the construction of a new acetylene plant at 560 Broadway, Gloucester, N. J. The buildings comprising the new unit in the "Airco" service system consist of a gas house, carbide storage building, and a generator house. All the buildings are built of fabricated steel, supported on concrete foundations, and have concrete floors.

Diefendorf Gear Corporation, 118 Dickerson St., Syracuse, N. Y., has been granted a license by the Westinghouse Electric & Mfg. Co., East Pittsburg, Pa., to manufacture gears from "Bakelite Micarta." The business of the company has grown so rapidly that larger quarters have been obtained at 324 Pearl St., where additional machinery is now being installed. The new quarters will provide double the present floor space.

Bourne-Fuller Co. and the **Upson Nut Co.**, Cleveland, Ohio, have been consolidated under the firm name of the Bourne-Fuller Co. for the purpose of more efficiently handling the business of the two companies, the ownership and management of which have been identical for the last eight years. The Upson Nut Co.'s plants will continue operations as heretofore under the name of the Upson Works of the Bourne-Fuller Co., the products of the nut and bolt departments being marketed under the same trademarks as in the past.

Adirondack Steel Corporation, Westervliet, N.Y., a subsidiary of the Dominion Foundries & Steel, Ltd., Hamilton, Ontario, Canada, has started operations, making steel castings. The company will employ from 900 to 1000 men when working at maximum capacity. The plant covers approximately 102,400 square feet of floor space, and as the corporation has thirty-two acres of land, plenty of room has been allowed for expansion. The foundry capacity is 120 tons of steel a day.

Nightingale & Baker is a partnership recently formed by G. V. Nightingale, formerly western sales manager for the Wilson-Maeulen Co., Chicago, Ill., manufacturer of electric pyrometers, and F. C. Baker, formerly district manager of the same company in Chicago, to act as manufacturers' agents. Nightingale & Baker will represent the Wilson-Maeulen Co. as general agents in all the territory west and southwest of Ohio and Michigan. The new firm is located at 163 W. Washington St., Chicago, Ill.

Velco Mfg. Co., Inc., Greenfield, Mass., has been formed to take over the entire assets of the V. E. LaPointe Mfg. Co., and the business of the latter company has been removed to Greenfield, Mass., where it is housed in a new plant providing more than three times the former capacity. Frank O. Wells, of Greenfield, Mass., former president of the Greenfield Tap & Die Corporation, is president of the new company; J. T. Seller is treasurer; and W. F. Elliott is works manager. The company will manufacture broaches and broaching machines.

Westinghouse Electric & Mfg. Co., East Pittsburg, Pa., announces the following promotions in its service department: G. W. Canney, formerly service manager at East Pittsburg has been transferred to the office of W. K. Dunlap, assistant to the vice-president; H. C. Richards, formerly district service manager at New York, has been transferred to East Pittsburg as electrical manager; A. D. Hunt, of the South Philadelphia works, has been made steam service manager; W. H. Keller has been made office service manager at East Pittsburg.

Roller-Smith Co., 233 Broadway, New York City, manufacturer of electrical instruments, announces the following changes in its sales organization: G. L. Crosby, previously sales manager, is now general sales manager at New York City; M. Frankel, previously assistant sales manager, is now western sales manager at Chicago; W. J. Shire, previously sales engineer, is now eastern sales manager at New York City; C. G. Kahsnt, previously sales engineer, is now export manager and district sales manager at New York City; F. R. Ryan, J. E. Wood and H. D. Baker remain district sales managers, respectively, of the Chicago, Cleveland, and Detroit territories; C. M. Hunt has been made sales engineer in the New York office, and M. B. Mathley, sales engineer in the Chicago office.

Reed-Prentice Co., Worcester, Mass., **Becker Milling Machine Co.**, Hyde Park, Boston, Mass., and **Whitcomb-Blaisdell Machine Tool Co.**, Worcester, Mass., have combined their sales, purchasing, accounting, and executive departments. The main offices are located at 53 Franklin St., Boston, Mass. J. P. Ilsley is general sales manager, with headquarters at Boston. The various agents throughout the United States that formerly handled the products of these factories are now displaced by direct factory branches in the machine tool centers of the country. These three companies now have combined sales branches in Boston, Worcester, New York, Detroit, Chicago, Cleveland, and Indianapolis. The Reed-Prentice Co. is located at Cambridge St., Worcester, Mass.; A. E. Newton remains vice-president and general manager. The Whitcomb-Blaisdell Machine Tool Co. is located at 134 Gold St., Worcester, Mass.; Charles Hildreth remains president and general manager. The Becker Milling Machine Co. is located at Hyde Park, Boston, Mass.; Scott Taylor is works manager. The other offices are as follows: Grand Central Palace, New York City, P. K. Dayton, sales manager; 26-28 N. Clinton St., Chicago, Ill., W. D. Creider, sales manager; 408 Kerr Bldg., Corner Fort and Beaubien Sts., Detroit, Mich., A. J. Strong, sales manager; 408 Frankfort Ave., Cleveland, Ohio, C. A. Severin, sales manager; 940 Lemcke Annex, Indianapolis, Ind., T. C. McDonald, sales manager.

AJAX

(Trade Mark Registered)

HOT METAL WORKING MACHINES

Forging Machine Protection

Ajax New Model Twin-Geared Upsetting Forging Machine

An increase in the life of a machine and decrease in necessary repairs are dollars in the pocket of the owner. Accordingly, in our effort to develop the full mechanical possibilities of the Forging Machine in our new model, we have also given much study to improving the wearing qualities of its parts.

Wearing areas have been enlarged and parts subjected to greatest strains much strengthened.

Improvements in design of parts were likewise effected as instanced by the new type of Header and Die Slides. As shown by figures 1 and 2, they are of overhung top suspended type, eliminating the bottom bearing. The sliding surface transferred to the lips which are bronze faced, and are to a very large extent, out of the range of scale and rust, which collected on the bottom bearings of the old model slide and caused excessive wear.

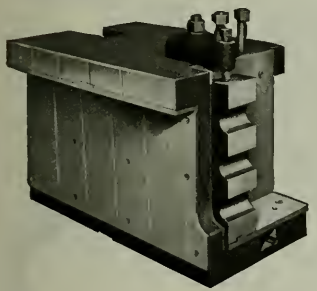


Fig. 1. Die slide showing overhanging support and bronze bearing surface.

Figure 3 is a longitudinal sectional drawing through the center of the machine, and shows the various working parts of the NEW MODEL Ajax Twin Geared Upsetters. As may be seen, there are no bottom bearings—a clear space is visible under both header and die slides.

The sliding surfaces are faced with the best bearing bronze. Ample oil grooves make uniform lubrication. Write for our descriptive book.

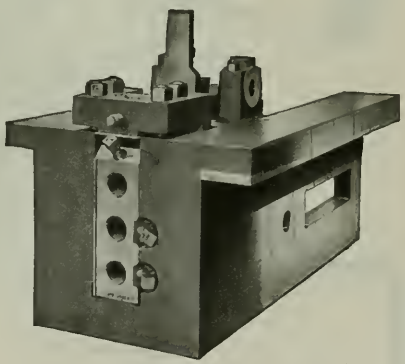
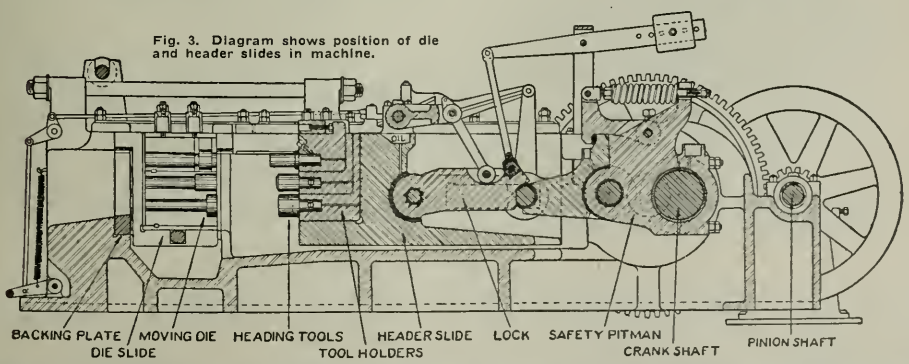


Fig. 2. Header slide showing overhanging bronze bearing and oil grooves.

Fig. 3. Diagram shows position of die and header slides in machine.

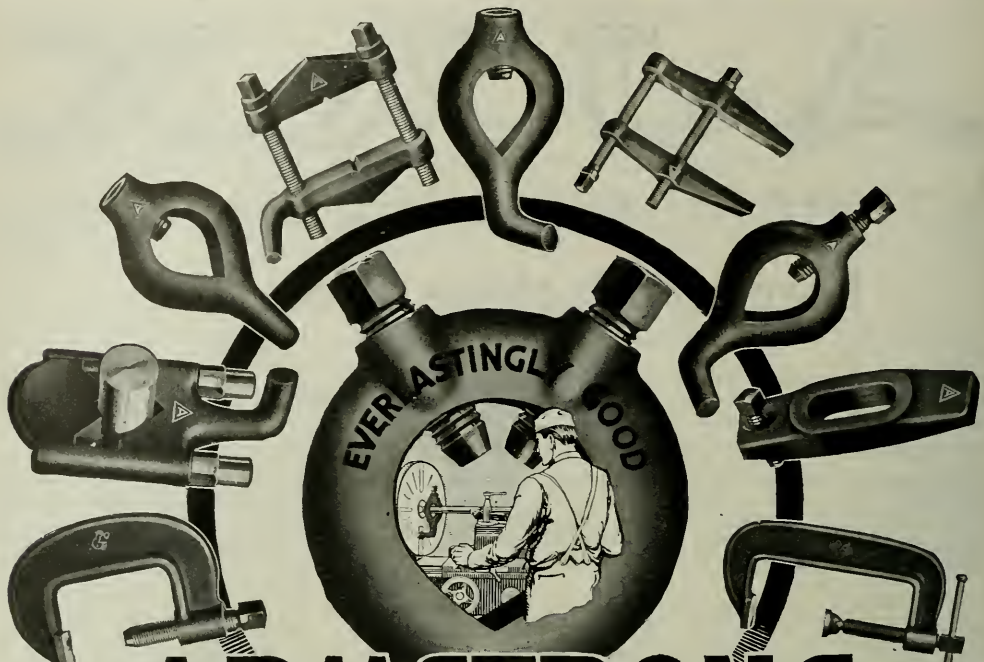


THE AJAX MANUFACTURING CO.

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CHICAGO, ILL.

CLEVELAND, OHIO

1369 Hudson Terminal
NEW YORK CITY



ARMSTRONG
TRADE MARK REG. IN U.S. PAT OFFICE
DOGS DROP FORGED CLAMPS

ALLOY STEEL SCREWS

The efficiency and life of a lathe dog or a clamp depend largely upon the quality of the screw.

We make the screws used in our dogs and clamps from a special chrome-nickel steel; they are given a special treatment and the points are hardened. They are practically unbreakable and will outwear soft steel or casehardened screws ten to one. These extra quality screws and their superior design and workmanship have earned for Armstrong Dogs and Clamps a preference based upon actual service. All kinds and sizes in stock.

Specify Armstrong when ordering and get the best

Catalog mailed free upon request

ARMSTRONG BROS. TOOL CO.
"THE TOOL HOLDER PEOPLE"
313 N. FRANCISCO AVE. CHICAGO, U.S.A.

CINCINNATI
16-INCH GEAR HOBBERS



For Accurate Gears and Quantity Production

Cincinnati 16″ Hobbers are designed to meet the essential requirements of strength, accuracy, speed and convenience of operation.

The weight of the machine, 5600 lbs., is an indication of its strength and rigidity, the extra metal being accounted for by the very generous dimensions throughout, and being so distributed as to provide the greatest stiffness possible. This contributes to the accuracy of the machine, and means not only increased life of the machine itself, but more important still, additional life for the hobs.

The strength of the hobber is transmitted directly to the hob, reducing the tendency to chatter to a minimum, and materially prolonging the life of the cutter. This is a real economy, particularly when working extremely hard metals.

For quantity production it has become the recognized and accepted means of cutting spur and spiral gears and splining shafts. It can be applied with equal facility to the cutting of ratchets and sprockets.

This is only one of the Cincinnati line—we have a size for every need.

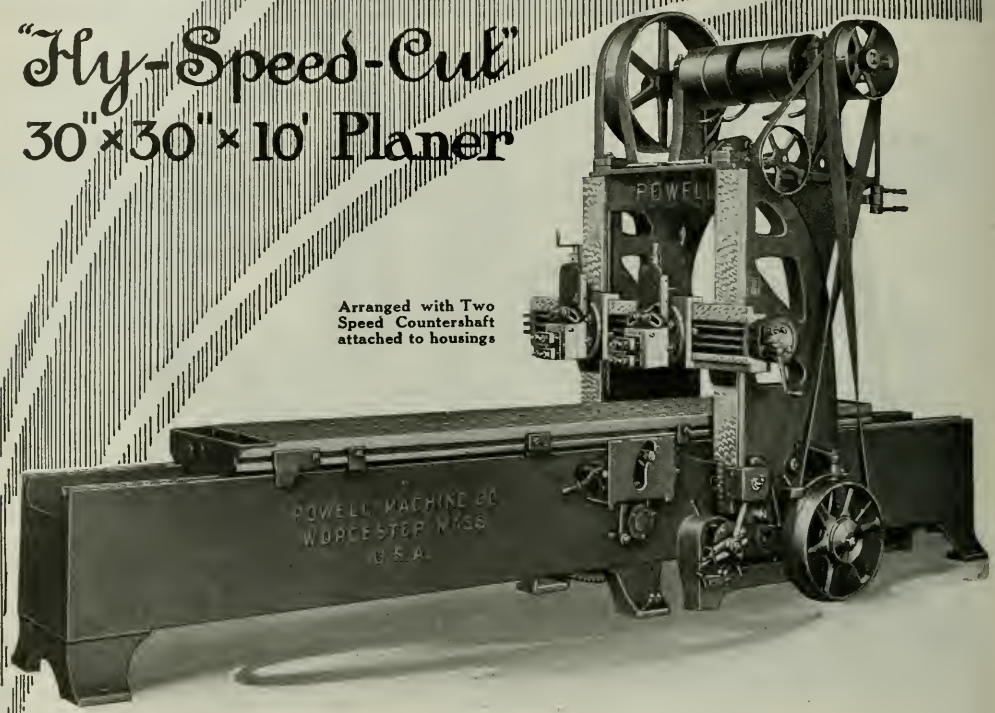
THE CINCINNATI GEAR CUTTING MACHINE COMPANY

(Subsidiary of The Cincinnati Shaper Co.)

CINCINNATI OHIO, U. S. A.

Powell

"Fly-Speed-Cut" 30"×30"×10' Planer



Arranged with Two Speed Countershaft attached to housings

Increases Cutting Speed or Checks It at will

The Powell Planer mechanically increases its initial cutting speed after the tool enters the cut. Retards to initial speed before reaching the end of the cut, absorbing shock of reversing at high speed. It jumps the open spaces at high speed. Operates at standard cut or accelerating cut. Choose your speed—vary it at will. The Powell takes 31 inches between housings and 31 inches under cross-rail. Roughs out and finishes cast iron at from 40 to 120 feet per 60 seconds, and steel at 30 to 180 feet in same time.

Write today for complete data.

POWELL MACHINE COMPANY

Sole Builders

245 Stafford Street **Worcester, Mass., U. S. A.**

LAPOINTE
BROACHING MACHINES

Simplify the Difficulties of Accurate Duplication

The increase in "interchangeable manufacture" in all classes of machines presents a growing necessity for the accurate duplication of difficult operations at a commercially possible price.

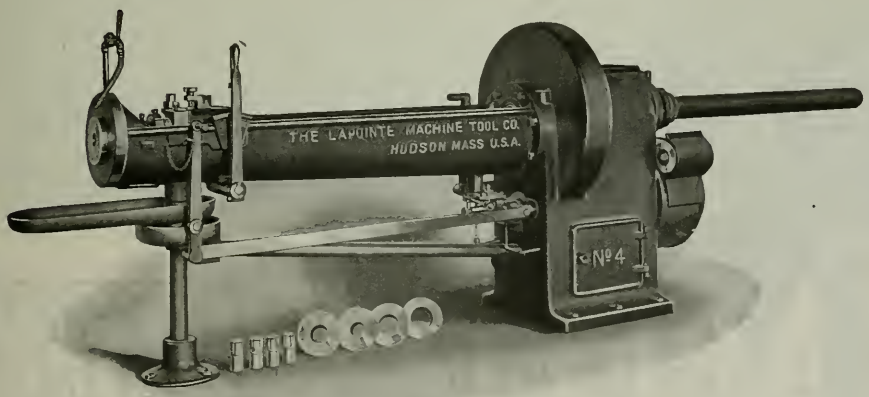
The problem of economically cutting odd-shaped holes in metal parts—long a stumbling block in the development of machinery—has been solved in many cases by Lapointe Broaching.

The simplicity of the operating principle of Lapointe Broaching Machines enables semi-skilled workers to operate them efficiently. The accuracy and speed of production in all metals, coupled with low operating costs, have made them a valuable factor in the development and manufacture of all kinds of machinery.

Manufacturers should know the cost-cutting possibilities of Lapointe Broaching on work now in their shops.

Designers *must* know the possibilities they open for improving the design and developing new machines.

Our engineers are here to show you whether *your* work looks possible or not. Put your problems up to them—and find out what Lapointe Broaching Machines can do.



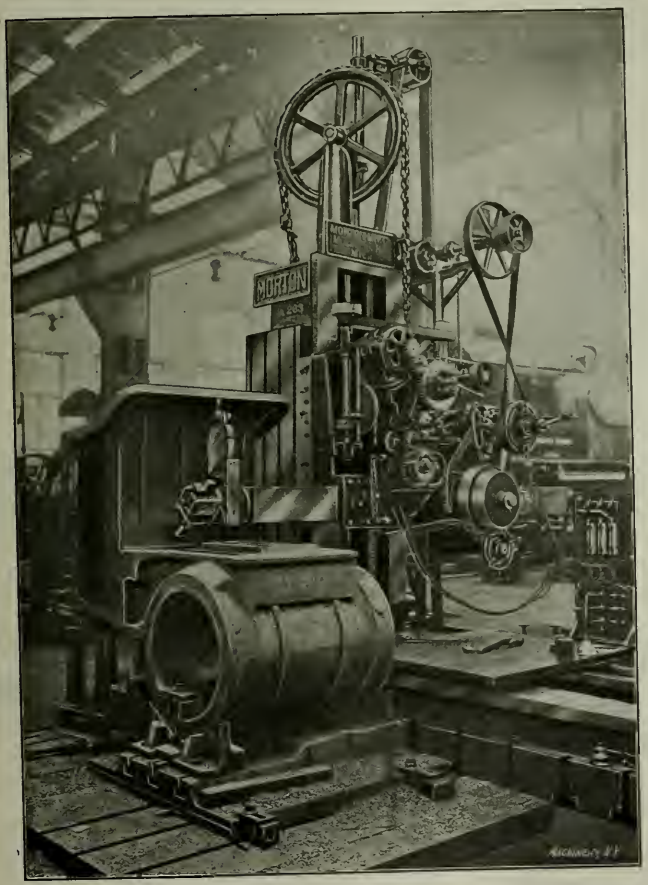
THE LAPOINTE MACHINE TOOL CO.

HUDSON MASSACHUSETTS, U. S. A.

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Do you buy
Steel Castings
or
Farrell-Cheek
Steel Castings
There is a definite difference which is recognized by a large per cent of the world's leading manufacturers.
This difference begins with the analysis of your blue prints and follows the casting throughout its making.
It is not a matter of so many blue prints specifying steel, alloy, etc., poured into such and such mould—and cleaned up to look pretty good.
This difference results from the vital interest of every skilled man in laboratory and foundry. Each order is treated as an individual problem which gives them a chance to demonstrate their master craftsmanship. Each man has a pride in his own accomplishment and the result of that united effort and personal interest cannot fail to produce a uniform, homogeneous casting true in every respect to specification.
Castings we are proud to make
Castings you are glad to take
Let us show you results on your next order.
Farrell-Cheek Steel Foundry Co.
"Makers of steel castings that are a little better than the next best."
Sandusky, Ohio
FARRELL-CHEEK
FC

The Morton Draw-cut Traveling Head Planer



Saves Three-Fourths of the Power Bill

One of the many points of superiority which the Morton Draw-cut Traveling Head Planer has over the ordinary housed planer is the great saving it makes in your power bill.

Operating on one-fourth the power necessary for a housed planer of equal capacity, it leaves the remaining three-fourths available for other uses. The power, in the case of the Morton, is used to *machine;* only an insignificant fraction being absorbed by friction, etc. In the case of a small job on an ordinary housed planer it sometimes happens that more power is wasted in reciprocating the parts of the machine than is used on the work.

Then there is none of the vibration and chatter so marked when taking heavy cuts in "difficult" metals with an ordinary planer.

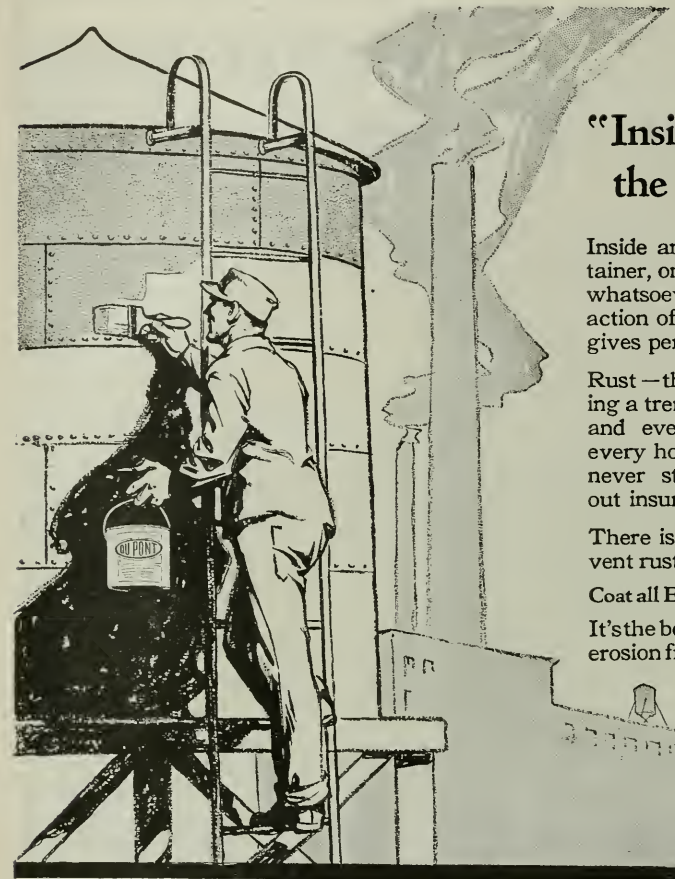
The traveling head enables operator to machine practically every part of even the most awkward casting without the necessity of resetting.

The Morton not only planes; it bores, mills, and performs a multitude of machining operations which might otherwise necessitate the installation of several machines. It will greatly extend the scope of your plant.

Send for Bulletin 8-D and find out all about the Morton Draw-cut Planer.

MORTON MANUFACTURING CO.

MUSKEGON HEIGHTS MICHIGAN, U. S. A.



"Inside and Outside the Water Tower"

Inside and outside any metal container, on the surface of any metal whatsoever that is exposed to the action of the elements, "Antoxide" gives perfect protection.

Rust—the Flameless Fire—is taking a tremendous toll in your plant and every plant in the country, every hour of the twenty-four. It never stops and you can't take out insurance against it.

There is just one *best* way to prevent rust or to stop it after it starts:

Coat all Exposed Metals with Antoxide

It's the best insurance against rust or erosion from the action of mild acids.

Antoxide—a Wonderful Product

—*a Du Pont Product*

The Du Pont name came to be a factor in American Business in 1802—118 years ago—and in that period it has come to mean just one thing—leadership.

"Antoxide" will do precisely what we claim for it—and more—because it has been designed to perform certain functions and tested in every conceivable manner to see that it does—in our own Research Laboratories where we employ the largest staff of chemists in the country.

The Du Pont Label is the guarantee of a superior product—the kind it will pay you to buy.

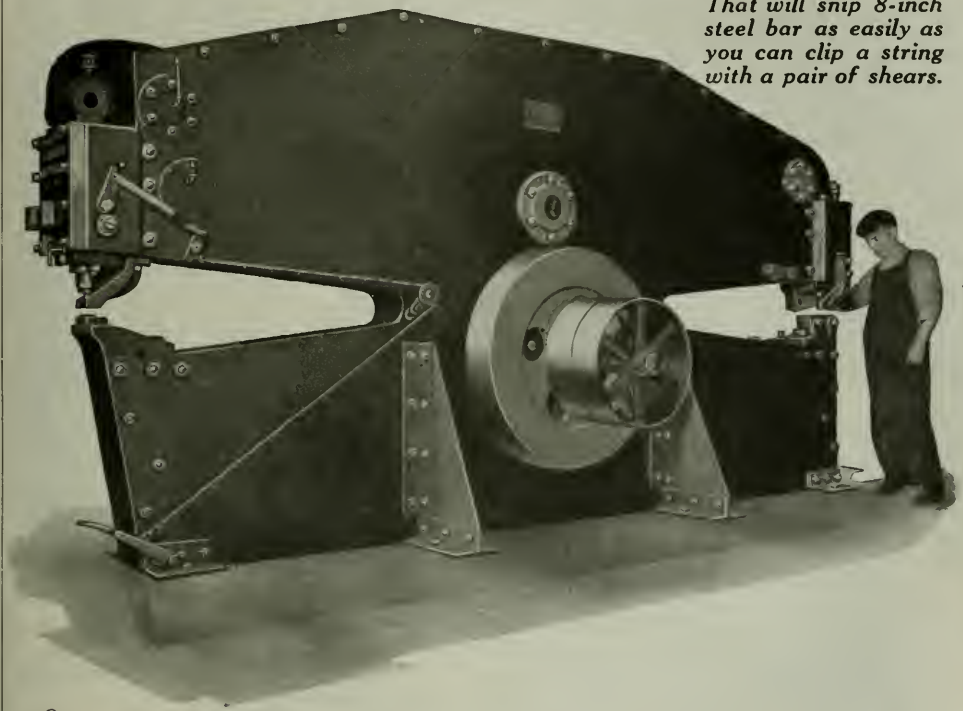


E. I. du Pont de Nemours & Company, Inc.
Sales Dept.: Paint and Varnish Division
WILMINGTON, DELAWARE

DU PONT ANTOXIDE

This Big Powerful Brute

That will snip 8-inch steel bar as easily as you can clip a string with a pair of shears.



Or

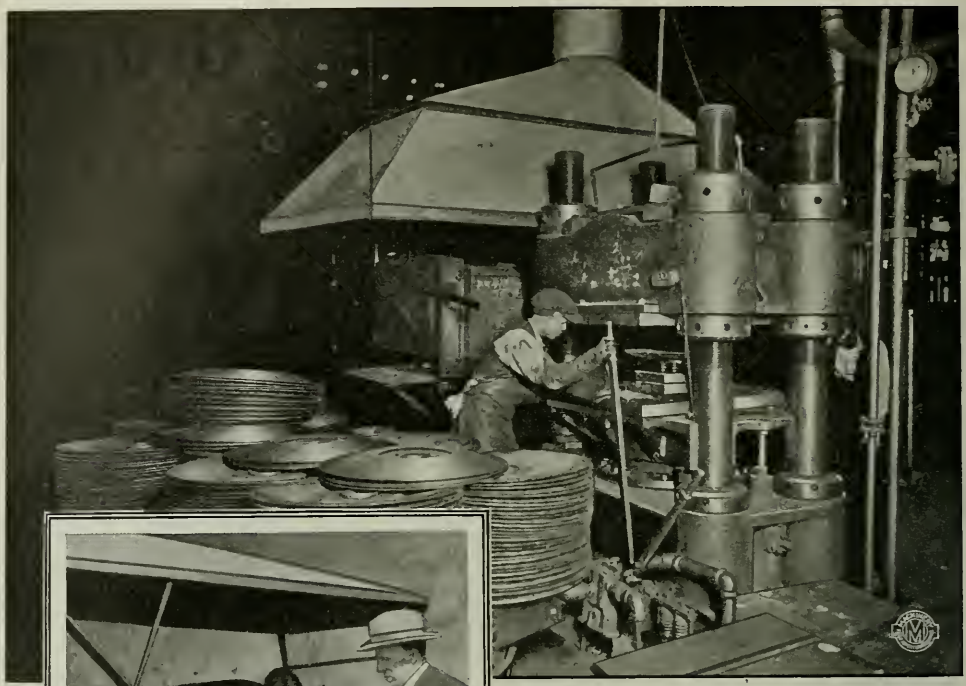
the little baby power shear that stands only 25 inches—the smallest power shear made—are two of an almost unlimited line of Buffalo Armor Plate Punches for Shears and Bar Cutters built for every purpose—hand or power. Armor Plate has a tensile strength of 75,000 lbs. per square inch—practically unbreakable. These machines are less than 1/3 as heavy as cast-iron machines of equal capacity.

"Buffalo"

Write for Catalog P-S
Dept. 51



BUFFALO FORGE COMPANY
Buffalo, N. Y.





Here is a Disteel Wheel demounted. Disteel is the new magic word in automobile manufacture. This steel disk wheel is replacing other types of wheels on many makes of cars.

You Know the Cars that Use DISTEEL WHEELS

Well, Here's the Press that Forms Them

Here's the thousand-ton Hydraulic Forming Press shaping the disks for Disteel automobile wheels. The operation (second in making the disks) includes flattening the hub section and sizing the center hole to 4.135″—production is 1,000 pieces per nine-hour day. The press is seven years old and is still on the job in the plant of the Detroit Pressed Steel Company.

There are Hydralic Presses for every requirement. Submit your specifications; our engineering staff is here to advise you on hydraulic work in any department or line.

We are engineers—builders of hydraulic machinery exclusively; write us today, while you have the matter in mind.

THE HYDRAULIC PRESS MFG. CO.

Engineer-Builders of Hydraulic Machinery Exclusively

Mount Gilead, Ohio, U. S. A.

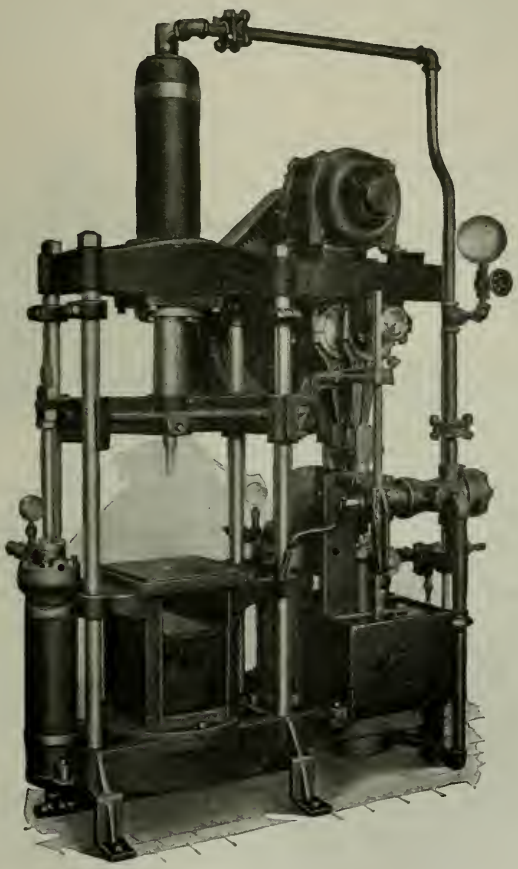
NEW YORK CITY BUFFALO DETROIT
CLEVELAND SAN FRANCISCO

"METALWOOD"

No. 350 High Speed Vertical Broaching Press

Ten 15" Work Strokes per Minute

Maximum Stroke 18"



Constant pneumatic pressure "push-back" cylinders adjusted to absorb shock of return stroke

"Originality is characteristic always of Metalwood Designs and Developments"

METALWOOD MANUFACTURING COMPANY

HIGH SPEED HYDRAULIC AND HYDRO-PNEUMATIC MACHINERY

DETROIT MICH.

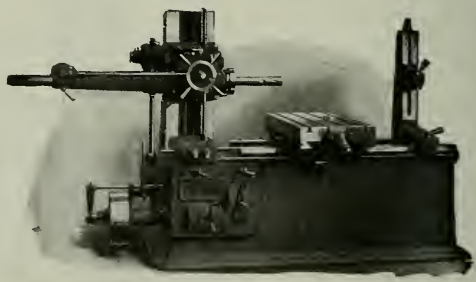
Versatility

CLEVELAND HORIZONTAL BORING, DRILLING AND MILLING MACHINES are adaptable to and will effectively, efficiently handle a varied assortment of work. Shopmen daily find new uses—new operations—which the machine handles advantageously.

Perhaps you are paying for a "CLEVELAND" without having the use of it. Better write for the circular right now—before you forget.

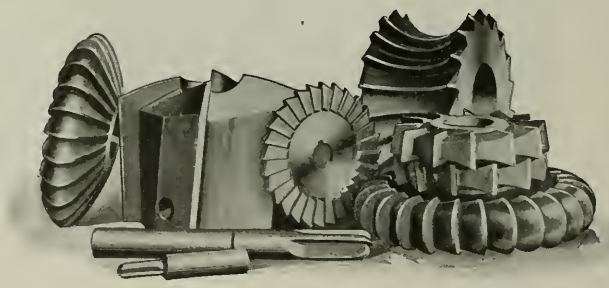
FOREIGN AGENTS:
G. H. Alexander Mchy., Ltd., Birmingham, England.
J. Horstmann, Paris, France.
Mayer & Lage, Inc., 120 Broadway, N. Y. For Siberia and Japan.

DOMESTIC AGENTS:
E. L. Essley Machinery Co., Chicago, Ill.
J. S. Miller Machinery Co., Pittsburgh, Pa.
D. Nast Machinery Co., Philadelphia, Pa.
Purinton & Smith, Hartford, Conn.
Brownell Machinery Co., Providence, R. I.
Marshall & Huschart Machinery Co. of Indiana, Indianapolis, Indiana.
O. R. Adams, Rochester, N. Y.



The Cleveland Machine Tool Co.
3221 Superior Ave. Cleveland, Ohio
Established 1907

S. C. CUTTERS



have made a reputation of accomplishing difficult tasks, which others said "could not be done." If you have a difficult cutter problem put the solution up to S. C. Engineers. Immediate delivery can be made of the usual sizes of standard cutters.

Your inquires will receive prompt attention.

THE SHIELDS CUTTER COMPANY

formerly The Cleveland Milling Machine Company

CLEVELAND, OHIO, U. S. A.

NEW YORK PITTSBURGH DETROIT

CLEVELAND

Open-side Planers

Planing Heavy Castings to Suit Exacting Customers

It takes good tools to do good work and the working equipment of big plants may be judged by the quality of their products. That this photograph of a Cleveland Open-side Planer was taken in the Johnston & Jennings (Cleveland) Plant lends added interest to the work shown.

There are three Cleveland Open-side Planers in the machining department of this big modern plant; an important part of the "behind the scenes" equipment that makes possible the high quality of work that is turned out. The hoisting machine base in operation weighs 3 tons—a bulky piece that would be difficult to set up on any other type of machine.

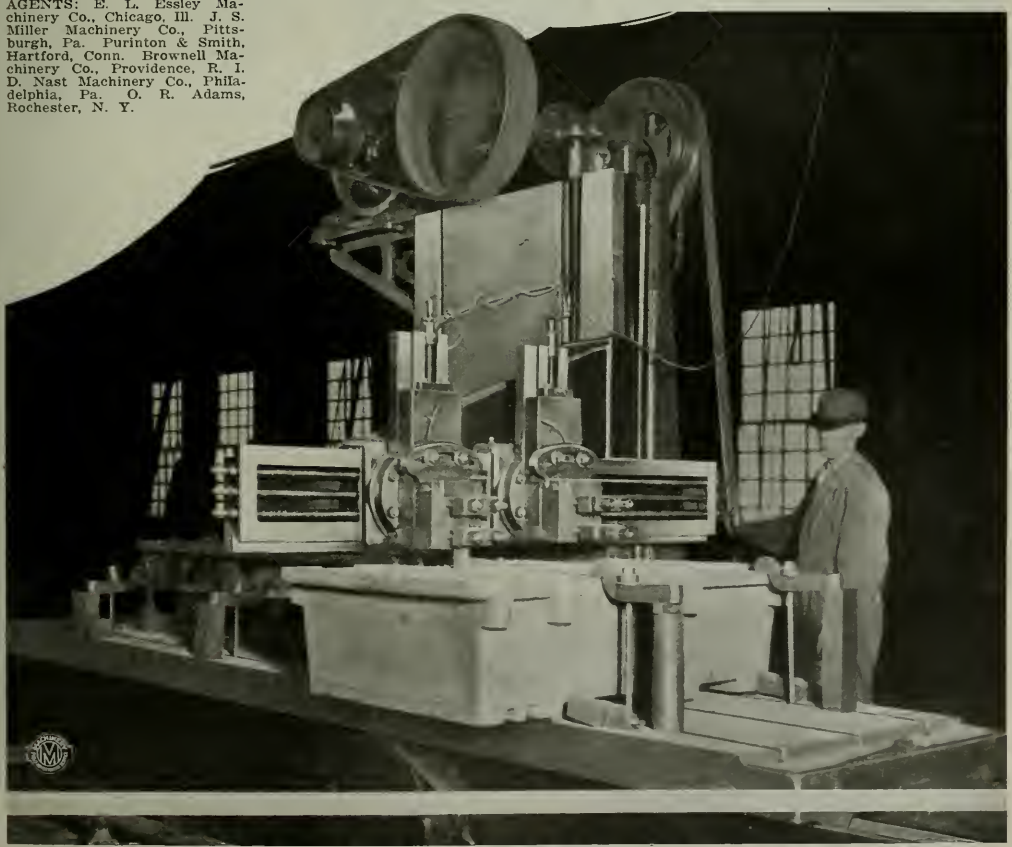
Wide range, heavy construction and extremely simple operation enable Cleveland Open-side Planers to handle all classes of work accurately and economically; their fundamental feature, the "Open-side" construction, makes it possible to take extremely wide work without difficulty. Built in sizes to take 26" to 72" beneath the cross rail. May we send you further details?

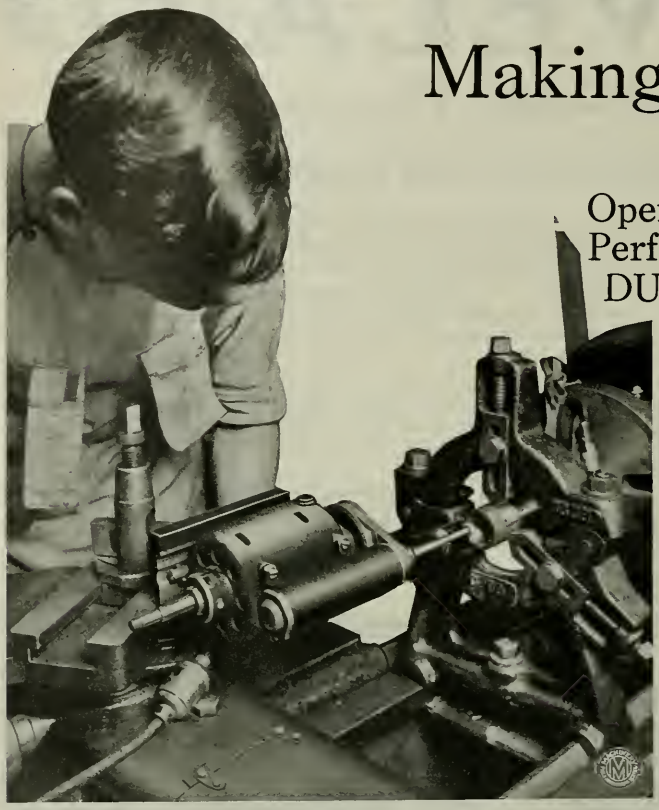
THE CLEVELAND PLANER COMPANY

Established 1900

3152 Superior Avenue **CLEVELAND, OHIO, U. S. A.**

AGENTS: E. L. Essley Machinery Co., Chicago, Ill. J. S. Miller Machinery Co., Pittsburgh, Pa. Purinton & Smith, Hartford, Conn. Brownell Machinery Co., Providence, R. I. D. Nast Machinery Co., Philadelphia, Pa. O. R. Adams, Rochester, N. Y.





Making Fine Tools

An Interesting Operation, Economically Performed by Means of a DUMORE GRINDER

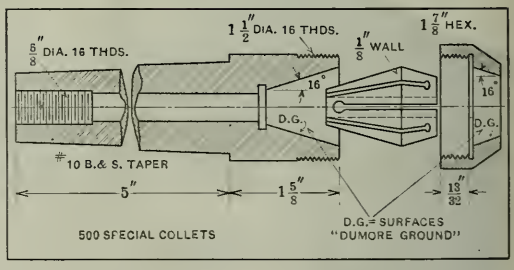
This photograph—taken at the City Engineering Company's (Dayton, Ohio) plant shows a Dumore Grinder finishing the main shank and head of a special draw-in collet. There were 500 put through in this special lot and the time for the operation shown averaged 8 minutes per piece.

The second operation, grinding the internal face of the collet nut, was also performed by this convenient precision tool.

Dumore Grinders are popular here as in every plant where fine tools are made. Their accuracy makes them useful for the finest finishing work; their simplicity and convenience make them practical for many difficult, almost inaccessible jobs.

Dumore Grinders transform any lathe into a precision grinder; they make fine finishing possible in every machine shop.

May we tell you more about them?



WISCONSIN ELECTRIC COMPANY

2526 Sixteenth Street RACINE, WISCONSIN

DUMORE

Dumore Grinders for Finishing to Close Limits

Accurate, Adjustable, Easily Attached and Adjusted



HIGH SPEED GRINDERS



Forging Eyes on Brake Hangers

on the

NATIONAL

Heavy-Pattern Forging Machine

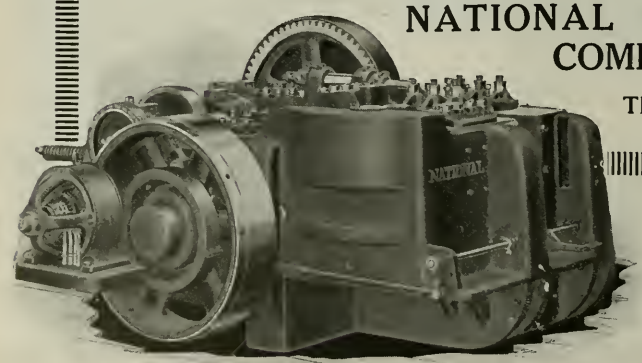
Generally this "eye" is completed under the Hammer, or flattened and punched by standing vertically in front of the heading ram of the Forging Machine.

In the National, the flattening and punching operations are effected by the side dies, making the job quicker and more economical.

The powerful side grip of the National simplifies and makes possible many forging jobs of this character, increasing the range of the machine and your profits as well.

Will be glad to look over your prints.

For details of the above job and dies ask for National Forging Machine Talk No. 36.



NATIONAL MACHINERY COMPANY

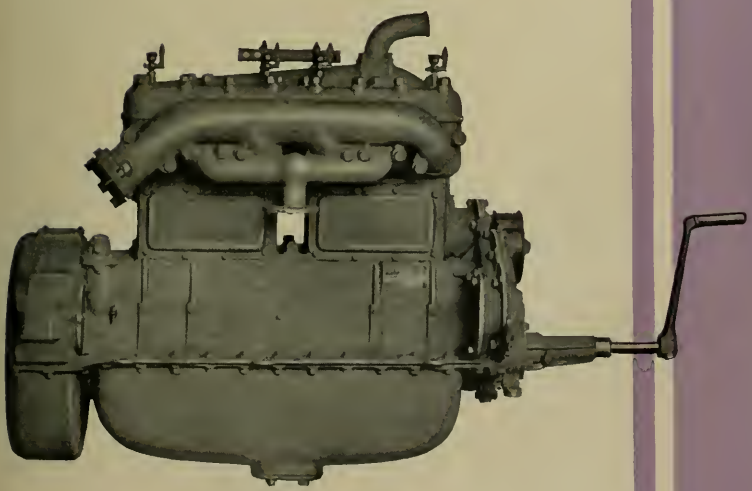
TIFFIN, OHIO, U.S.A.

ARE YOU RECEIVING
NATIONAL FORGING MACHINE
TALKS?

The Grinding Wheel *and* The Gasoline Engine

How Grinding has Made Possible the Twentieth Century Power Unit

BUDA



TRADE NORTON MARK

Grinding Is More Than an Economic Factor in the Production of the Gasoline Engine—It is a Fundamental Process Upon Which Design Is Based



Grinding Cylinder Castings, Heald Machines.



Limits are plus or minus .001"; stock removed .008" to .012"



Wheels are Norton Crystolon, 24-J, $3\frac{1}{2}$" x $\frac{3}{4}$" x $\frac{1}{4}$"

Time was when the most advanced idea of grinding was to mount a grindstone on a wooden horse in a corner of the shop for the touching up of a tool, perhaps, which was rubbed up against the wheel revolved by foot power and roughly made as fit as any operator desired or imagined necessary. A little later human power was eliminated and the grindstone was hitched up to a belt, thus bringing into existence a primitive type of grinding machine.

Then came a period of constant advancement in grinding means and methods. Knack gave way to science; crude makeshifts fell down before intricate machines of efficiency, and grinding work was produced with speed and accuracy.

Grinding goes hand in hand with modern invention. The requirements of speed, endurance and compactness, prescribe accuracy in machining the parts of a mechanism—and the practical science of grinding has so kept pace with imaginative genius of the inventive minds of the period that the niceties of perfect fitting and perfect running parts which formerly dwelt in the mind of the theorist have been brought into actual existence.

That invention which seems to best typify twentieth century American progress is the gasoline engine, for its use is so general as to have practically put it ahead, as a factor in transportation, of the nineteenth century marvel propelled by steam. The gasoline engine is the motive power of the automobile, the aeroplane, the cycle, the launch, the tractor—in fact of every kind of modern means for doing work and

TRADE NORTON MARK

effecting transportation. And it is not radical to state that grinding science is responsible for the remarkable development of this power unit which has revolutionized industry, transportation, thought, and modern life; FOR THERE ARE FEW PARTS OF GASOLINE ENGINES WHICH ARE NOT GROUND. The Middle West is the home of the automobile industry and here, side by side, is to be found the companion industry for the manufacture of gasoline engines. At the Buda Company, Harvey, Illinois, the Norton grinding wheel, machine, and methods make up a large part of the equipment for the transforming of metal into the complexities of the rapid, accurate working of the Buda engine.



Grinding Pistons; Norton Machines; Norton Wheels, Alundum 24 Combination L18"x2½"x5"

The gas engine builder and the well-informed mechanical man to whom the inner workings of his automobile engine are no enigma, are naturally interested in the operations which make the engine possible. What grinding did for the evolution of the gasoline engine can be summarized in a recounting of the grinding operations as they are carried on at the Buda plant.



Pistons are Gray Iron, 4½" x 5⅜". .030" stock is removed, output 300 per day.

Cylinder Grinding

The cylinder is the fundamental of the engine and in the proper grinding of this part lies the efficiency of the larger me-



Camshafts are rough ground with Norton Alundum Wheels, 24-Q18"x1¾"x5" and finish ground with a Norton Alundum 24-L 18" x 1¾" x 5" wheel.



Gilford-Wood Company Ice Cutting Machine, Buda Engine

TRADE NORTON MARK



Testing Concentricity of Crankshaft with Dial Gauge.

chanical structure. Buda cylinders are cast four en bloc and are ground in this plant on Heald Cylinder Grinders equipped with Crystolon wheels 24-J, 3½″ x ¾″ x 1¼″. The cylinders come from the Boring Department with from .008″ to .012″ stock left on the diameter to be ground. The limits are plus or minus .001″. Each machine completes twelve castings in an eight-hour day, a total of 48 cylinders.

Piston Grinding

In the grinding of the pistons is again exhibited the advantage of this modern method of machinery for effecting nicety of fit and the consequent gain toward the perfect running of the motor. Although the piston grinding department of the Buda plant is not large, the operation is interesting and has been developed to a point of high efficiency. The pistons come rough-turned from the lathes about .030″ oversize and are ground down to within limits of plus or minus .0005″ on a Norton grinding machine employing Alundum wheels 24 combination L, 18″ x 2½″ x 5″. The output is 300 in an eight-hour day and three machines easily handle the work. In setting up the pistons, one end is centered and a cap having a center hole,



Looking into the grinding wheel storeroom. "Buda" carries a big stock of Norton Wheels.



Crankshafts, Rough and Finish Ground, both Main Bearings and Crank Pins.



TRADE NORTON MARK

is fitted over the open end of the piston, the cap being held in by a dummy wrist pin which goes through the piston and the shank of the cap, thus enabling the pistons to be ground on center.



Rough Grinding Valve Heads, Norton Machine, Norton Alundum Wheel 24-M, 20"x2"x12½"

Connecting Rod Bushings

Grinding follows all along in the story of the Buda engine. The upper connecting rod bushing, which is of cast bronze, is bored, reamed, and faced on one end in a screw machine, but no turning or finishing is done on the outside diameter. The bushings are placed on a lathe arbor and are ground down to 1.314" with a grinding limit of plus or minus .0005". These bushings are a press fit in the connecting rods. Formerly there was an intermediate operation of rough turning to within .015" or .020" of size on the screw machine, but now *they are ground directly to size from the rough.* It can be readily seen that a great saving was brought about by eliminating this turning operation on the outside diameter. From ⅛" to 3/16" of stock is removed in grinding and production is 600 in eight hours. A Norton 24 combination M, 20" x 4" x 12½", wheel is used and a perfect surface is attained on the bushing.



Finish Grinding Valve heads, Norton Machine, Norton Alundum Wheel 24-M, 20"x2"x12½"



Placing Push Rods into Collets for Grinding Shanks.

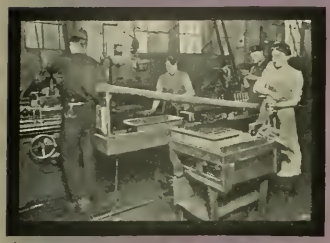


Bowen Motor Railways Corporation—Passenger Car, Buda Engine.

TRADE NORTON MARK



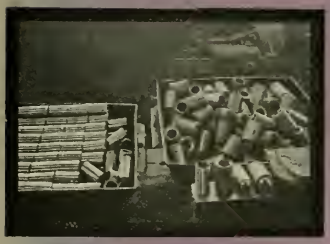
Grinding Push Rod Shanks, Norton Wheels, 24 combination M, 20"x4"x 12½"



Valve Push Rods are Ground on Centers, Center Plugs being Screwed into the Tapped End. The Flange End Goes into a Screw Collet.



Grinding Connecting Rod Bushings, Norton Wheel 24 combination M, 20"x4"x 12½"



These Bushings are Ground Directly to Size from the Rough.

Crankshaft Bearings

Grinding the crankshaft bearings is an important operation. Two Norton grinding machines are used for roughing and two for finishing. On the roughing operation, .060″ of stock is removed from the center bearing and .045″ is removed from the rear and front bearing, leaving .005″ to .008″ of stock for finishing. The wheels used on these operations are originally 26″ in diameter and are employed for grinding the crankpins. When they have worn down to 22″ in diameter, they are sent over to the bearing grinding machines where they are finished out.

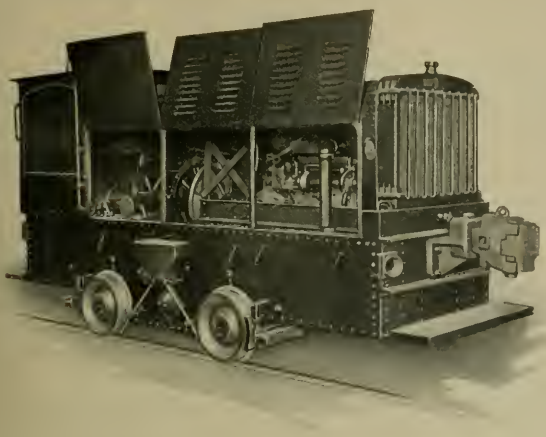
After the crankshafts are ground, a sclerescopic reading is taken which must show a point between 41 and 45. Any crankshaft which varies more than .001″ in concentricity is rejected. In the grinding of these crankshafts much attention is given, and at the same time a very good production is maintained. Roughing is accomplished at the rate of 55 per eight-hour day, and about 58 are turned out in the finishing operation in the same time.

Crankshaft Pins

The grinding of the crankshaft pins is done on four Norton machines—two for roughing and two for finishing. A 6636-O Alundum wheel is used for both operations. In the roughing .090″ of stock is removed, leaving about .010″ to .015″ stock to finish. The finish grinding is done to a limit of plus or minus .001″ and the production is 60 a day (eight hours), for each operation.

Push Rod Heads

A Norton grinding machine, equipped with an Alundum 24 combination wheel, 20″ x 2″ x 12½″, is the efficient medium for grinding push rod heads. The push rods are held in a collet which has a stop inside, the push rod projecting 2″ from the base of the collet. The wheel speed is 1150 r.p.m., that of the fixture is 200 r.p.m. Production is from 850 to 900 a day, the finish is very high, and the surface must be exactly at right angles to



Industrial Locomotive, Cummings Machine Co., Buda Engine.

the axis of the push rod. The push rods are electric furnace steel, bone hardened 1/16″ deep, and a sclerescopic reading is taken after grinding. The minimum reading is 70 and the preferred reading 80.

Push Rod Shanks

Grinding push rod shanks is a job of which the Buda Company is justly proud. Two Norton grinding machines have handled the work, one doing the roughing and the other the finishing. A ⅜″—24 tapped hole runs into the end of the push rod for a distance of ⅞″ and there is a center hole at the other end.

After the rods are rough-ground, the operator places them on a chute where they slide to the second operator who takes the finishing cut. On the roughing operation .030″ of stock is removed, leaving .005″ for the finisher. The limits are plus or minus .0005″ and the production is 900 in an eight-hour day, roughed and finished. The wheels used on both machines are Norton 24 combination M, 20″ x 4″ x 12½″.

Grinding Camshafts

The grinding of the camshafts at this plant calls for rather large equipment. Six Norton grinding machines are employed, three for roughing and three for finishing and seven different types of cams are ground. For roughing, an Alun-





Roughing Camshafts Norton Machine Norton Alundum Wheel, 24-Q 18″x 1¾″x5″



Finish Grinding Camshafts, Norton Machine, Norton Alundum Wheel, 24 Combination L, 18″x 1¾″x5″

Grinding Oil Pans. Diamond Face Grinder. Norton 14-L Alundum Silicate Wheel.





Oil Pans, Joints are Ground, $\frac{3}{16}$" to $\frac{7}{32}$" stock removed.





Bell Housings, Water Jacket Covers and Exhaust Pipes are Ground to Make them Water and Oil Tight. Diamond Face Grinder, Norton 14-L Alundum Silicate Wheel.

dum wheel, grain 24, grade M, 18" x 1¾" x 5", is used and for finishing an Alundum 24 combination K, 18" x 1¾" x 5", wheel is used. On the roughing machine 43 camshafts are ground to a wheel. The total roughing production is 35 for an eight-hour day. There are eight cams, one eccentric on every shaft, and some cams have 5/16" of stock to be removed. From .020" to .025" of stock is left for finishing. On the finishing operation, the cams are held to plus or minus .001" and the production is 45 shafts a day.

There is grinding on practically every part of the Buda gasoline engine and in every case the finishing is accomplished through this modern means of machining which insures niceties of fit, truth in the running of the parts, a perfect turning unit.

A gasoline engine for practical, economical, and convenient use is unthinkable without grinding. Steady development of this practical method through constant research has created a science which has exactness for its limit, and which affords an ever-increasing store of grinding information. The machining problem which has received no solution, or only an unsatisfactory setting, not worth-while to the manufacturer, is welcomed by the Norton Engineering staff at Worcester as a means for experimentation which serves as a step in the evolution of the science of the grinding wheel.

NORTON COMPANY

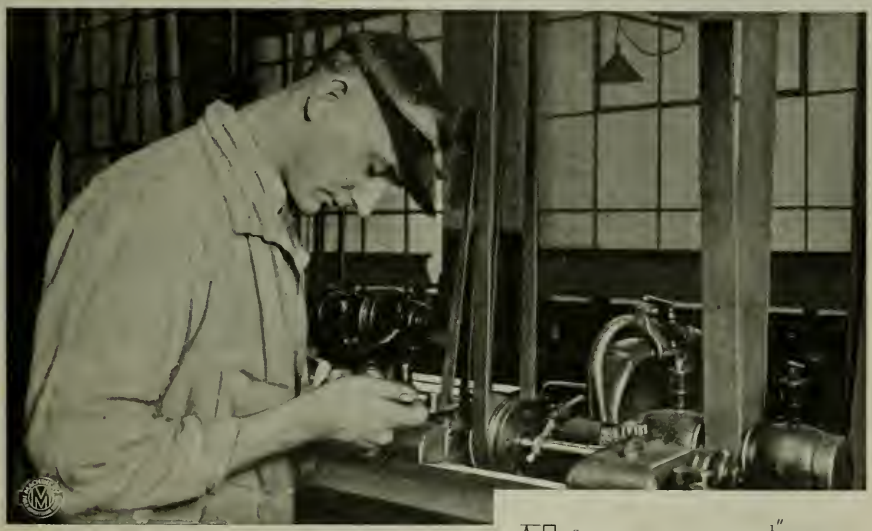
WORCESTER MASS., U. S. A.

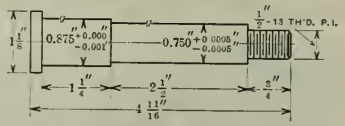
TRADE NORTON MARK

Greenfield

TRADE MARK REG. U.S. PATENT OFFICE

No. 1 GRINDER





Three Years In This Shop. Accurate? Listen to This—

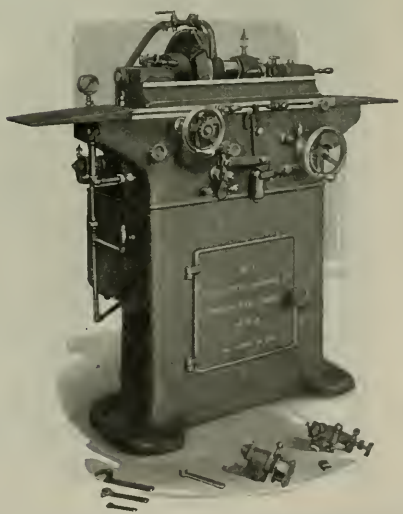
This Greenfield No. 1 Grinder handles *all* small cylindrical grinding for the Hartford (Conn.) Special Machinery Company, the operation illustrated being typical of the close dimensions to which much of the work is held.

It consists of grinding two diameters on studs for glass making machinery, dimensions and limits being clearly indicated in the accompanying sketch.

The machine is as accurate today as when first installed and the company is well pleased with its service—accuracy, output and cost.

There are distinctive advantages about this simple, well balanced machine which practically eliminate the weaknesses common to many similar machines.

Let us describe them.

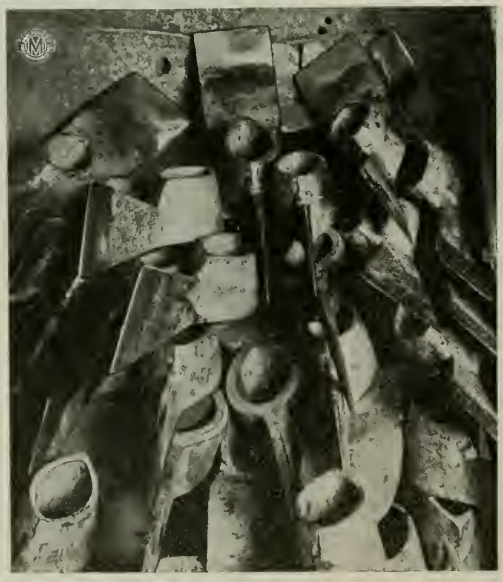


THE GREENFIELD MACHINE COMPANY

Greenfield Mass., U. S. A.



DIVINE POLISHING SERVICE



We'll Tell You How to Get the Most from your Equipment and We'll Install an Equipment That you can Get the Most From.

FIRST of all the *right* equipment. Next the best way to apply it. Divine Brothers' Service covers both these necessities. For example, one of our experts made a thorough investigation of the polishing requirements of the Iron City Tool Co., Shuster, Pa. He traced the progress of the work through the factory from start to finish, superintended the installation of polishing wheels, glue heater, abrasives, etc. As a result the mattocks, picks, sledges and other tools made by this concern have an attractive and serviceable finish, are more readily marketable, and the polishing costs have been reduced to a minimum.

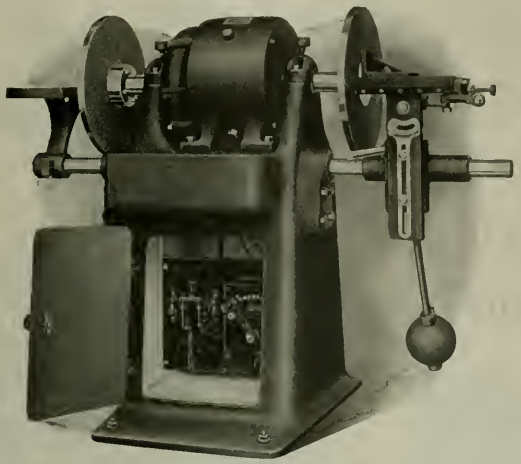
Let us tell you what Divine Brothers' Polishing Service will do for you. Write.

ENGINEERING DEPARTMENT

DIVINE BROTHERS CO.

UTICA NEW YORK, U. S. A.

Illustrating ring wheel grinding operation.



Complete description on request.

Antigo Disc Grinders

18-inch Machine With Motor Drive

A strong, rigid, double-duty grinder at which two men can work at the same time. The machine is simple in design, durably constructed, and has many practical advantages. Its field is general grinding and the production of duplicate parts; it is rapid, accurate, economical, and not afraid of hard work.

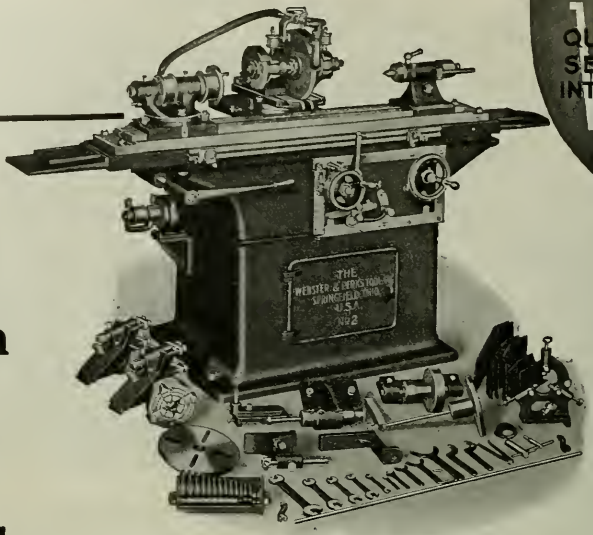
Both wheels operate simultaneously at full speed; ring wheel chucks are interchangeable with disc wheels. Tables may be plain or lever feed, both alike or "assorted." Lever feed table, adjustable to any angle up to 45 degrees, oscillates forward and backward, and has vertical adjustment of 4½". A 5 horse-power motor does the driving.

Antigo Disc Grinders are made in several styles and sizes, furnished with steel discs 30", 27", 23", or 20" diameter and adjustable ring wheel chucks 8" to 20" diameter. Don't buy machines of this type without investigating Antigo Grinders.

MURRAY-MYLREA MACHINE CO.

ANTIGO **WISCONSIN, U. S. A.**

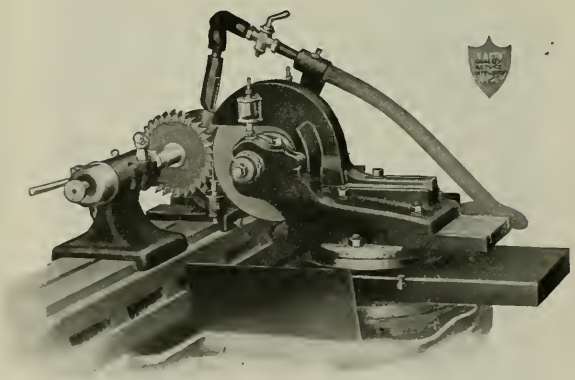
Agent for Michigan: J. C. AUSTERBERRY, 65 Shelby Street, Detroit



QUALITY
SERVICE
INTEGRITY

Cylindrical Grinding on The W & P Universal Grinder

The Cutter Tooth-rest is regularly supplied with this machine



Grinding Face of Milling Cutter, with Center Wheel.

In sharpening straddle milling cutters and similar cylindrical work on which duplicate faces must be successively presented to the wheel, the cutter tooth-rest is used to locate the edges to be ground.

This attachment has such a wide and practical application to modern cylindrical and cutter grinding that we consider it indispensable, and include it regularly in the standard equipment of all our universal machines. The "blade" of the rest is made of spring steel and permits the edges to slip by.

In the set-up here shown, the work is mounted on an arbor held between centers and the center wheel used for grinding. Next month we'll show you this versatile and productive machine set up for side cutter grinding.

THE WEBSTER & PERKS TOOL COMPANY

SPRINGFIELD P. O. Box 1301 OHIO, U. S. A.

BLANCHARD

High Power Vertical Surface Grinders

This No. 10 Blanchard Grinds Dies Fast, Yet Safely

Dies are expensive and easily spoiled. The saying, "Better be sure than sorry," applies with special force to die grinding. You must be sure you do not overheat the surface or edges. With most grinders this means you must go very slowly. Not so with the Blanchard. The Blanchard will grind dies in a fraction of the time required by other machines with perfect safety.

For example, this No. 10 Blanchard ground 1/32″ from the face of each of these four 6″ by 6″ hardened dies in five minutes—less than half an hour for the lot.

Blanchard Grinders are handling this class of work daily in dozens of shops.

Many firms that use our large No. 16 grinder for production, find our No. 10 machine a great time saver in their toolrooms.

Descriptive circular on request.

BLANCHARD

Trade Mark Reg. U. S. Patent Office.



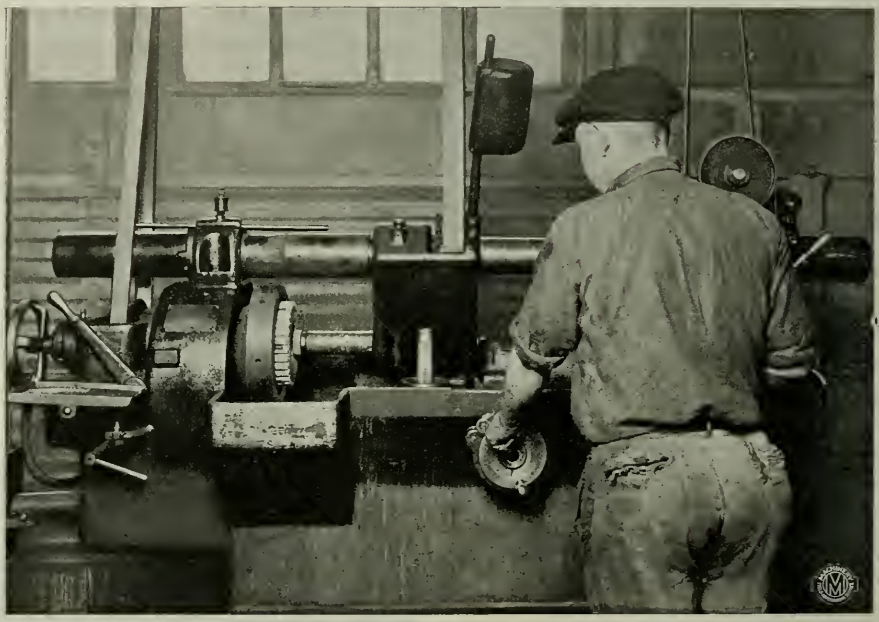
Next month we will show you in this space an example of production work on the No. 10

THE BLANCHARD MACHINE CO.

64 STATE STREET **CAMBRIDGE, MASS., U. S. A.**

UNITED STATES: Henry Prentiss & Co., Inc., Motch & Merryweather Machinery Co., Marshall & Huschart Machinery Co., W. E. Shipley Machinery Co., Kemp Machinery Co., Robinson, Cary & Sands Co., Pacific Tool & Supply Co. CANADA: Williams & Wilson, Ltd., F. F. Barber Mchy. Co., Ltd. GREAT BRITAIN: Burton, Griffiths & Co., Ltd. FRANCE: Aux Forgea de Vulcain. ITALY, SWITZERLAND, BELGIUM, SPAIN and PORTUGAL: Allied Machinery Co. of America. SWEDEN: A/B Rylander & Asplund.

BRYANT CHUCKING GRINDERS

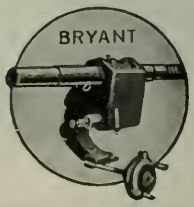


Insure Accurate Bores in Accurate Gears

Bore Grinding is in most cases an important operation in which accuracy is carefully gaged and for which the machine is carefully chosen.

The Hart-Parr Co., Charles City, Iowa, use two Bryant Chucking Grinders for this class of work. The one shown is Bore Grinding intermediate gears for Hart-Parr Tractors. The bore is two inches deep, ground to 4.375″ in diameter with limits of plus 0.003″ and minus nothing; about 0.015″ of metal is removed. Production is 15 per hour.

Bryant Chucking Grinders give good production with a high degree of accuracy on all classes of internal work that can be chucked. If you want to save time *and money* on work of this class, ask us about these machines.



BRYANT CHUCKING GRINDER CO.

SPRINGFIELD VERMONT, U. S. A.

DIRECT REPRESENTATIVES: Chicago, L. C. Gilchrist, 1262 Columbia Ave.; Detroit, B. J. Riordan, 263 St. Paul Ave. AGENTS: Cleveland, Cincinnati and Pittsburgh, Motch & Merryweather Machinery Co.; New York, Boston, Buffalo, Rochester, Syracuse, Scranton and Hartford, Henry Prentiss & Co.; San Francisco and Los Angeles, Berger & Carter Co.

It Cuts

That's the Secret of the Efficiency of Aloxite Cloth

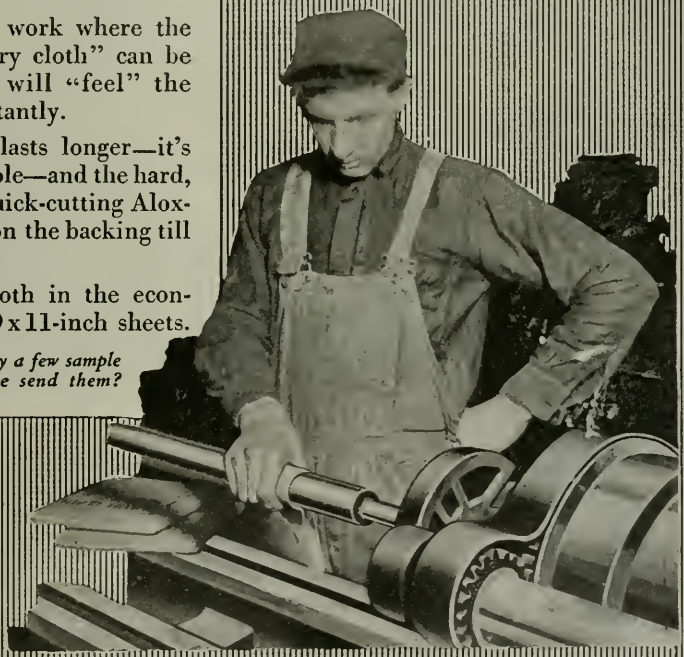
IT isn't a case of slow, time-killing rubbing when you are using Aloxite Cloth, because it cuts clean and fast, always leaving a smooth, uniform finish.

Use it on any work where the ordinary "emery cloth" can be used and you will "feel" the difference—instantly.

Aloxite Cloth lasts longer—it's extremely flexible—and the hard, sharp, tough, quick-cutting Aloxite grains stay on the backing till worn off.

Get Aloxite Cloth in the economy rolls—or 9 x 11-inch sheets.

Will you try a few sample sheets if we send them?



Aloxite Cloth

The Cloth that cuts

The Carborundum Company, Niagara Falls, New York

New York Chicago Boston Philadelphia Cleveland Cincinnati
Detroit Pittsburgh Grand Rapids Milwaukee

Lafayette Universal Grinder

Read What This User Says—

LAFAYETTE

THE BORG & BECK CO.
MANUFACTURERS OF
The Borg & Beck Clutch
For Automobiles & Commercial Vehicles
CHICAGO, ILL.

June 11th, 1920.

Mr. W. M. Mennon, President,
Lafayette Tool & Equipment Co.,
21 S. 12th Street,
Philadelphia, Pa.

Dear Sir:

We have now been using one of your Universal Grinders for about three weeks in our Tool Department and elsewhere throughout our plant, and we thought it may be of interest to you to learn just what the opinion of our department heads is, regarding the performance of the machine.

The report seems to be general that it is a very high class product, equal to grinding threads, producing an excellent finish in grinding holes, outside diameters and threads of all pitches.

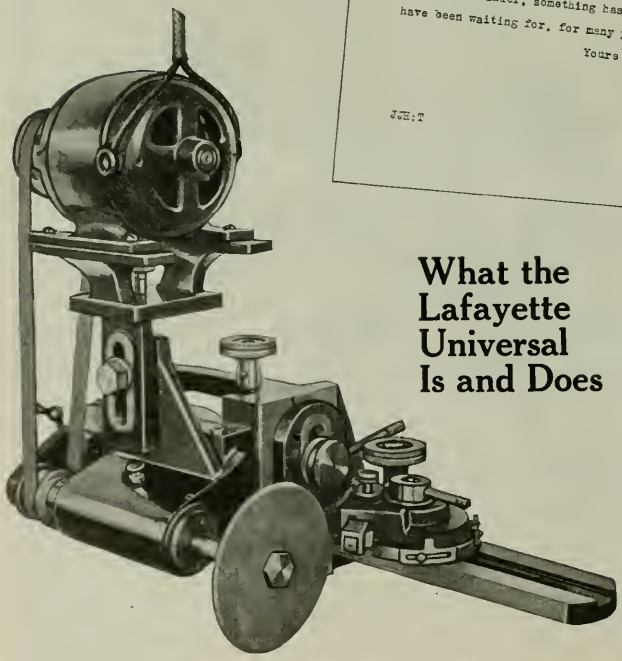
It is most highly appreciated by our gauge and tool-makers. In fact, the general impression is, that in the Lafayette Universal Grinder, something has been offered to the trade that they have been waiting for, for many years.

Yours very truly,

THE BORG & BECK CO.

J. J. Hartley
Factory Manager.

JJH:T



What the Lafayette Universal Is and Does

A precision tool of strong and rigid construction to grind threaded and plain cylindrical, internal, surface, cutter and tool work in wide variety. Has extraordinary accuracy—limits of .0001" are easy to attain.

Use the Lafayette for grinding threads, taps, dies, hobs, worms, reamers, gages of all description, drill bushings, circular forming tools, mandrels, end mills, counterbores and a hundred other types of work. Where can you find a grinder for $240.00 which will perform so many widely varying operations—which will so quickly repay your investment?

Write for Catalog

THE LAFAYETTE TOOL & EQUIPMENT CO.

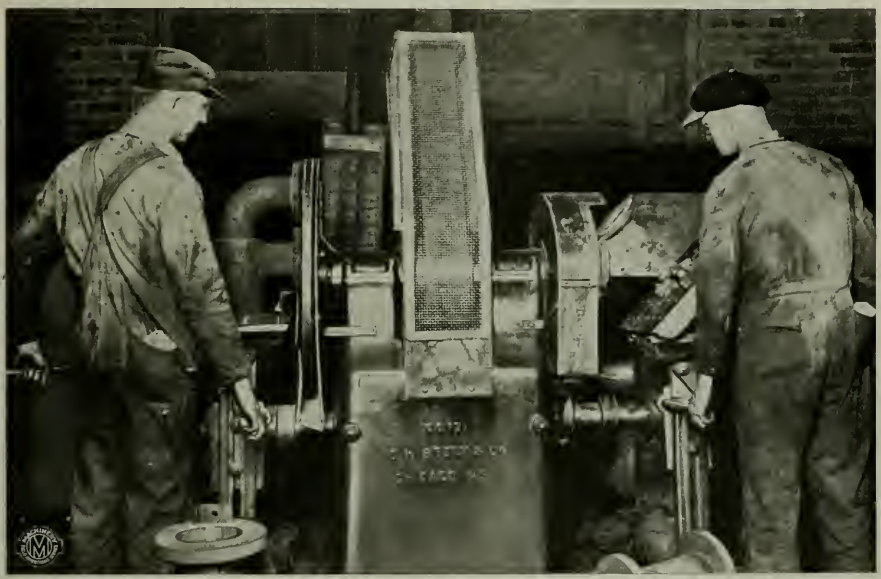
MANUFACTURERS OF PRECISION TOOLS

General Soles Offices:
21 South 12th St., Philadelphia, Pa.

Works:
Lafayette, Indiana

BESLY GRINDING

vs. Facing in the Lathe



Simple and Economical

BESLY CHICAGO



A little more than a year ago, at the Northwest Engineering Works, of the Emergency Fleet Corporation, Green Bay, Wisconsin, various cast-iron flanges for tug boat fittings were faced on a lathe. Today they are handled by this No. 17 Besly Grinder in half the time and with only unskilled operators.

This machine is equipped with a ring wheel chuck on one side and a disc wheel opposite.

When photographed, it was facing a manifold on one end and a "Y" on the other—the latter being located by a readily adjustable angle plate. Stock removed never exceeds 1/16". With speed, economy and versatility all to the credit of Besly Grinding—both on odd jobs and long runs—you'll find profit in a closer investigation.

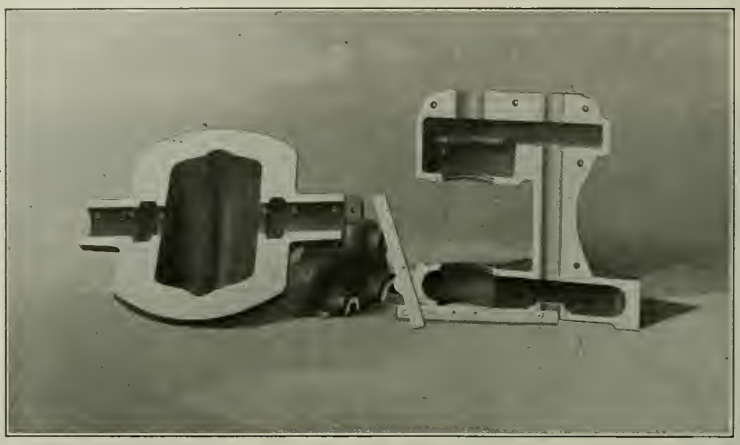
Catalog on request.

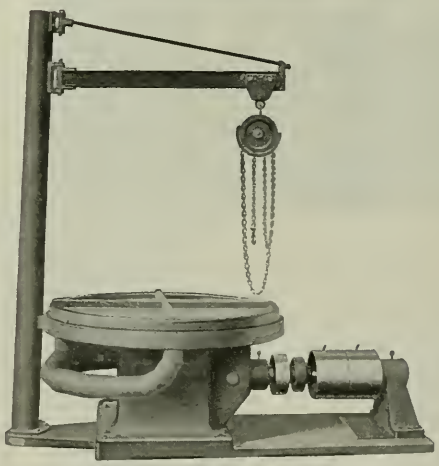
CHARLES H. BESLY & COMPANY

Originators of Disc Grinders

120-B North Clinton Street CHICAGO, ILLINOIS, U. S. A.

We Know You Can Do It!





It's easy to obtain good production on gear housings similar to those shown above, when you finish them on the GARDNER No. 24 Disc GRINDER equipped with our G. I. A. Discs.

50 Per Hour On This Job— We Know You Can Do It, Too!

"When You Think of a Disc Grinder, Think of a Gardner"

GARDNER MACHINE COMPANY

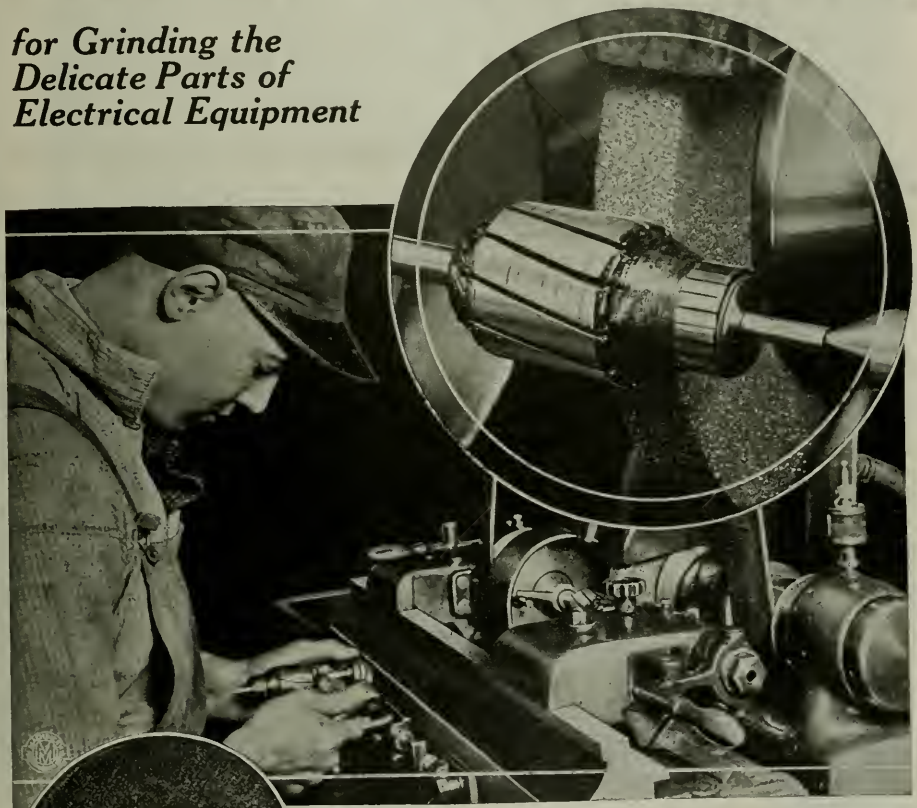
414 Gardner St., Beloit, Wis., U. S. A.

New York Office: 6 Church Street Chicago Office: 32 N. Clinton Street

REPRESENTATIVE IN GREAT BRITAIN: Alfred Herbert Co., Ltd., Coventry, England
REPRESENTATIVE IN PARIS, TURIN, AND BARCELONA: Allied Machinery Co. of America

Abrasive Grinding Wheels

for Grinding the Delicate Parts of Electrical Equipment





There are few things in the realm of mechanical equipment which must be ground with such extreme care as parts for electric motors and apparatus.

This photograph was taken in a large New York City plant where Abrasive Grinding Wheels are used exclusively for this type of work.

The operation being performed is the grinding of an armature for an electric motor. Rough grinding removes .008" and finish grinding .004".

There's an Abrasive Grinding Wheel for every grinding need; let us tell you which is best for each job in your plant. Write.

TRADE ABRASIVE MARK

ABRASIVE COMPANY MAIN OFFICE AND WORKS **Bridesburg, Philadelphia**

CHICAGO BRANCH: 566 West Washington Boulevard

FOREIGN AGENTS: England, Wales, Scotland, Ireland, Burton, Griffiths & Co., Ltd., London; France, Belgium, Switzerland, Fenwick Freres & Co., Paris, Liege and Zurich; Norway, Sweden, Denmark, Akt. Wilh. Sonesson & Co., Malmo, Stockholm, Gothenburg, Copenhagen; Finland, Julius Tallberg, Helsingfors; Holland. Spliethoff, Beeuwkes & Co., Rotterdam; Spain, J. Vilaseca Bas, Barcelona; Australia, Engineering Supply Co. of Australia, Ltd., Brisbane; B. K. Morton, Prop., Ltd., Melbourne and Sydney; Argentine Republic and Uruguay, A. G. Burbanks, Buenos Aires; Peru, Enrique Humphreys & Co., Lima; Manila, P. I., Milton E. Springer & Company. CANADIAN AGENTS: Montreal, Toronto, Canadian B. K. Morton Co., Ltd.; Halifax, Austen Bros.

DESMOND-STEPHAN
GRINDING WHEEL DRESSERS

Efficient Tools For All Wheels

Desmond-Huntington Dresser



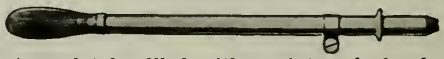
Made in three sizes. For use on the largest and hardest wheels, where quick action is desired. The cutters of No. 2 are 2⅜" in diameter and have a width of face of 1".

Diamond Hand Tool



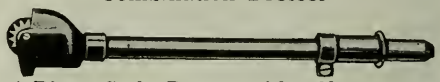
We import the highest quality diamonds and will gladly send stones for inspection.

The Diamo-Carbo Dresser



A steel tube filled with an intensely hard abrasive which will cut all but the coarsest and hardest wheels.

Combination Dresser



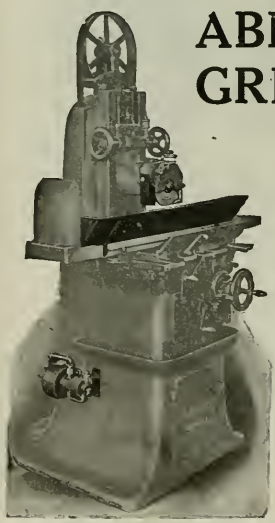
A Diamo-Carbo Dresser with a Sherman or Huntington Dresser set in the handle end; useful for dressing all classes of wheels up to the coarsest and hardest.

Write for a complete list (with prices) of our entire line.

THE DESMOND-STEPHAN MFG. COMPANY

URBANA — OHIO, U.S.A.

The Canadian Desmond-Stephan Mfg. Co., Ltd., Hamilton, Ont.
Alfred Herbert Ltd., Agents for Great Britain.



ABRASIVE GRINDERS

The cut shows one of these machines equipped with centrifugal pump. Spray guards and special wheel hood for wet grinding.

CAPACITY
22 × 8 × 12
Wheels to 8-inch diameter by ¾-inch thick.

Circular?

ABRASIVE MACHINE TOOL CO.

F. N. MacLEOD, President and General Manager

EAST PROVIDENCE — RHODE ISLAND

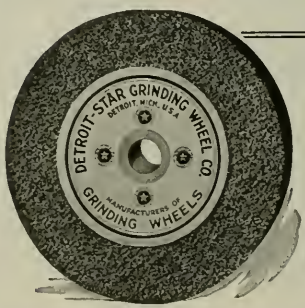
FOREIGN AGENCIES: Aux Forges de Vulcain, France; Burton, Griffiths & Co., Great Britain; I. Lambercier & Co., Switzerland; Selson Engineering Co., Italy; Wilh. Sonesson & Co., Sweden; A. R. Williams Mchy. Co., Canada.

What Do DETROIT-STAR GRINDING WHEEL CO. You Grind?

Grinding already occupies an important place in modern shop practice and there's no limit apparently to its application.

Detroit-Star Grinding Wheels are available in grains, grades, shapes and sizes to handle any operation to which grinding may be applied.

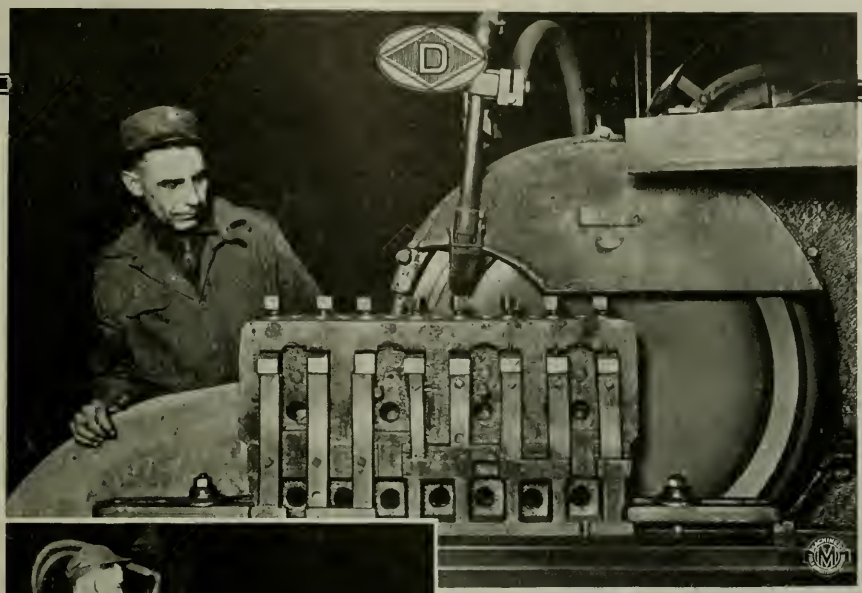
Catalog on Request



DETROIT-STAR GRINDING WHEEL CO.

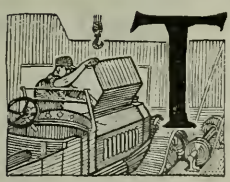
Detroit Michigan
U. S. A.

New York Office: 9-11 W. Broadway, New York City. C. H. Westerberg, Mgr.

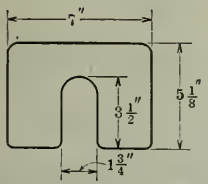




How's This, Mr. Production Manager?



THE American Hoist & Derrick Company, St. Paul, Minn., used to finish friction head gib castings for American Hoisting Engines on a milling machine —one every 7 minutes. Nowadays, however, these parts are located in a simple fixture on this Diamond Face Grinder and finished four at a time in 12 minutes—3 minutes each—an increase of more than 100 per cent in output. The accompanying sketch shows the requirements for the operation.



MATERIAL REMOVED:-
FROM 1/64" TO 1/16"
AVERAGE 1/32"

Saving of skilled labor and maintenance is also frequently an appreciable item in favor of "Diamond Grinding."

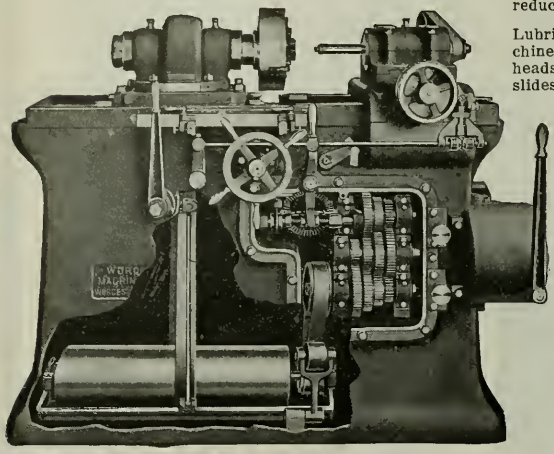
Other examples of Diamond Grinding are described in our pamphlet "The Diamond on the Job." It is yours on request.

Diamond Machine Co.
Providence, R.I., U.S.A.

EXCLUSIVE AGENTS: Chas. A. Strelinger Co., Detroit, Mich.; E. A. Kinsey Co., Cincinnati, O.; E. L. Easley Machinery Co., Chicago, and Moline, Ill., and Milwaukee, Wis.; Strong, Carlisle & Hammond, Cleveland, O.; Somers, Fitler & Todd Co., Pittsburgh, Pa.; Vonnegut Mchy. Co., Indianapolis, Ind.; Williams & Wilson, Ltd., Montreal, Que., Can.; Chas. Churchill & Co., Ltd., London, Eng.; Fenwick Freres & Co., Paris, France; The Horne Co., Ltd., Tokyo, Japan.

A Wide Range Grinder—More Than Ordinarily Rigid

The
CHURCHILL
Internal Grinder



The Churchill Internal Grinder with gear box cover removed to show feed and speed mechanism.

With all internal mechanism of this machine thus fully exposed, its distinctive advantages will be readily understood—the location of the work-head drum on ball bearings, six inches from the bottom of the base, the automatic box in which practically the whole control centers, and the system of firmly gibbed slides by which both wheel head and work spindle are rigidly secured, and vibration is reduced to the minimum.

Lubrication is another well-planned feature of this machine. Oil pockets in the base, oil cups on work and wheel heads, and oil pockets in the ways on which the work table slides provide an ample supply to all moving parts.

This machine grinds 10" deep and swings work up to 18" diameter.

Details on request.

Churchill-Morgan Crittsinger, Inc.

Formerly

Worcester Machine Works, Inc.

Sawyer Bldg. WORCESTER, MASS.

Convenient, Rigid and Compact

WOODS
No. 1 Universal Tool and Cutter Grinder

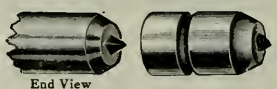
Made in Three Sizes



Box type knee entirely encircling the column, table well gibbed for its entire length and swiveling type headstock all make for rigidity with minimum floor space; graduation for taper grinding, adjustable stops and micrometer dials for both elevating and cross travel screws aid the operator in making adjustments, and a full complement of attachments for all classes of internal and surface grinding within the range of "its 9" swing" make this machine both popular and profitable in any tool-room.

WOODS ENGINEERING CO.

ALLIANCE OHIO, U. S. A.



End View

FRANCIS
Diamond Grinder Tools

for truing emery and carborundum wheels are giving great satisfaction everywhere because of the hard and high quality diamonds used. They will keep your abrasive wheels in good cutting condition.

Ask for descriptive circular and let us send you an assortment for selection.

FRANCIS & CO.

50 State St., Hartford, Conn., U. S. A.

Established in 1799. First National Bank Bldg.

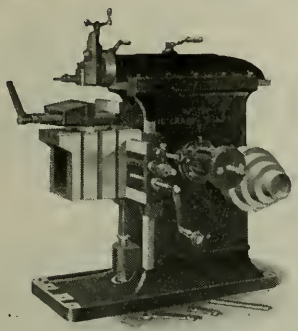


End View



WHIPP Crank Shapers

16" Single Geared—20" Back Geared



The design and construction of Whipp Shapers have made them in demand for general work. Only the best of materials are used, and unusual accuracy is maintained.

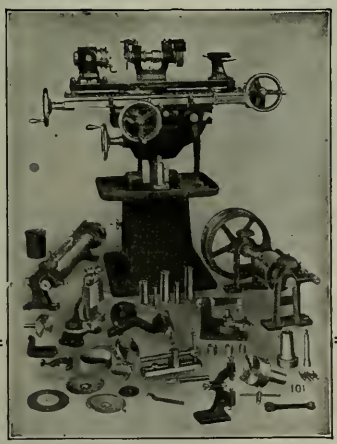
If you have work requiring a shaper—investigate what we have to offer.

Complete information gladly sent on request

The Whipp Machine Tool Co.
SIDNEY OHIO

OAKLEY No. 2

UNIVERSAL CUTTER and TOOL GRINDER

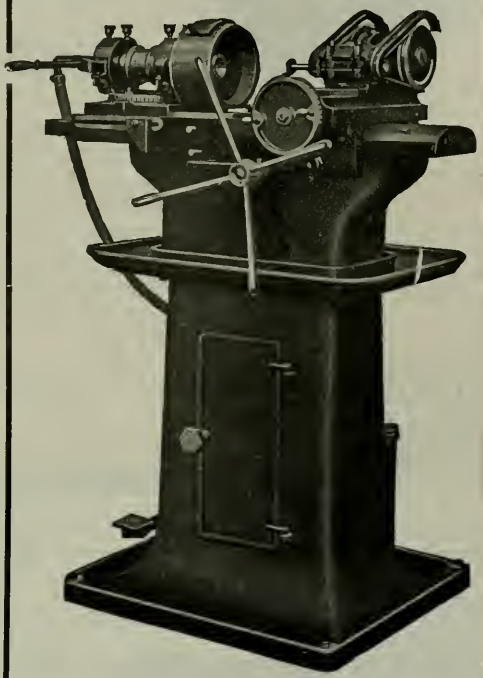


Built as a grinder should be. Exceptionally heavy—rigid and accurate. Adapted for all tool room grinding. *Send for detailed catalog.*

THE OAKLEY MACHINE TOOL CO.
OAKLEY, CINCINNATI OHIO

CAPITAL

Internal Grinder



Forward!

Looking forward we soon realize that there must be a radical change in equipment now if we are to successfully compete with conditions.

Grinding, which has grown greater in importance year by year ever since the advent of the machine tool, will occupy a more important place than ever.

In the front rank of modern grinding equipment comes the Capital Internal Grinder—a *machine tool* for grinding holes $\frac{3}{16}$" to 2" in depth, accurate within limits of .0001". The facts are in Bulletin No. 2. Ask for a copy.

LANSING STAMPING AND TOOL COMPANY
LANSING MICHIGAN



VITRIFIED
GRINDING WHEELS

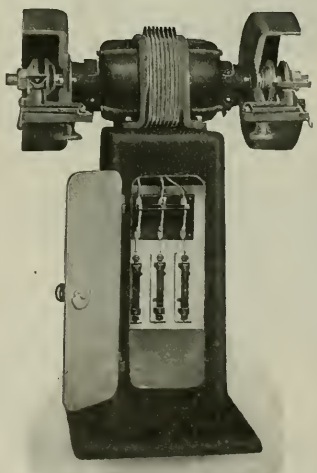
Reputation rather than appearance should be your standard for judging grinding wheels. "Beauty is only skin deep" and grinding wheels to be profitable must give uniformly satisfactory service clear down to the stub.

So take a look at the service records of Vitrified Grinding Wheels. You'll be surprised to find how much more work they produce, how much less dressing and truing they require and how much more economically "Vitrified" shops are run.

Catalog lists and describes the whole line.

VITRIFIED WHEEL CO.
Westfield, Mass.

RANSOM
Motor Driven Grinder

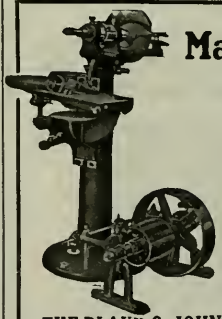


Fitted With General Electric Motor

Dust proof machines, compact, well built and carefully balanced, made to carry wheels from 12" to 30" in diameter.

The cut shows our No. 11 machine which carries 12" wheels.

RANSOM MANUFACTURING CO.
OSHKOSH WIS., U. S. A.



Maine to California

Meaning that the Waterbury Grinders are resident in every state. These machines handle die, toolroom and surface grinding. Simple, accurate, fast, efficient with 9" x 18" work space, three point suspension table support, capacity for hard work and a record for dependability, they have advantages you can't afford to overlook. Circular sent on request.

THE BLAKE & JOHNSON CO., Waterbury, Conn., U.S.A.

Bridgeport Heavy Duty Floor Grinders

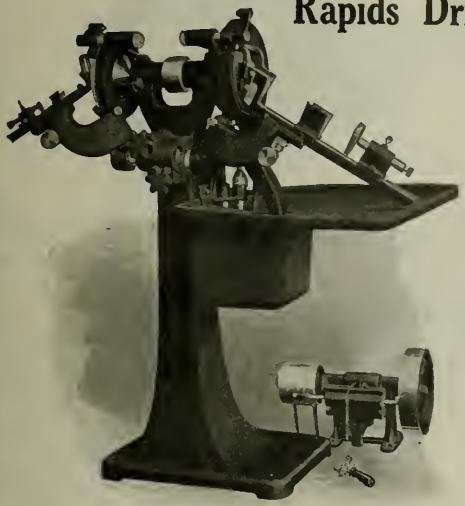
produce results and save power. Heavy Bases, Large Spindles, Powerful Motors and Ball Bearings are reasons why. Safety Collars and Steel Guards give the needed Safety. These are points the wise buyer considers today. Investigate the Bridgeport Line.

Catalog showing our line of 450 belt and motor driven grinders, also grinding wheels, is yours for the asking.



THE BRIDGEPORT SAFETY EMERY WHEEL CO., Inc.
83 Knowlton Street
BRIDGEPORT CONN.

Correct Drill Grinding Means Quick Drilling—Grand Rapids Drill Grinders Guarantee Both



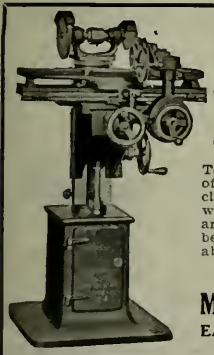
The cost of an operation is more influenced by the condition of the tools used to perform it than by any other single factor. Correctly ground drills may make all the difference between profit and loss in your drilling operations.

Drill grinding the "Grand Rapids" way will speed up your drilling work—will lengthen the working lives of your drills. Grand Rapid Drill Grinders will sharpen your drills with uniform, predetermined accuracy. We guarantee it.

Send for your copy of the Grand Rapids Drill Grinder Book.

GRAND RAPIDS GRINDING MACHINE CO.

29 Ottawa Avenue, N. W. GRAND RAPIDS, MICH.



STERLING

Universal Cutter and Reamer Grinder

Tool-rooms need the convenience of this grinder, adapted for all classes of small work, and provided with table which revolves entirely around head. Swings 9", takes 16" between centers; a durable, dependable, economical machine.

Write for circular

McDONOUGH MFG. CO.

EAU CLAIRE WIS.

Emery Wheel Dressers

Two Sizes **Nos. 1-2**

CUTTERS

We make the regular Huntington (Pattern) for all sizes.
Roughing for No. 1 and 2. Paragon for No. 1 only.

GEO. H. CALDER Lancaster, Pa., U. S. A.

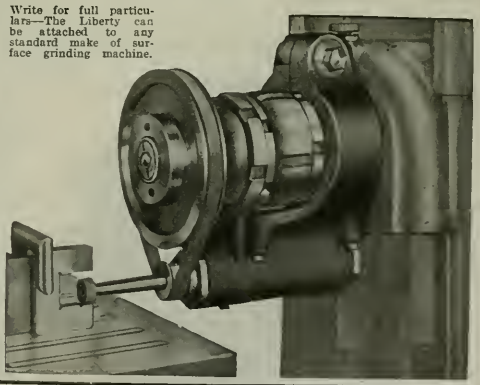
BRISTOL PRECISION ROTARY SURFACE GRINDER

is guaranteed to grind accurately within 0.00025". Let us send catalog of complete line of high grade tools

BRISTOL MACHINE TOOL COMPANY
BRISTOL, CONN.

Successor to C. G. CARRIGUS MACHINE COMPANY

Write for full particulars—The Liberty can be attached to any standard make of surface grinding machine.



A HIGH SPEED ATTACHMENT FOR YOUR SURFACE GRINDER

SPECIFY THE LIBERTY

Put the Liberty on your pay-roll—a high grade, high speed attachment for surface grinders.

Finish your work the modern way, by grinding, but DON'T grind a part of it and omit the grinding of an important surface solely because you can't reach it with big wheels.

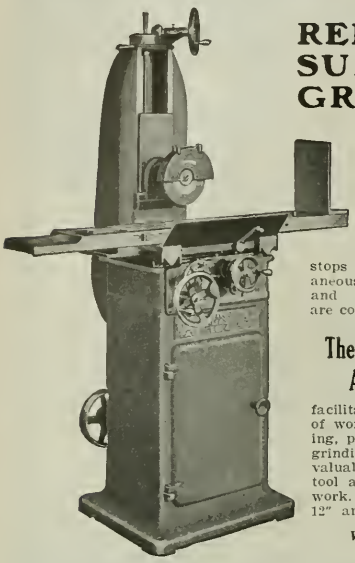
WAIT just long enough for us to send you a LIBERTY and see for yourself what splendid results it will give right on your own work.

Furnished ready for work, including an assortment of wheels most suited to the average kinds of work.

High Speed spindle runs 15,000 to 20,000 R.P.M. driven by an endless canvas belt, which can be simply yet positively adjusted to the correct tension.

LIBERTY TOOL AND GAUGE WORKS
Woonsocket, R.I.

Time and Money Savers



REID No. 2 SURFACE GRINDER

An efficient grinding unit for both toolroom and factory, it is both accurate and easily operated.

Pushrod at center of hand wheel stops and starts instantaneously. Close limits and speedy production are combined.

The Reid Universal Angle Fixture

facilitates the setting up of work on drilling, milling, planing, shaping and grinding machines. Is invaluable for die sinking, tool and experimental work. Sizes 6" x 9", 8" x 12" and 12" x 18".

Write for details.

Reid Brothers Co., Inc.
BEVERLY MASS., U. S. A.
English Agents:
Oliver Machinery Co., Ltd., 201-203 Deansgate, Manchester, England



Grinding Wheels
Abrasives
Abrasive Cloths
Dressing Tools
Grinding Machinery

We manufacture grinding wheels for all purposes.

Clevite for steel and hard metals.

Clevorundum for cast iron and soft metals.

Our "Silicate" wheels can be manufactured to your order in a few days, thus avoiding delay and inconvenience in your factory through having to wait several weeks for deliveries.

We carry a full line of ABRASIVES for the polishing trade.

THE CLEVELAND ABRASIVE WHEEL CO.
2629 East 25th Street CLEVELAND, OHIO

The Profit in Grinding is All in the Wheel



Sterling Grinding Wheels

insure a high percentage—increase output and lower the cost of high class grinding.

Write for Catalog

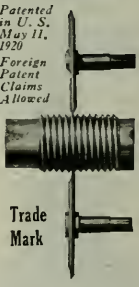
The Sterling Grinding Wheel Co.
FACTORIES AND OFFICES: TIFFIN, OHIO
Selling Agency:
L. BEST COMPANY, 28-30 West Broadway, New York
Chicago Store: 30 North Clinton St.

Multi-Graduated Precision Grinder

For Thread Grinding

Accurate, Rapid, Economical, price within the reach of any shop

Patented in U. S. May 11, 1920
Foreign Patent Claims Allowed

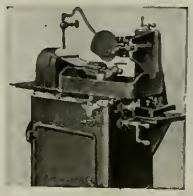


"DUPLEX THREAD GRINDER"

For production grinding of threads

PRECISION AND THREAD GRINDER MFG. COMPANY
Mfg. Plant and Offices:
1932-34 Arch Street, Philadelphia, Pa.

Trade Mark



Hobs--Hobs--Hobs

Reduced to Just Plain

HOBS

By a common sense method of economical and rapid grinding in an accurate automatic machine. **DON'T RUIN** your expensive hobs by sharpening them with the usual makeshift methods.

Our machines in sizes to take every size Hob.

Send for circular "HY"
Automatic Hob Grinder
The H. E. Harris Engineering Company
Bridgeport, Conn.

How the Cost of Dressing Emery Wheels Can Be Reduced!



By Mounting the Diamonds Used for That Purpose, in Froidset Holders

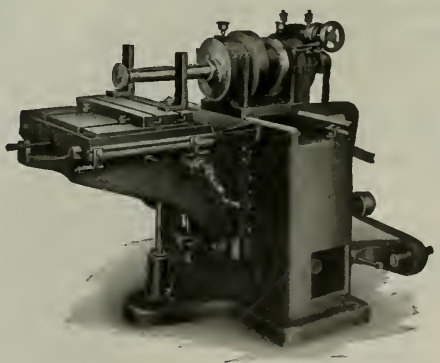
Secures better service, more durability, prevents carbonization, softening of stone, loss of weight, checks or fractures. We will set one of your own stones in Landis, Norton or hand tool dresser GRATIS for a test. For descriptive circular write Tool Department.

THE S. ROSE COMPANY, Inc., 1133 Broadway, New York City

THE LARGEST STOCK OF INDUSTRIAL DIAMONDS FOR ALL PURPOSES CONSTANTLY ON HAND

MADISON CYLINDER GRINDER

A simple, rigidly constructed cylinder grinding machine particularly adapted to a wide range of work.



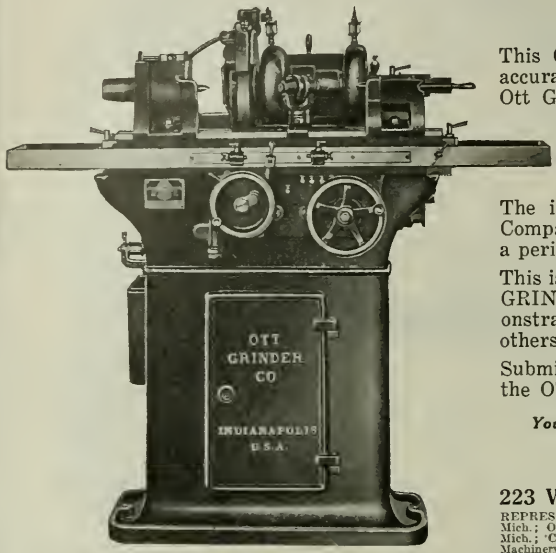
Write for particulars

MADISON MACHINE TOOL COMPANY

609 East Washington Avenue Madison, Wisconsin

Twenty Ott 5" x 18" Plain Grinding Machines

Have been installed in the grinding department of the National Twist Drill & Tool Co. of Detroit, Mich.



Ott 5 x 18 Plain Grinding Machine with Automatic Feed

This Company has found that the simplicity, accuracy, quality and production capacity of Ott Grinding Machines answer their requirements to such an extent that as additional equipment is required to meet their increased production demands, OTTS have been purchased.

The installation of the National Twist Drill Company has been covered by four orders over a period of about two years.

This is but one example of the satisfaction OTT GRINDING MACHINES have given, as demonstrated by repeat orders. There are many others.

Submit your grinding data to our dealers or to the OTT Service Department.

You will be furnished with production data of value

OTT GRINDER CO.

223 W. Tenth St. Indianapolis, Ind.

REPRESENTED BY: McMollen Machinery & Supply Co., Grand Rapids, Mich.; Ogden R. Adams, Rochester, N. Y.; Cadillac Tool Co., Detroit, Mich.; Cleveland Tool & Supply Co., Cleveland, Ohio; Coghlin-Kirkby Machinery & Supply Co., Toledo, Ohio; Syracuse Supply Co., Syracuse, N. Y.; Dale-Brewster Machinery Co., Chicago, Ill.; Swind Machinery Co., Philadelphia, Pa.; L. S. Devos, Export Representative, New York, N. Y.; The Fairbanks Co., St. Louis, Mo.; F. O. Stallman Supply Co., San Francisco and Los Angeles, Cal.; Barbour, Love & Woodward, Inc., New York, N. Y., and Selson Engineering Co., London, England.

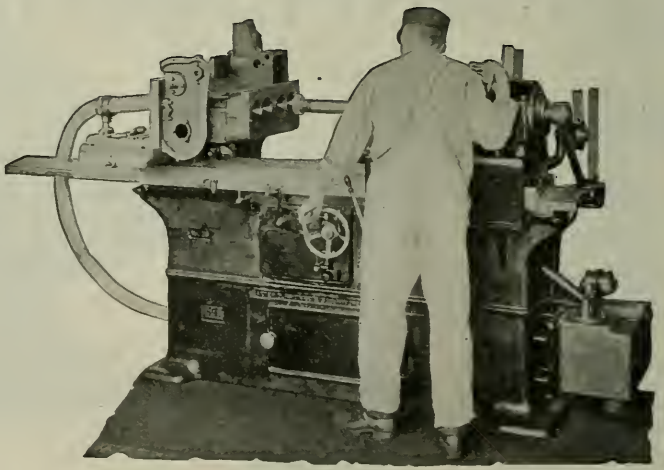
WHITNEY CYLINDER GRINDER

For grinding all kinds of gasoline engine cylinders as well as castings too large or too heavy to revolve.

Machines furnished to grind holes from 3" up to 7" diameter and 14" deep.

Also equipped to grind holes as large as 14" diameter and 20" deep.

Write for new catalog



BAXTER D. WHITNEY & SON, INC.

DOMESTIC AGENTS: E. A. Kinsey Co., Cincinnati, Ohio. Strong, Carlisle & Hammond Co., Cleveland, O., and Detroit, Mich. E. L. Essley Machinery Co., Chicago, Ill. The Motch & Merryweather Machinery Co., Pittsburgh, Pa. Machine Tool Engineering Co., New York City. Sherritt & Stoer Co., Philadelphia, Pa. Carey Mchy. & Supply Co., Baltimore, Md. W. H. Savage, Fitchburg, Mass. Colcord-Wright Mchy. & Supply Co., 1223-1229 North Broadway, St. Louis, Mo.

WINCHENDON MASS., U.S.A.

PACIFIC COAST AGENTS: Portland Machinery Co., Portland, Ore. Perine Machinery Co., Seattle, Wash. Pacific Tool & Supply Co., San Francisco, Cal. CANADIAN AGENTS: Canadian Fairbanks-Morse Co., Montreal, P. Q. FOREIGN AGENTS: Buck & Hickman, Ltd., London, England. Fenwick Freres & Co., Paris, France.

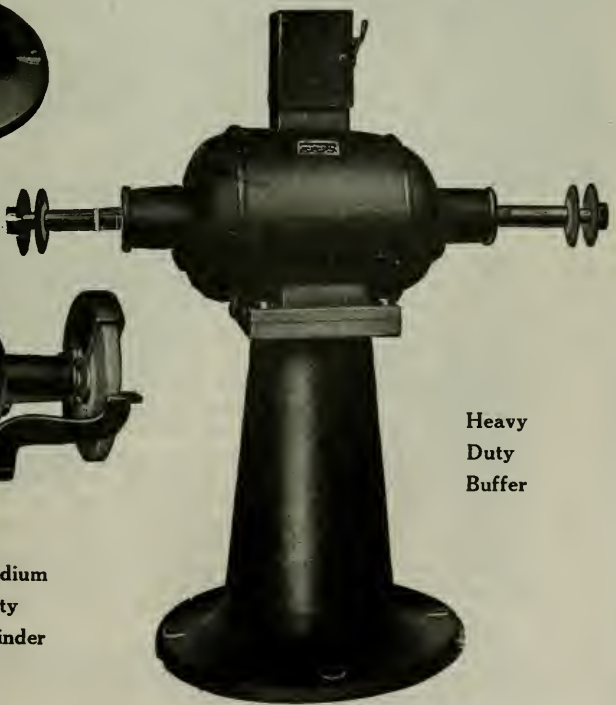
DILLON ELECTRIC GRINDERS and BUFFERS

Self-Contained — Ball Bearing
Dust Proof — Noiseless

Made for Either Direct or Alternating Current



Medium Duty Buffer



Heavy Duty Buffer

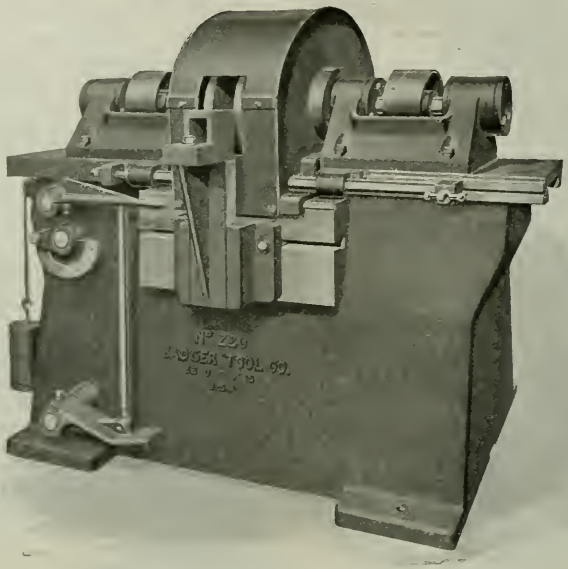


Medium Duty Grinder

Note the simplicity of design and elimination of excess parts.
Heavy Duty Machines made in 3, 5 and 7½ H. P. capacities.
Medium Duty Machines made in ½, 1 and 2 H. P. capacities.

Write for Details

THE DILLON ELECTRIC CO.
CANTON OHIO, U. S. A.



No. 220 Badger Grinder

There are a great many smaller parts having two opposite parallel faces which can be finished to size more economically on a double spindle disc grinder than by any other known process. Such parts, for example, as forged wrenches, piston rings, gear blanks, pliers, coil and leaf springs, carbon brushes, etc., etc. This work is being done successfully on Badger Grinders every day showing a marked saving in time and improved quality of finish. Parts which formerly could not be handled successfully on this type of grinder because of inaccuracy are now being finished to very close commercial limits on Badger Grinders.

We have incorporated in our double spindle type of machine many long needed features which make it possible to obtain very unusual results. Our special ball bearing spindle mountings; the long sliding ways absolutely protected against wear from grit; the unusual rigid base design and the positive micrometer stop make it practical to secure large outputs within very close limits. Angular adjustment of the heads allows the grinding of tapered surfaces as well as parallel. Abrasive cylinders held in chucks are interchangeable with disc wheels allowing wet grinding on parts requiring this treatment.

The No. 220 Badger Grinder can be furnished in belt or motor drive with complete dust exhaust system, wet grinding attachment and various styles of work supports.

Send samples to our Service Department for free demonstration grinding

BADGER TOOL COMPANY

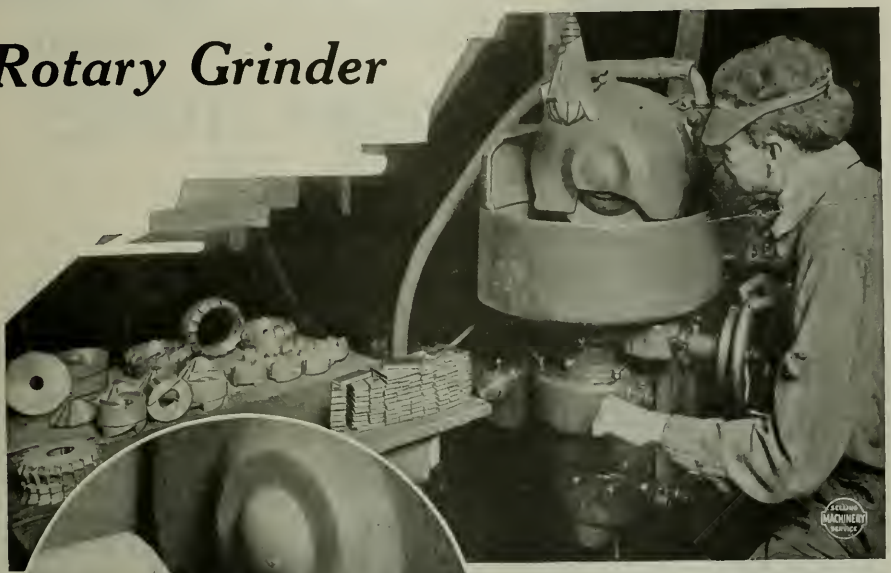
BELOIT, WISCONSIN, U. S. A.

E. B. GARDNER, President R. D. GARDNER, Treasurer

REPRESENTATIVES IN ALL PRINCIPAL CITIES AND FOREIGN COUNTRIES

PERSONS-ARTER

Rotary Grinder





Speed
Precision
Versatility

These three unquestioned attributes of the Persons-Arter Rotary Grinder are all advantageous on the type of work handled by the Gorham Tool Company, Detroit, Michigan.

Observe the varied work on the table; note the ten blades for inserted-tooth milling cutters on the magnetic chuck. These blades are 2½″ x 1″ x 5/16″, both sides being ground.

Despite the limits imposed—one-half thousandth of an inch—production averages 50 per hour. Three sizes: 8″, 12″, 16″.

Write for complete data.

THE PERSONS-ARTER MACHINE CO.

72 Commercial Street **WORCESTER, MASS.**



Power Feed—Centerless
Completely Guarded for Safety

PRODUCTION
Polishing and Finishing
MACHINES

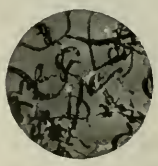
CUT CHIPS INSTEAD OF GRINDING DUST

Again we repeat, "it's the two-belt principle that does the trick"—a patented system which we own exclusively.

By means of this system we immediately dispose of the chips as they are generated or cut; after the belt passes the point where work is held it expels the chips and then resumes its normal position again.

Furthermore, cutting is substituted for grinding; minute machining for wearing, and the by-product is chips—instead of dust.

We will gladly send you complete details. Write for a "Production" estimate on your work—we'll show you speed as well as economy.



Above illustration shows chips magnified fourteen diameters

PRODUCTION MACHINE CO.

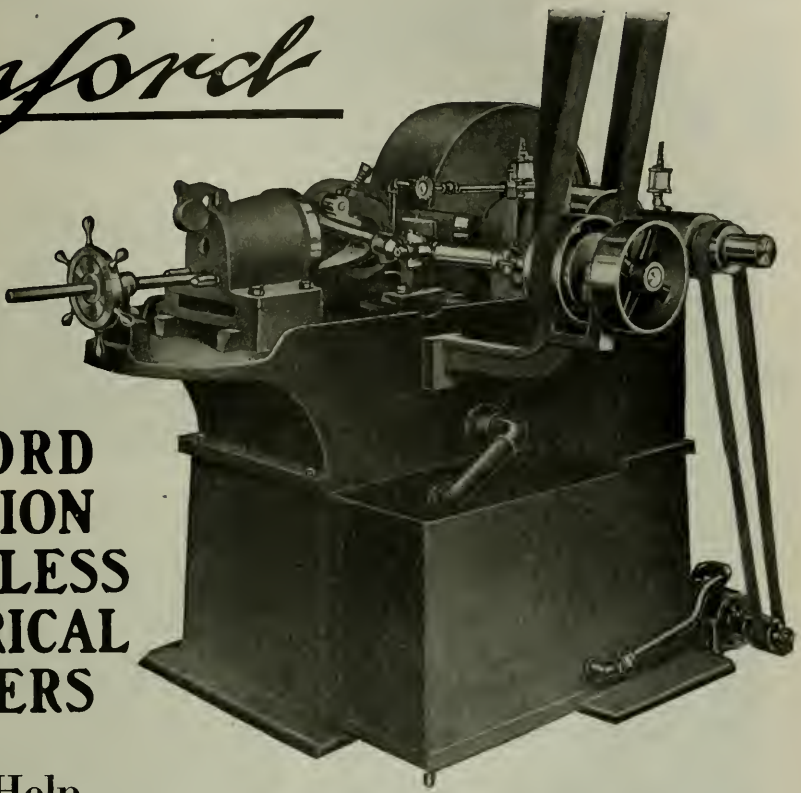
(Formerly Blevney Machine Company)

GREENFIELD MASS., U. S. A.

OVER-SEAS REPRESENTATIVE
ALMACOA ALLIED MACHINERY COMPANY OF AMERICA ALMACOA
51 CHAMBERS ST. NEW YORK, U.S.A.

CADILLAC TOOL CO. DODGE POWER BLDG., Detroit
FEDERAL MACHINERY SALES CO., Chicago, Milwaukee

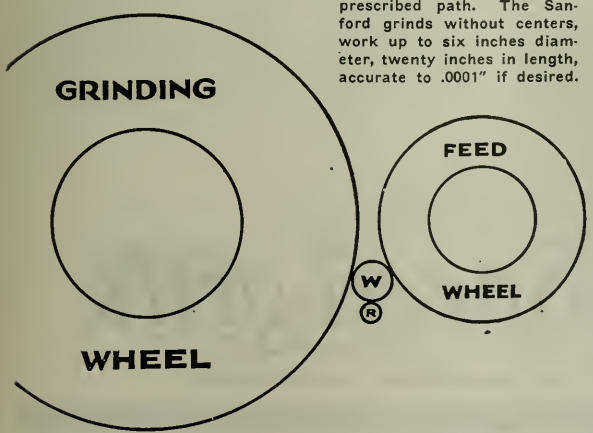
Sanford



SANFORD PRECISION CENTERLESS CYLINDRICAL GRINDERS

Just Can't Help Doing Accurate Work

The work W—travels on the cylindrical rest R—and has "nowhere to go" but in the prescribed path. The Sanford grinds without centers, work up to six inches diameter, twenty inches in length, accurate to .0001" if desired.



The remarkable and unusual accuracy of the Sanford Machine is due to the three-point contact between the grinding wheel, feed-wheel and cylindrical work rest. The result must be right. In fact the Sanford Precision Centerless Cylindrical Grinder can't help being accurate as the accompanying diagram shows.

The centerless method of cylindrical grinding has long been looked upon as the ideal system for big healthy production of cylindrical pieces. But, it was not until the advent of the Sanford that this system became practical and automatically adapted itself to modern shop practice.

Why not write for particulars?

RUSSELL, HOLBROOK & HENDERSON, Inc.

30 Church Street NEW YORK CITY



Why Schmidt Played Off Key

SQUAWK!

The Conductor rapped testily on the opened score and glared over at the brasses. (I was sitting in the back of a Broadway Movie Palace listening in on a rehearsal of the orchestra.)

The cornetist on his right—the alto saxophone player on his left—both stared accusingly at the red-faced Schmidt who sat looking at his new saxophone with a puzzled air.

"We're playing no Chinese scales this morning, Mr Schmidt," said the Conductor with heavy sarcasm. "If you'll please to stick to the music as written we'll go on with the rehearsal. Ready!"

My mind turned back to my last summer's trip through the Buescher Band Instrument Company's plant. I can't play two notes on a saxophone but from what I learned on that trip I knew what was wrong with Schmidt's saxophone.

* * * * * * * *

"It's ticklish close work," said Mr. Lewis. "The mouthpiece of a saxophone has got to be right." We stood in the finishing room of the Buescher Band Instrument Company's big factory out in Elkhart, Indiana, where the famous Buescher True Tone band instruments are made.

All around me workmen were putting the finest sort of finish on the gleaming brass and silver instruments with strips of fast cutting Speed-grits.

"You see," Lewis went on, "if the rubber mouthpiece of a saxophone is the least bit out of true—lower on one side than on the other—it will squeak and squawk—usually at the wrong time. And look here!" He took a trombone from one of the finishers.

"The slightest leak in the slide or joint of these fellows and their tone goes howling to the dogs. With Manning Speed-grits these parts are finished to less than one-thousandth of an inch.

"Accurate? We have to be. Think of our awful responsibility. Possible discords, you know. We make harmony here—nothing else."

Incidentally there's complete harmony between Buescher workmen and Speed-grits.

Good workmen know the difference.

Manning Speed-grits

Look for this trade-mark on the back of every sheet, belt or disc.

Write for "The Difference Book." Address the Manning Abrasive Co., Factory and Laboratory, Troy, N. Y. Sales offices in Boston, Chicago, Cincinnati, New York, Philadelphia, St. Louis, San Francisco, and other principal cities. Look for Manning Abrasive Co. in your telephone book.

Speed-grits

comes in the following varieties:
GARNET PAPER
GARNET CLOTH
GARNET COMBINATION
FLINT PAPER
EMERY CLOTH
EMERY PAPER
METALITE CLOTH
HANDY ROLLS
GRINDING DISCS
DURITE CLOTH
DURITE PAPER
DURITE COMBINATION
DURUNDUM PAPER
DURUNDUM CLOTH

Manning Speed-grits

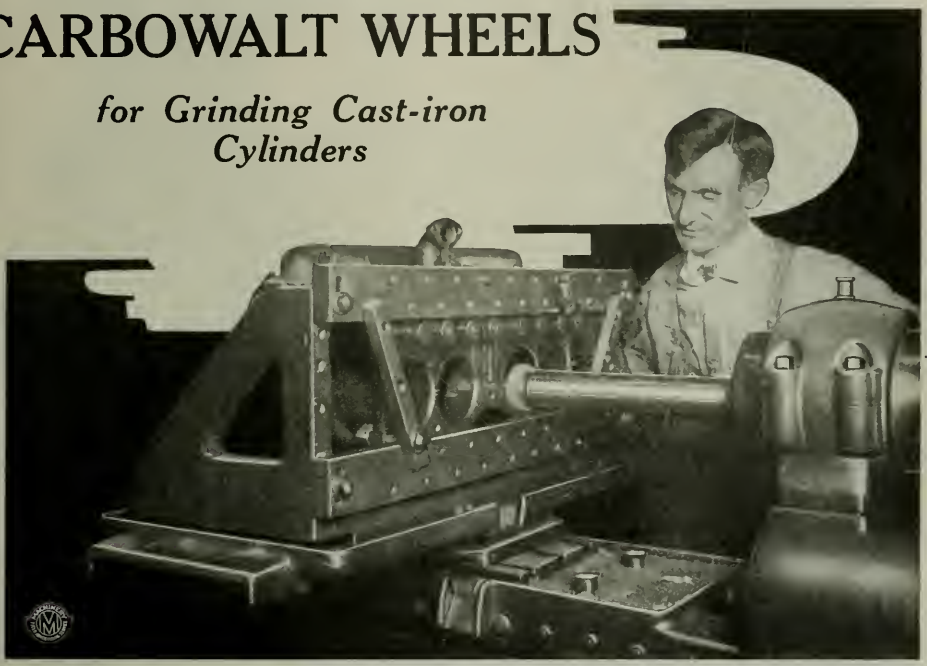
Reg. U.S. Pat. Off.

Don't say sandpaper—say Speed-grits

WALTHAM

CARBOWALT WHEELS

for Grinding Cast-iron Cylinders



State the details of your grinding requirements and we will show you what Waltham Grinding Wheels can do to speed up production in your plant.

In the grinding of cast-iron cylinders, fast work and high quality of finish are necessary. This was the problem that confronted the Wadell Motor Corporation, Newark, N. J., (where they repair anything from a motorcycle to a Packard, and keep four cylinder grinders busy).

They felt there must be a quicker method than the one they were using—and they found this quicker method by using Waltham Carbowalt Grinding Wheels.

A two months' trial of Waltham Wheels greatly increased cylinder grinding production without in any way lowering the quality of the finished work—and as a result, Waltham Grinding Wheels have been made "standard" for this work. It was found that a 3½" x ¾" x 1¼" 36s-J Carbowalt Wheel on a Heald machine was capable of removing more stock in a given time than any other grinding wheel this company had ever tried.

ALOWALT

CARBOWALT

WALTHAM GRINDING WHEEL CO.

WALTHAM, MASS., U. S. A.

Thompson Universal Grinders

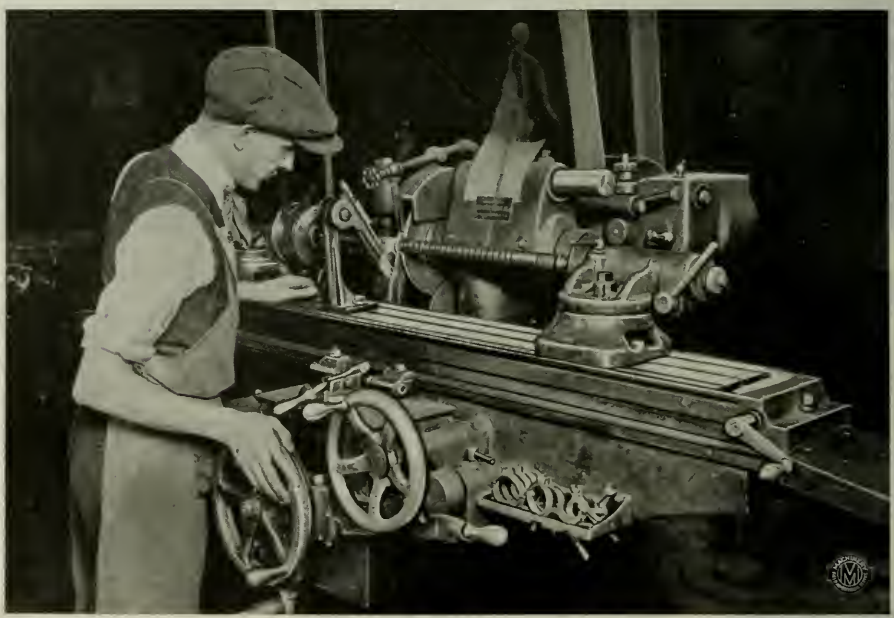
Accurate, Wide Range Machines with Valuable Production Possibilities

Grinding broaches is a "particular" job, the accuracy of the broach decides the value of the entire broaching operation.

That's why—in this plant—they grind their broaches as well as all other special tools on a Thompson Universal Grinder. The ease with which this machine can be set up for internal, external or surface grinding, the accuracy with which it performs these varied operations, the operating conveniences that insure rapid production are all "economy" features that are important factors in deciding production costs.

The Thompson Universal Grinder has a capacity for cylindrical grinding 10″ in diameter to 36″ long; surface grinding 48″ by 8″; internal grinding to 12″ diameter and knife grinding to 48″ long. Adapted for grinding tapers up to 3″ per foot. An accurate, adaptable and economical machine.

Send for details.



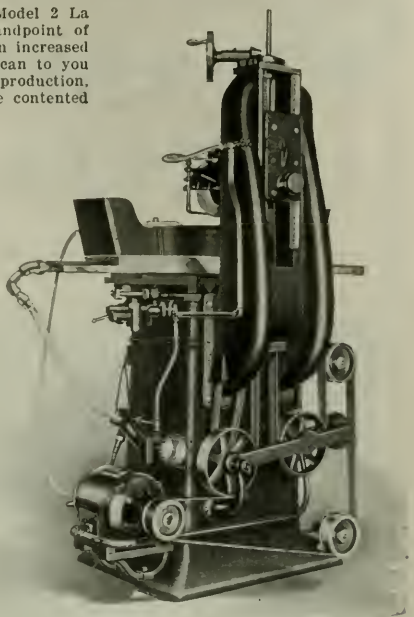
Photographed at the Gorham Tool Co., Detroit, Michigan

THE THOMPSON GRINDER COMPANY

SPRINGFIELD **OHIO, U.S.A.**



Study the features of Model 2 La Salle, not from the standpoint of what they mean to us in increased sales; but what they mean to you in better work, greater production, more economy and more contented workmen.



This Tool Gives Surface Grinding Satisfaction

MODEL 2 LA SALLE

(Capacity 20" x 6" x 10")

This many-featured La Salle Automatic Surface Grinder does its work with the greatest amount of satisfaction to the user because the working units are all practical and desirable features designed to make the La Salle as near perfect as is possible.

For grinding dies, punches and all varieties of small tools, you will find the La Salle does better work, increases production, is most economical and keeps the operator in a contented frame of mind. It will be found indispensable for many manufacturing jobs, finishing bright and true surfaces or parts of tools and instruments.

In this La Salle Model 2 there are featured fifteen practical working units, including: Direct motor drive, using 1½ H. P. motor, for either direct or alternating current; coolant control; wheel truing device, cast in one piece with wheel guard, enables operator to true wheel without disturbing work on table; special feature for preserving alignment, the most important point in a grinding machine.

The Model 2 Grinder can be furnished with a magnetic chuck. This chuck is supplied only on special order, and is not a part of the regular equipment.

We are also able to furnish 4-inch index centers for grinding taps, hobs and other milling cutters.

More complete particulars on request.

LA SALLE TOOL COMPANY
LA SALLE ILLINOIS, U.S.A.

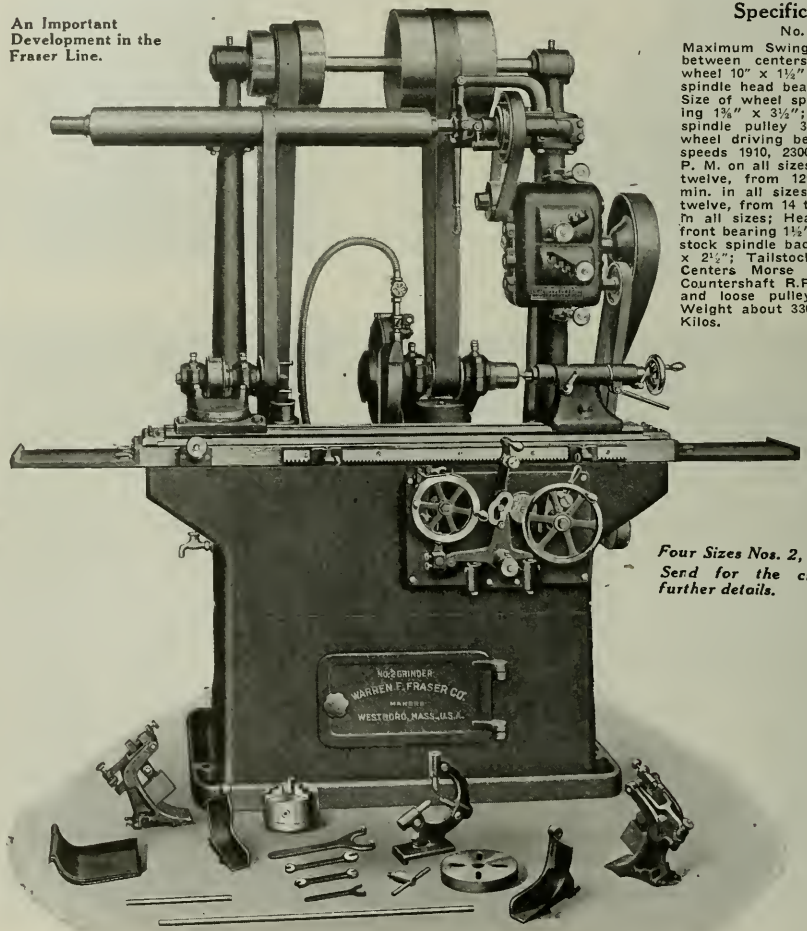
LA SALLE

FRASER UNIVERSAL GRINDER

HIGH-POWERED SELF-CONTAINED

The self-contained construction makes available a greater range of table and work speeds and permits the machine to be set up without the erection of overhead shafting, etc.

An Important Development in the Fraser Line.



Specifications

No. 2

Maximum Swing 11"; Distance between centers 30"; Size of wheel 10" x 1½"; Size of wheel spindle head bearing 1½" x 4"; Size of wheel spindle tail bearing 1¾" x 3½"; Dia. of wheel spindle pulley 3¾"; Width of wheel driving belt 2½"; Wheel speeds 1910, 2300, and 2875 R. P. M. on all sizes; Table speeds twelve, from 12" to 235" per min. in all sizes; Work speeds twelve, from 14 to 279 R. P. M. in all sizes; Headstock spindle front bearing 1½" x 2½"; Headstock spindle back bearing 1¼" x 2½"; Tailstock spindle 1¼"; Centers Morse Taper No. 2; Countershaft R.P.M. 900; Tight and loose pulleys 2½" x 10" Weight about 3300 lbs., or 1497 Kilos.

Four Sizes Nos. 2, 2A, 3, 3A. Send for the circular for further details.

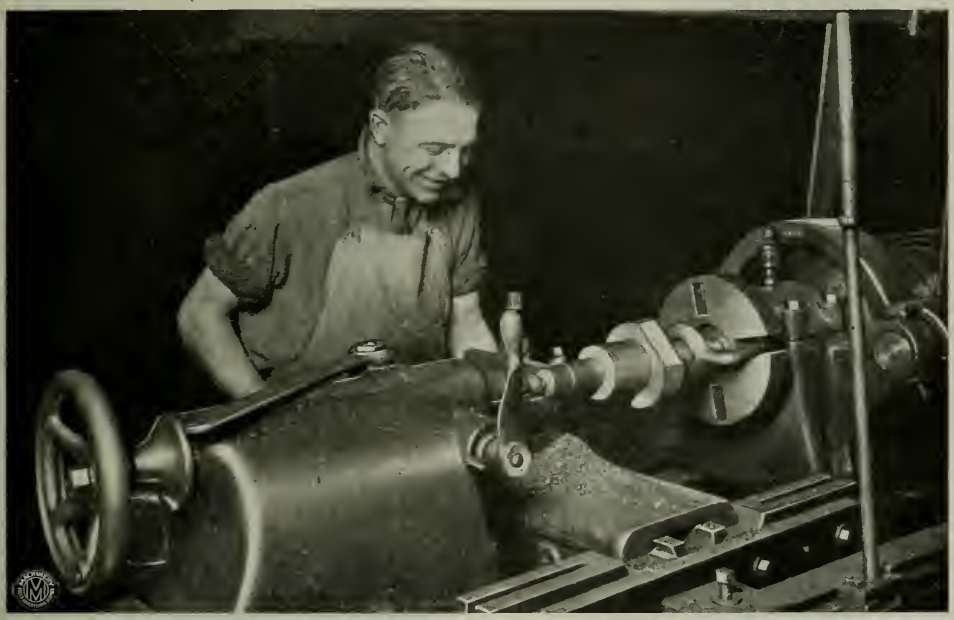
WARREN F. FRASER COMPANY

Westboro, Massachusetts

THE SIDNEY MACHINE TOOL COMPANY

SIDNEY LATHES

Machines Built to Traditional Standards



"Sidney Lathes are very accurate." The fact that this endorsement comes from a builder of high class machine tools—always the most discriminating class of judges—gives it more than ordinary weight and significance.

The Moline (Ill.) Tool Company, which holds this favorable opinion, owns two Sidney Lathes, the oldest installed more than eight years ago. One of them is shown turning a spindle adjusting head for the famous "Hole Hog" Cylinder Boring Machine—an operation requiring a high degree of accuracy and a fine finish.

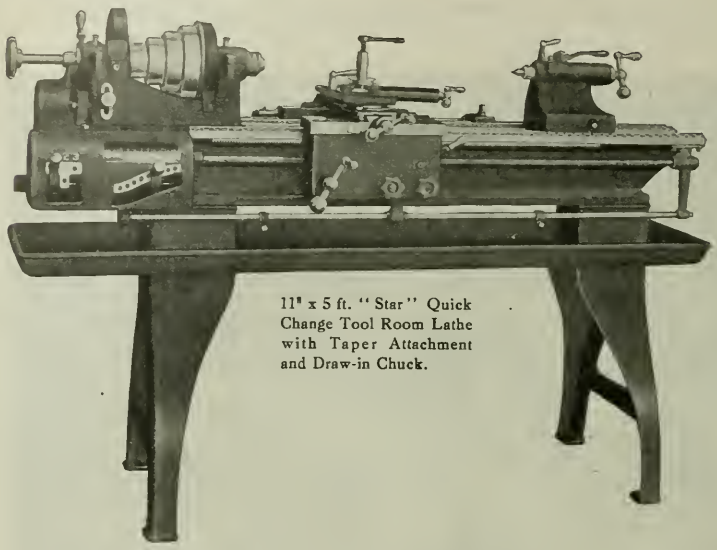
The record of "Sidney-for-Service" Lathes is one of achievement. Designed and built by men with long experience in machine building—men who put reputation before profits—they had exclusive operating conveniences and structural advantages which made them pioneers in their class. And these accurate, wide range machines have consistently maintained their leadership, were pace makers during the late war and are constantly setting new standards for quality, quantity and cost of output under modern methods of duplicate manufacturing.

Complete description of the "Sidney-for-Service" line on request.

THE SIDNEY MACHINE TOOL CO.

SIDNEY **OHIO, U. S. A.**

"STAR" LATHES

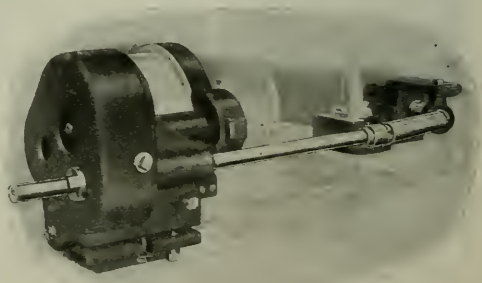


11" x 5 ft. "Star" Quick Change Tool Room Lathe with Taper Attachment and Draw-in Chuck.

For People Who take a Pride In their Toolrooms

STAR LATHES

Closer limits and the necessity for more careful work without lowering production have created a need for better tools. The attainment of this end is only possible if the toolroom equipment is beyond reproach. It is not economical to put small parts in a large lathe—equipment should be adapted to the work. "Star" Lathes are built for people who take a pride in their equipment, and sell for a price you are willing to pay. Cut shows the 11" x 5' "Star" Quick Change Toolroom Lathe. Write for complete list.



Relieving attachment for Star Lathes

The "Star" Relieving attachment is used for accurately backing off a large variety of milling cutters, end mills, reamers, etc. Stroke is adjustable while machine is in motion to give any amount of relief from 0" to ⅛", amount being indicated by graduations. Order your attachment with lathe, or separately if you are equipped with former.

THE SENECA FALLS MFG. COMPANY, Inc.

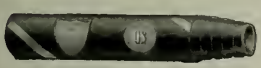
381 FALL STREET SENECA FALLS, NEW YORK



Rainbow Belt



4810 Air Hose



Rainbow Steam Hose



Rainbesto Rod Packing

Rubber Goods For All Industries

THE mill supply salesmen and the practical factory men of the United States Rubber Company are qualified through study and experience to recommend the right mechanical rubber goods for any condition existing in this industry.

They are ready to assist mill operators by advising as to the best application of mechanical rubber goods in order that the greatest possible service may be obtained for every dollar invested.

United States Rubber Company

The World's Largest and Most Experienced Manufacturer of Mechanical Rubber Goods

BELTING	HOSE	PACKINGS	MISCELLANEOUS
Transmission "Rainbow," "Pilot" "Shawmut"–"Giant Stitched"	**Air** "4810," "Dexter"	**Sheet** "Rainbow," "Vanda," "Paramo"	Mats, Matting and Flooring, Plumbers' Specialties, Rubber Covered Rolls, Friction Tape, Splicing Comp'd. Dredging Sleeves, Hard Rubber Goods, Printers' Blankets, Tubing, Soles, Heels, Jar Rubbers, Moulded Goods
Conveyor "United States," "Grainster"	**Steam** "Rainbow," "Giant," "Perfected"	**Rod** "Wizard," "Rainbesto," "Peerless," "Honest John," "No 573" and hundreds of other styles in coils, rings, gaskets and diaphragms —	
Elevator "Matchless," "Granite," "Grainster"	**Water** "Rainbow," "Mogul," "Perfected"	**Usco Valves** —	
Tractor "Sawyer Canvas" "Little Giant Canvas"	**Suction** "Amazon," "Giant"	THE RIGHT PACKING IN THE RIGHT PLACE	
Agricultural "Rainbow," "Bengal" "Grainster," "Sawyer Canvas"	**Garden** "Rainbow," "Mogul," "Lakeside"		
	Also Hose for Acetylene, Oxygen, Acid, Air Drill, Auto Radiator, Car Heating, Air Brake, Gasoline, Oil, Hydraulic, Chemical, Coke, Creamery, Discharge, Vacuum, Sand Blast, Spray, etc		

UNITED STATES RUBBER COMPANY
US
RUBBER SYSTEM
AND ASSOCIATED COMPANIES

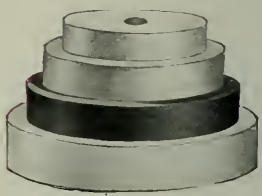
Rubber Goods For All Industries

BEING in close touch with the trade and with each other, our salesmen and factory men are able to combine their experience for the benefit of our customers, large or small.

Take advantage of this Company's facilities and experience when in the market for rubber goods. Through our nearest Branch you can obtain the fullest co-operation of our organization.



Sawyer Conveyor Belt



Pump Valves



Rainbow Packing



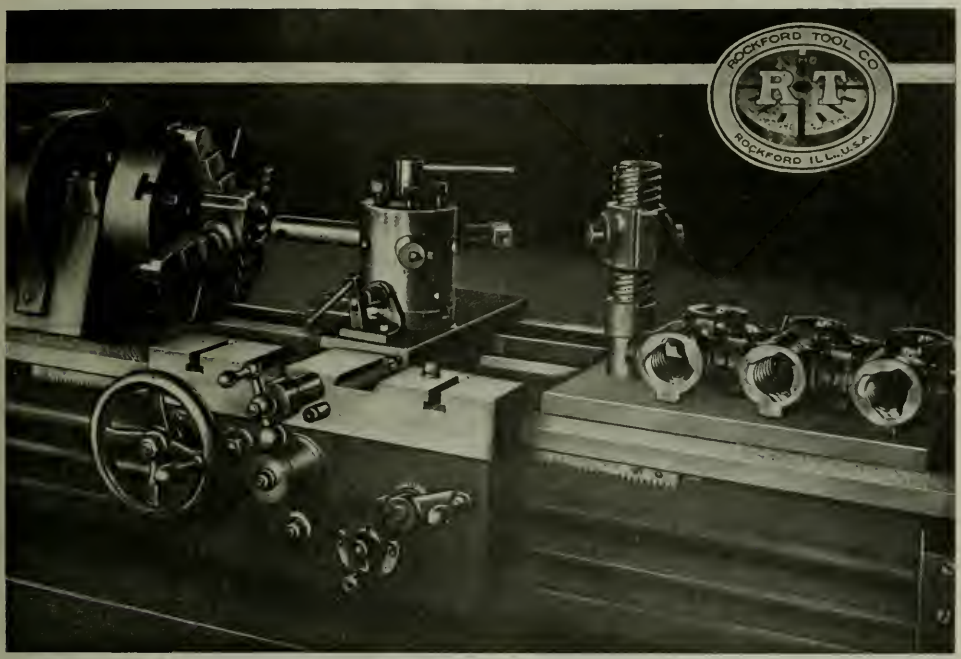
Perfected Water Hose

United States Rubber Company

The World's Largest and Most Experienced Manufacturer of Mechanical Rubber Goods

BELTING	HOSE	PACKINGS	MISCELLANEOUS
Transmission "Rainbow," "Pilot," "Shawmut"–"Giant Stitched"	**Air** "4810," "Dexter"	**Sheet** "Rombow," "Vanda," "Paramo"	Mats, Matting and Flooring, Plumbers' Specialties, Rubber Covered Rolls, Friction Tape, Splicing Comp'd, Dredging Sleeves, Hard Rubber Goods, Printers' Blankets, Tubing, Soles, Heels, Jar Rubbers, Moulded Goods
Conveyor "United States," "Grainsler"	**Steam** "Rainbow," "Giant," "Perfected"	**Rod** "Wizard," "Rainbesta," "Peerless," "Honest John," "No 573" and hundreds of other styles in coils, rings, gaskets and diaphragms —	
Elevator "Matchless," "Granite," "Grainster"	**Water** "Rainbow," "Mogul," "Perfected"	**Usco Valves** —	
Tractor "Sawyer Canvas," "Little Giant Canvas"	**Suction** "Amazon," "Giant"	THE RIGHT PACKING IN THE RIGHT PLACE	
Agricultural "Rainbow," "Bengal," "Grainsler," "Sawyer Canvas"	**Garden** "Rainbow," "Mogul," "Lakeside"		
	Also Hose for Acetylene, Oxygen, Acid, Air Drill, Auto Radiator, Car Heating, Air Brake, Gasoline, Oil, Hydraulic, Chemical, Coke, Creamery, Discharge, Vacuum, Sand Blast, Spray, etc		

UNITED STATES RUBBER COMPANY AND ASSOCIATED COMPANIES — US — RUBBER SYSTEM



"Locomobile" Steering Nuts—Faced, Bored and Threaded on This 15-Inch "SUNDSTRAND"

Indorsement?

How About This—

Machine, work and set-up are clearly shown in the accompanying photograph furnished by the Alling-Lander Company, Inc., of Sodus, N. Y., whose letter is here quoted to explain the operation.

" . . . Material is phosphor bronze and the thread 1½" lead, triple, right-hand Acme. The lead screw was driven from the headstock in the usual way at a speed of 327 R.P.M. Time required to face one end, rough and finish bore and thread these parts was 22 minutes each, and the lathe made no more fuss or noise than if it were doing a light turning job.

"We manufacture these nuts for the Locomobile Company of America, so it is needless to mention the accuracy with which they must be machined. We have no other lathe in our shop that . . . would handle this work as economically and accurately as this Rockford . . ."

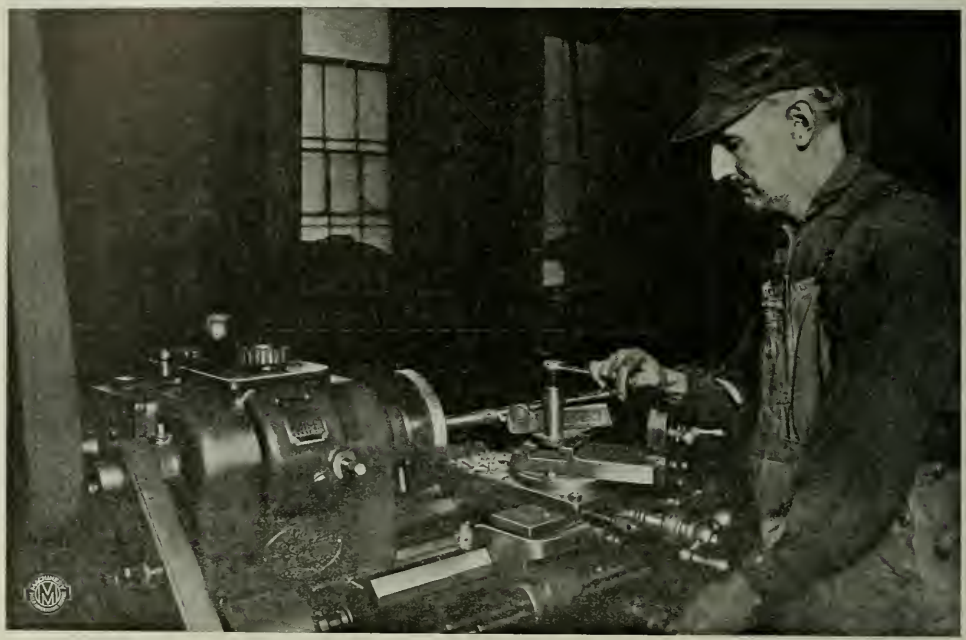
If the above endorsement interests you we'll be glad to tell you more about the machine.

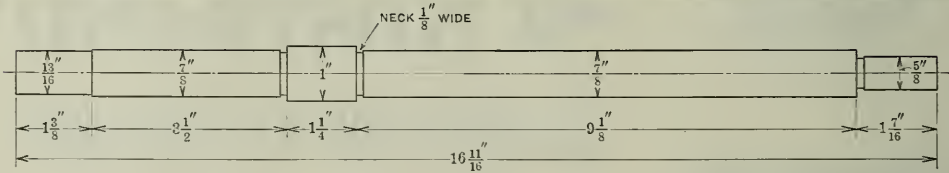
ROCKFORD TOOL CO.

2502 Eleventh St. **Rockford, Ill.**

FOREIGN DEALERS: Aktiebolaget Rylander & Asplund, Stockholm, Sweden; A. A. Jones & Shipman, Ltd., New Century Works, Leicester, England. Societa Anonima, Adler & Co., Milano, Italy. R. S. Stokvis & Zonen, Ltd., Rotterdam, for Holland, Belgium and France.

The Adams





One of the most interesting things about the Adams "Short-Cut" Lathe is the number of diversified industries it is entering. Here we see it in the plant of a big machine tool builder. Why did they adopt it? No secret about it—simply a matter of dollars and cents.

The Adams "Short-Cut" Lathe is made for the average job. When you put the average job in a heavy engine lathe, you are not only wasting power, wasting time and wasting a big proportion of your lathe investment, but you're losing in accuracy. The photograph shows an Adams "Short-Cut" Lathe at work on a back gear shaft for a shaper, dimensions of former being shown in sketch. These shafts, made from 1″ cold rolled steel, are turned out in six operations as follows; Face ends to length, cut three necks 1/8″ wide to give clearance for the wheel when grinding, turn the 7/8″ diameter 9 1/8″ long, leaving .012″ to grind, turn the 7/8″ diameter 3-1/2″ long, leaving a like amount to grind,

O. R. ADAMS MANUFACTURING

AGENTS: Ogden R. Adams, Rochester, Syracuse, Buffalo; Fairbanks Co., Boston, New York, Baltimore, Philadelphia, Washington, Chicago; W. M. Pattison Supply Co., Cleveland, Ohio; Gang Machinery Co., Cincinnati, Ohio; National Supply

"Short-Cut" Lathe

Adams Short Cut lathe Rochester, N.Y.

TRADE MARK REGISTERED

Successfully Takes Over Much of the Work of Heavy Engine Lathes, Giving Greater Speed, Convenience and Economy

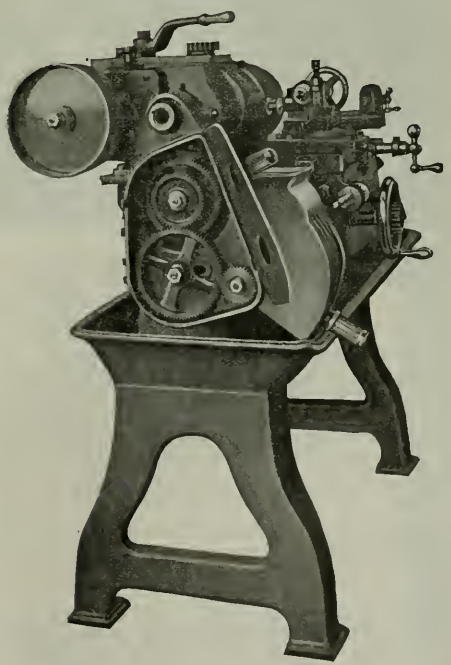
Write for full details of this up-to-date lathe and see what it will do for you.

turn the 13/16" to size, and lastly turn the 5/8" diameter, leaving as before .012" to grind.

It takes only twenty-five hours to turn out the full batch of 100 shafts; in other words, fifteen minutes for each.

The Adams "Short-Cut" Lathe is enormously powerful, and having all the features of a standard engine lathe doesn't need a specially trained operator. It has six speeds which can be changed without stopping. Thrust of steel spindle is taken on S.K.F. self-aligning ball bearings. A wide range of speeds is easily made. Every detail has been so carefully thought out that maximum efficiency is predetermined.

One of the most interesting features of the Adams "Short-Cut" Lathe is the TAPER ATTACHMENT, which can be supplied if desired. This is fastened to bed in planed T-slots so that carriage carries no extra weight except that of taper extension arm. Tapers up to 1½" per foot can be cut the whole length between centers.



CO., Inc., Norton Street, Rochester, N. Y.

Co., Toledo, Ohio; Herberts Machinery & Supply Co., Los Angeles, Cal.; Allied Machinery Co., France, Belgium, Spain and Italy.



PORTER-CABLE LATHES

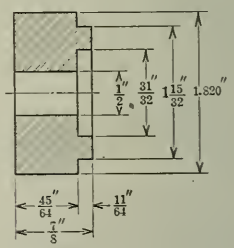
"Fill the Broad Need for Precision and Speed"

It is nearly three years since this rapid and versatile producer was installed in the Cincinnati-Bickford Co.'s model shop. It is used extensively for second operation work—turning small gears, collars, studs, etc., which have been previously roughed out on the big automatics. The sketch below indicates the close dimensions to which it machines and the micrometer on the end of the bed in the accompanying illustration shows how rigidly they are maintained.

Machine Steel Clutch Gear Blanks—Four Minutes Each.

This output is excellent, for the stock is tough and the piece is machined all over which necessitates turning it around on the arbor after the back is faced, the total schedule of operations being as follows: First, face back; second, turn blank around on arbor and turn outside diameter—removing 1/32″ of stock; third, face front to dimensions; fourth, turn small diameter and face shoulder.

Output, as above stated, is uniform—four minutes each, fifteen per hour. If this class and quality of service interests you, we'll be glad to send details of the machine.



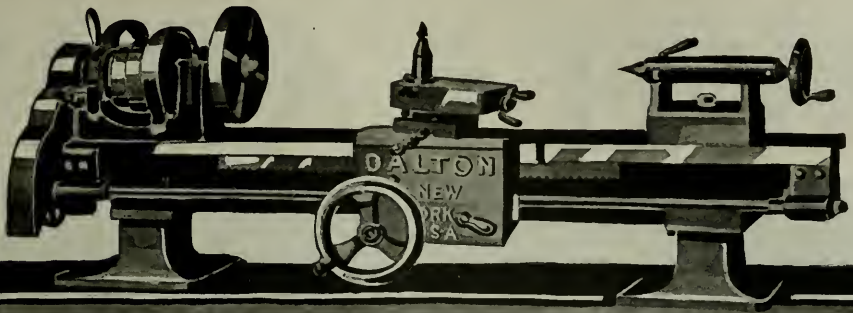
SMALL CLUTCH GEAR BLANK

MACHINE STEEL

THE PORTER-CABLE MACHINE COMPANY

Syracuse, New York, U. S. A.

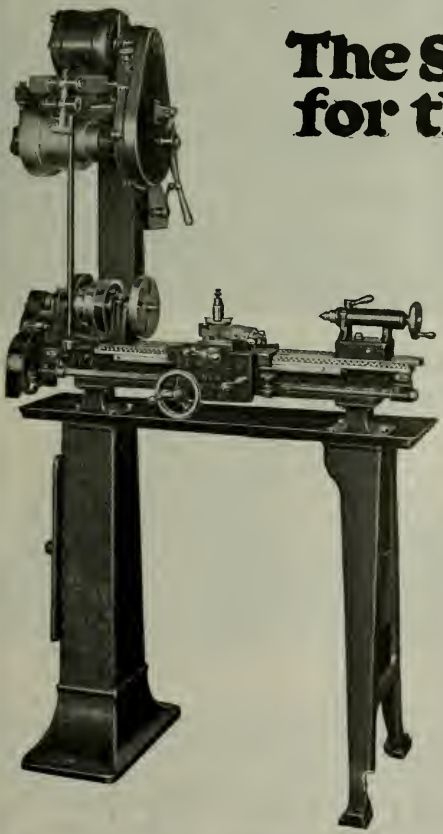
AGENTS: Barbour, Love & Woodward, Inc., New York City; Colcord-Wright Machinery & Supply Co., St. Louis; E. L. Easley Machinery Co., Chicago and Milwaukee; Pacific Tool & Supply Co., San Francisco and Los Angeles; Chas. A. Streifinger Co., Detroit; Strong, Carlisle & Hammond Co., Cleveland; Syracuse Supply Co., Syracuse, Buffalo and Rochester; Vonnegut Machinery Co., Indianapolis; Harold A. Wright, 201 Devonshire Street, Boston; Luster Mchy. Co., Philadelphia, Pa.; EXPORT REPRESENTATIVE: Benjamin Whittaker, Inc., 21 State St., New York City; Vulcan House, 56 Ludgate Hill, London, E. C.; Fenwick Freres & Co., Paris, Barcelona, Liege, Turin, Zurich; Burton, Griffiths & Co., London; Bevan & Edwards Pty., Ltd., Melbourne; R. S. Stokvis & Zonen, Ltd., Rotterdam; Yamatake & Co., Tokyo; V. Lowener's Maskinforretning, Sverre Mohn, Christiania; Aktibolaget V. Lowener, Stockholm; V. Lowener, Copenhagen.



"DALTON SIX"

Type B-4-Actual Swing 7¼ Inches

The Small Lathe for the Big Job



DIRECT or alternating current supplied.

Motor runs in one direction. Spindle reverses for thread cutting.

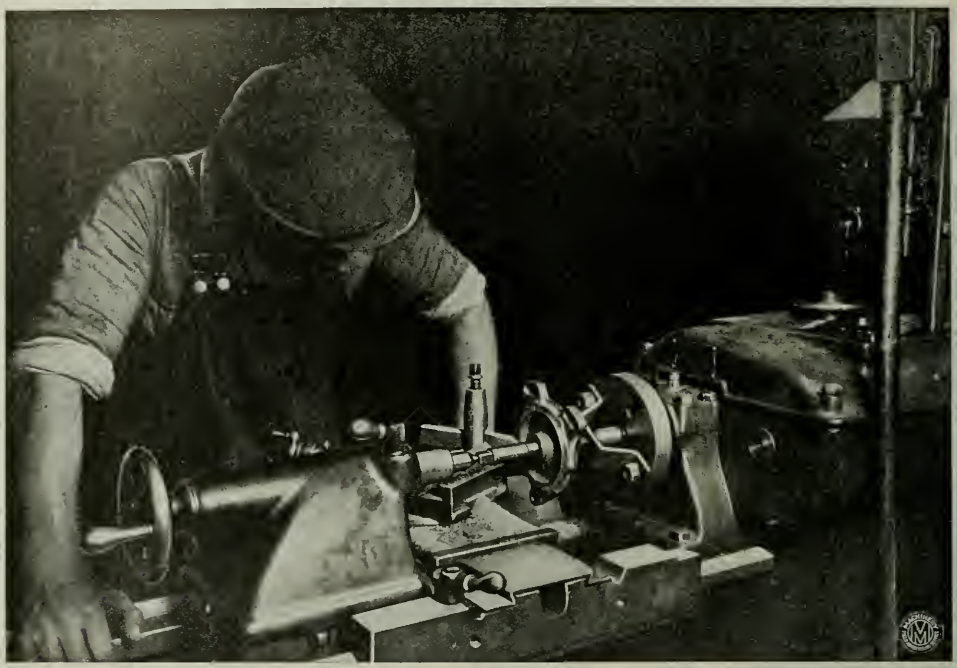
Length of bed 30 or 36 inches.

Collet capacity 1-2" or 13 M. M.

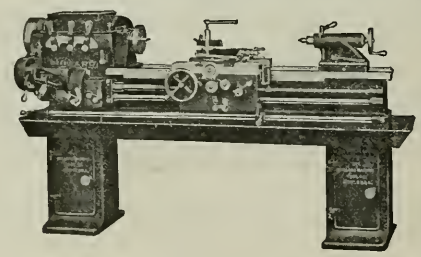
Write for Bulletin B-652

DALTON
Manufacturing Corporation
SOUND BEACH, CONN., U. S. A.
Cable Address: "Aledal, New York"

WILLARD



Seventeen Willard Lathes in the East Springfield Plant of the Westinghouse Electric & Mfg. Co.



Willard High Power Toolroom Lathes have steel gears throughout, ball bearings liberally used and any of 12 speeds instantly available. Further details on request.

The work shown is a rear bracket for the frame of an automobile starting motor. Material is cast iron, and two operations are performed. The first to turn the shoulder on the bracket to fit the motor frame, the second to turn the side of the bracket. Owing to the power and convenience of the Willard Lathe, on which these operations are performed, output is 800 brackets per 9¾-hour day.

This machine, in company with every other machine in the plant, including the other 16 "Willards," is equipped with Westinghouse Motors.

THE WILLARD MACHINE TOOL CO.

A STREET, BOX 784

Cincinnati Ohio, U. S. A.

PITTSBURGH

Simplicity and Power Are Outstanding In this 36-inch Double Front Geared Lathe

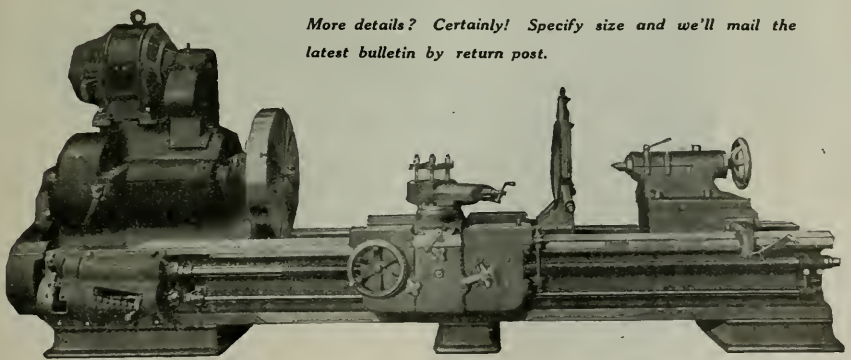
Wherever a D. C. drive is practicable, this powerful and simple engine lathe is the logical choice for heavy duty turning within its range.

Gearing at front of head instead of the usual back gearing, eliminates the lifting action on the spindle under cut, and facilitates gear shifting. Spindle is a 6″ diameter forging of high carbon, open hearth steel, 8″ long on front bearing with a 2¼″ hole through its entire length and large, self-oiling bearings of 6-1 copper and tin.

Apron is rigid, double plate type regularly furnished with all Pittsburgh Lathes, its studs and shafts casehardened, ground and provided with double bearings. Leadscrew is splined its full length and a long key in the lateral feed gear rides in this spline, driving all feeds except for thread cutting.

Design, material and workmanship of the tailstock, carriage and taper attachment are quite in keeping with the rest of the machine which is guaranteed to bore straight and face square within .001″ per foot.

More details? Certainly! Specify size and we'll mail the latest bulletin by return post.

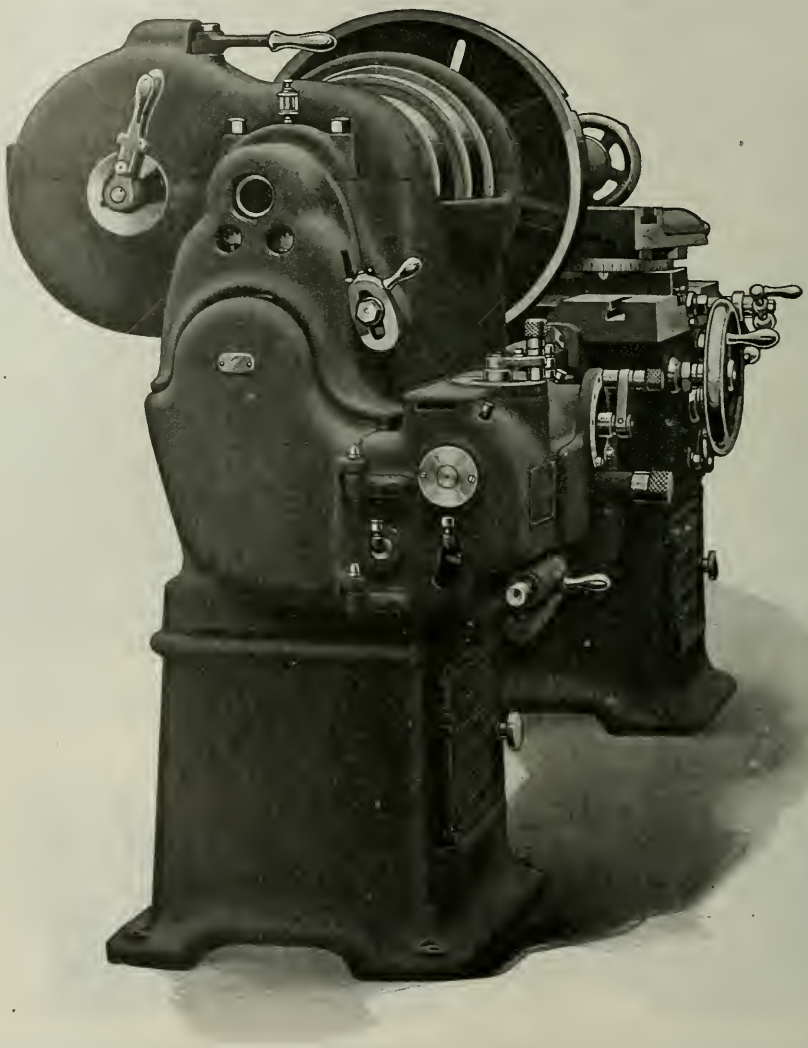


PITTSBURGH MACHINE TOOL CO.

Braddock, Pa., U. S. A.

Eccles & Smith Co., Seattle, Wash.
Swind Machinery Co., Philadelphia, Pa.
Backer Machine Tool Snpply Co., New York.,
Harold A. Wright, 201 Devonshire St., Boston, Mass
Wm. C. Johnson & Sons, St. Louis, Mo.
Wolverine Machinery & Snpply Co., Detroit, Mich.
Thompson Machinery Co., Pittsburgh, Pa.
Eccles & Smith Co., Portland, Ore.
Hendey Machine Co., Chicago, Ill.

New Type 20" Instantaneous Change Gear Engine Lathe

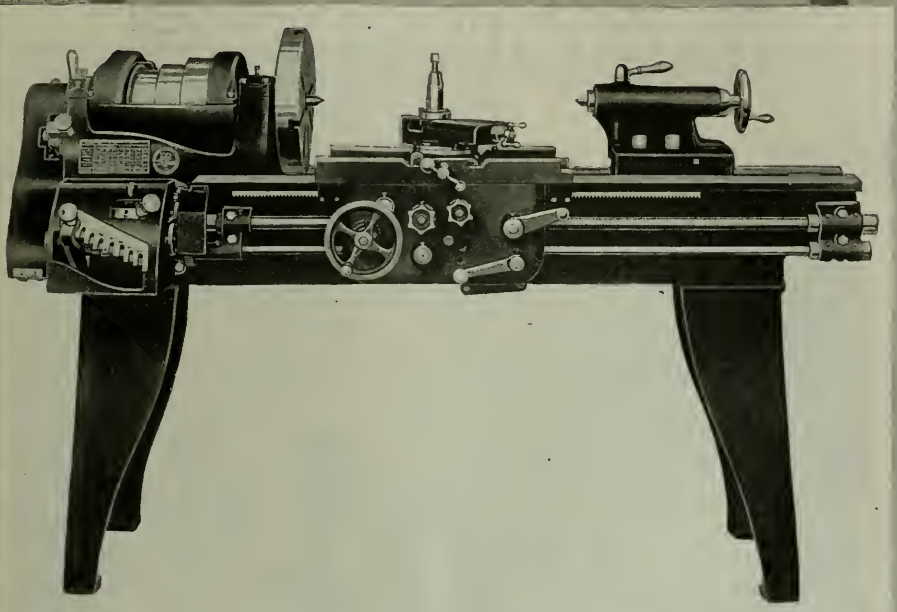


Three Step Cone, Double Back Gear, Double Plate Apron

THE BOYE & EMMES MACHINE TOOL CO.

CINCINNATI *ENGINE LATHES* OHIO

MONARCH



"Satisfaction to the Purchaser" is the policy of the Monarch organization. From the department for the purchase of raw material through the entire production department and into the sales organization this influence dominates.

It is clearly apparent in the final drastic inspection which every Monarch Lathe receives before receiving its final O. K. tag. The success of this policy is best demonstrated in the fact that a large percentage of the yearly sales go to present users. Each year the Monarch organization builds and sells more Monarch's than there are lathes produced by any other high grade lathe manufacturer.

DISTRIBUTORS:

Lynd Farquhar Co., Boston, Mass.
Brownell Machinery Co., Providence, R. I.
Purinton & Smith, Hartford, Conn.
Vaodyck-Churchill Co., New York, N. Y.
Syracuse Supply Co., Syracuse, N. Y.
Syracuse Supply Co., Buffalo, N. Y.
Syracuse Supply Co., Rochester, N. Y.
Simmons Machine Co., Albany, N. Y.
Morris Machinery Co., Newark, N. J.
Monarch Machinery Co., Philadelphia, Pa.
J. S. Miller Machinery Co., Pittsburgh, Pa.
Randle Mchy. Co., Cincinnati, Ohio.
Greensboro Supply Co., Greensboro, N. C.
John P. Dale Machinery Co., Nashville, Tenn.
Oliver H. Vaa Horn Co., New Orleans, La.
Cameron & Barkley, Jacksonville, Fla., and Charleston, S. C.
The Walraven Co., Atlanta, Ga.
Hartfelder-Garbut Co., Savannah, Ga.
W. M. Pattison Supply Co., Cleveland, Ohio.
Coghlin-Kirkby Machinery & Supply Co., Toledo, Ohio.
Osborne & Sexton Machinery Co., Columbus, Ohio.
Vonnegut Machinery Co., Indianapolis, Ind.
Chas. A. Strelinger Co., Detroit, Mich.
McMullen Machinery Co., Grand Rapids, Mich.
Badger-Packard Machinery Co., Milwaukee, Wis.
Northern Machinery Co., Minneapolis, Minn.
Colcord-Wright Machinery & Supply Co., St. Louis, Mo.
English Tool & Supply Co., Kansas City, Mo.
Sunderland Machinery & Supply Co., Omaha, Neb.
Headrie & Bolthoff Mfg. & Supply Co., Denver, Colo.
Salt Lake Hardware Co., Salt Lake City, Utah.
General Machinery Co., Spokane, Wash.
Hallidie Machinery Co., Seattle, Wash.
Portland Machinery Co., Portland, Oregon.
Herbert Machinery & Supply Co., San Francisco, Cal.
Herbert Machinery & Supply Co., Los Angeles, Cal.
E. L. Essley Machinery Co., Chicago, Illinois.
V. Lowener, Denmark, Finland, Norway and Sweden.
Smith Courtenay Co., Richmond, Va.
Chas. A. Strelinger Co., Windsor, Ont., Canada.
William Blake Patterson, Special Representative, Switzerland and Italy.

THE MONARCH MACHINE TOOL CO.
SIDNEY, OHIO.

SEBASTIAN LATHES

High Grade Standard Machines for Tool Room and Shop—

The Sebastian Cone Head Engine Lathe

A Good Lathe at a Fair Price—this is the standard to which each Sebastian Lathe is built—the reason for the universal satisfaction that is found in their use.

Carefully built, well balanced and well braced, with semi-enclosed construction for the head stock to increase the strength and lessen vibration; with operating conveniences and ample lubrication to insure easy operation, this Sebastian Cone Head Lathe is a good example of the Sebastian Line.

Made in 13″ and 15″ sizes and may be had with a gap bed 7¾″ long, 3½″ wide without extra charge.



Write us for the details —or see our lathes at your dealers

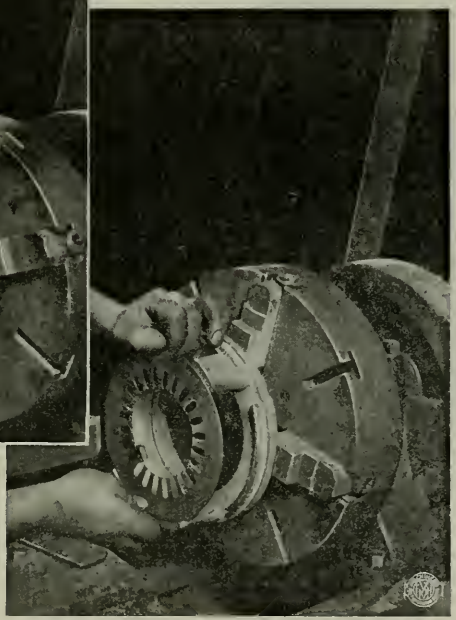
THE SEBASTIAN LATHE COMPANY
154 CULVERT STREET CINCINNATI, OHIO

"LEHMANN LATHES"

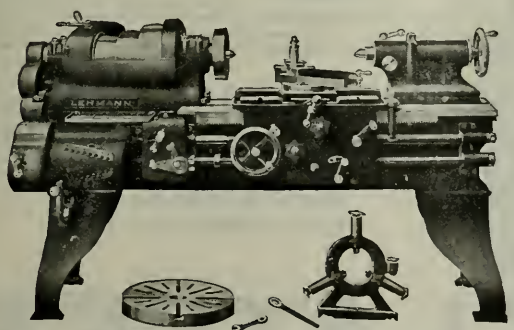
Are Much in Evidence on Important Work Like This



It is a significant fact that the engineers of the St. Louis Electrical Works, St. Louis, Mo., first selected "Lehmann Lathes" for their most important work, and that now there are more "Lehmann Lathes" in this plant than those of any other make.



"Lehmann Lathes" meet the needs of precision production, and are real time-savers. The photograph illustrates a "Lehmann Lathe" boring a stator ring for a "St. Louis" ½ H. P. polyphase motor. Two boring cuts are taken in addition to one internal facing cut. Production averages at the rate of six per hour despite the fact that the limits are plus or minus 0.001".



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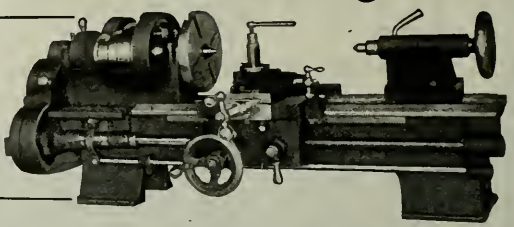
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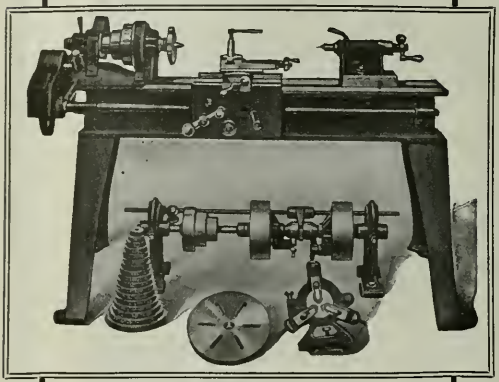
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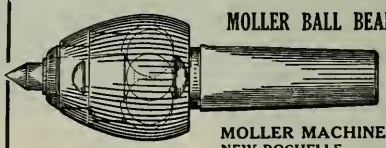
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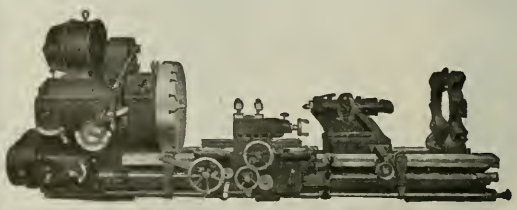
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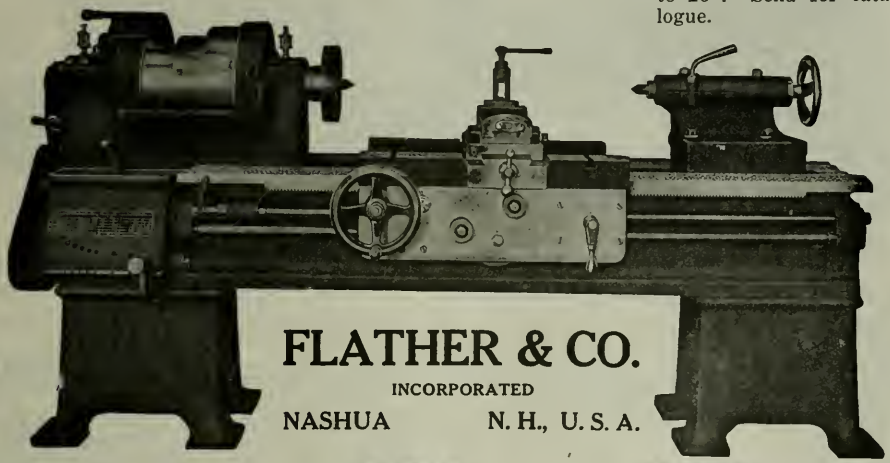
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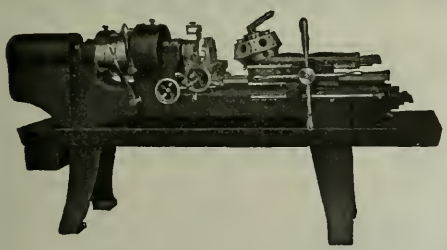
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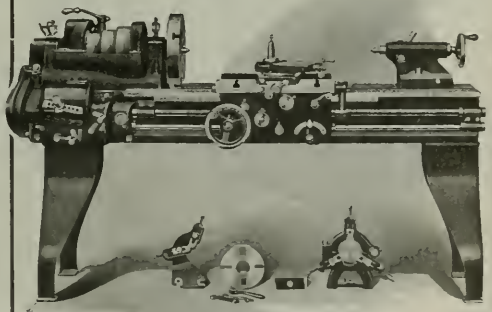
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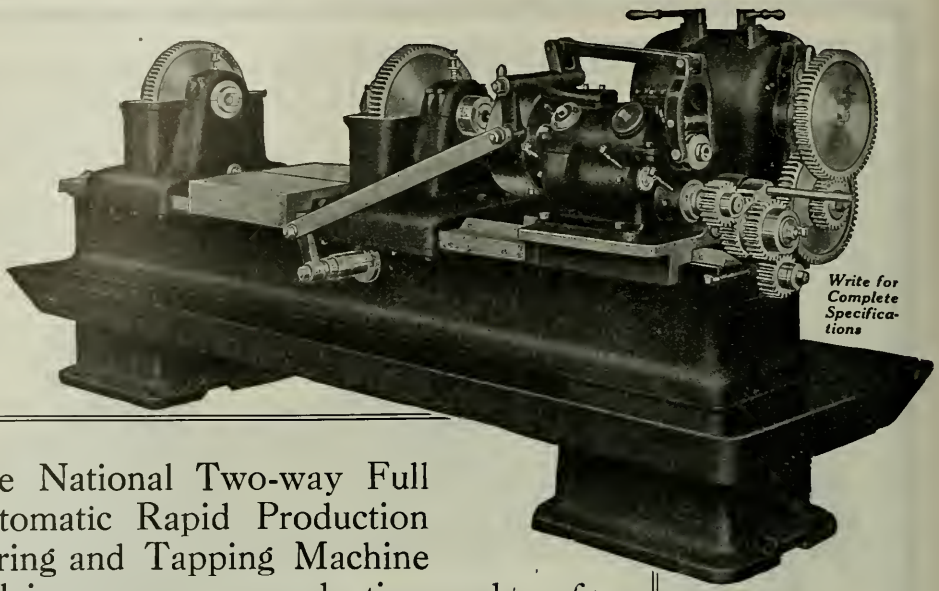
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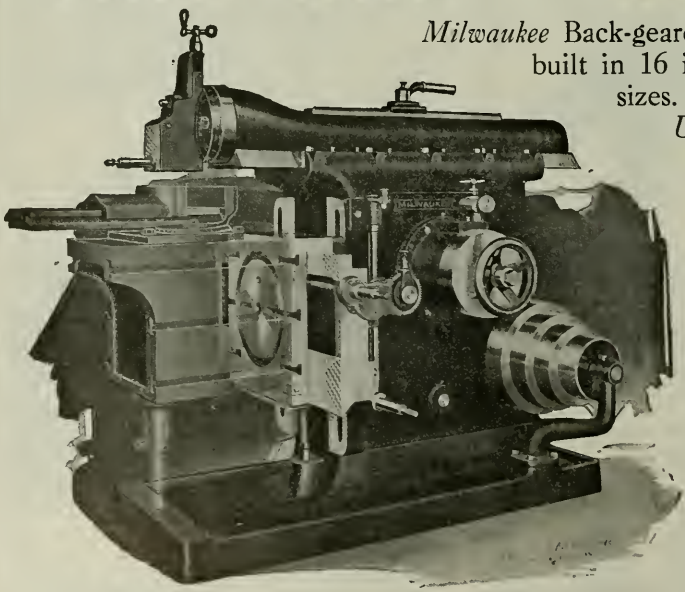
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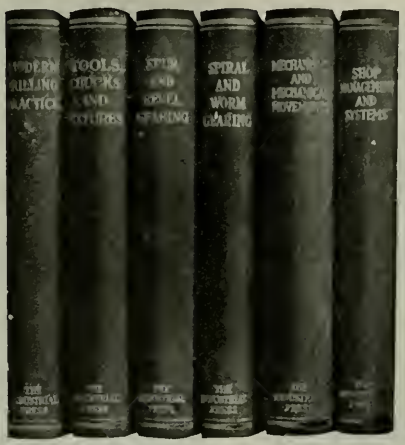
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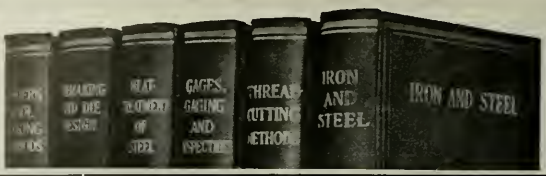
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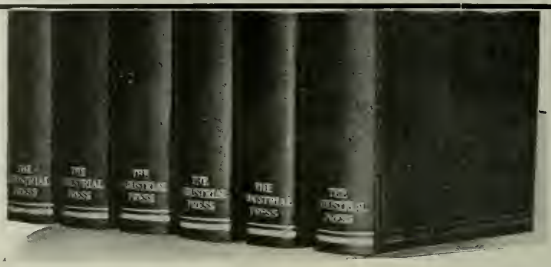
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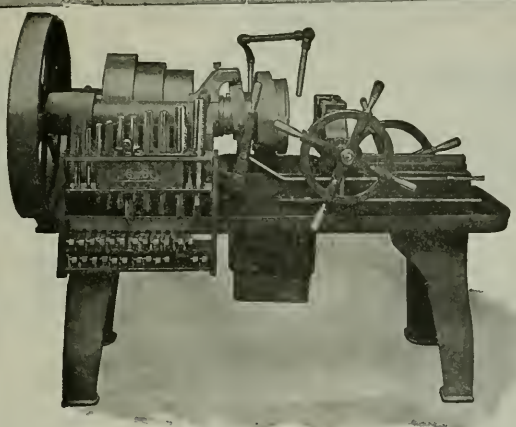
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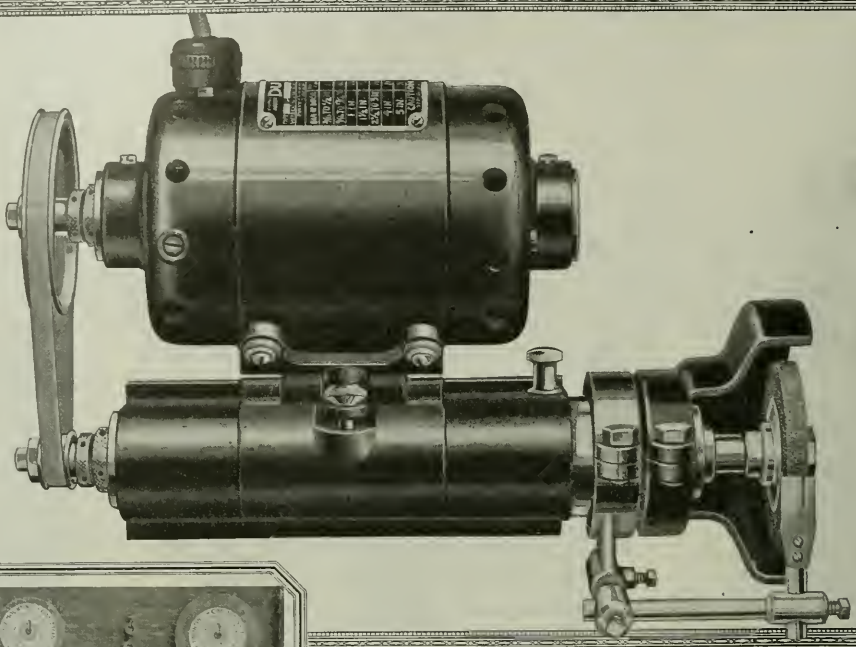
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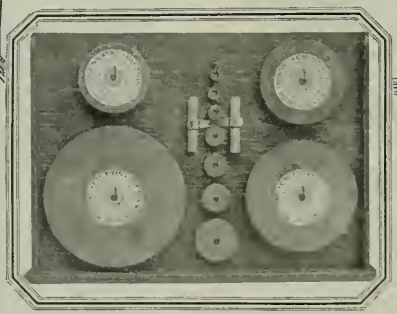
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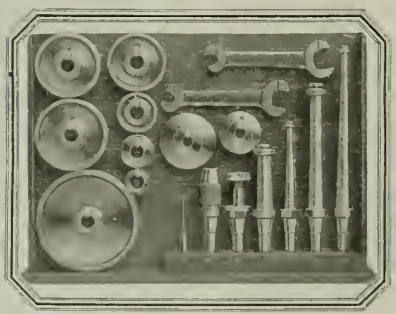
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SPECIFICATIONS

Motor—¼ H.P. Universal type operating on either D.C. or A.C. Spindle speeds—3600 to 50,000 R. P. M. Bearings—selected, dust-proof, ball bearings. Length of Travel—5½". Net weight—Without equipment, 25 pounds. Net Weight—With equipment, 35 pounds. Shipping Weight—45 pounds.

EQUIPMENT

Twelve elastic wheels are furnished.

Diameter	Diameter
5"	13/16"
4"	9/16"
3"	½"
2½"	7/16"
1½"	⅜"
1"	¼"

Two ¾" round emery pencils.
Four extension spindles, as follows, for internal work:
One ⅝" x 2"—heavy duty.
One ⅝" x 4"—heavy duty.
One 7/16" x 3"—light duty.
One ⅝" x 6"—light duty.
One wheel arbor with two sets wheel collars for wheels from 2" to 5".
One wheel arbor equipped with special chuck for grinding button dies.
One extension spindle for above chuck.
One wheel guard and cutter grinding rest.
One cross feed lever. 10' reinforced portable cord.
Two Shanks—½" x 1" and ⅝" x 1⅜".
One C-H feed through switch.
One attachment plug.
One hardwood carrying case for wheels and tools.

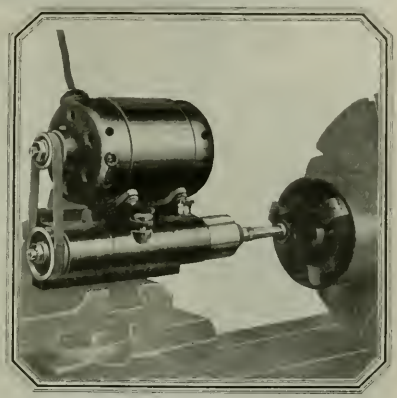
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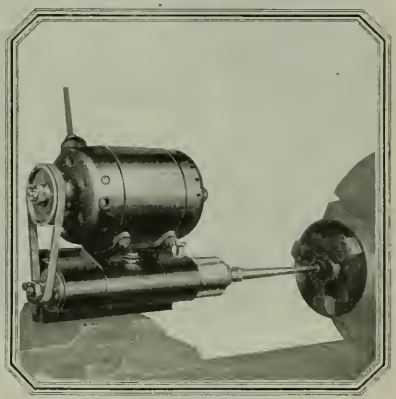
The Dumore No. 3 Grinder can be used on fine tool work and production work where close limits are essential.

The combination of spindles and quick change pulleys furnished as regular equipment with a Dumore No. 3 Grinder enables the mechanic to obtain exactly the right grinding speed for all jobs. Seven interchangeable spindles and pulleys give a speed range from 3600 to 50,000 R.P.M.



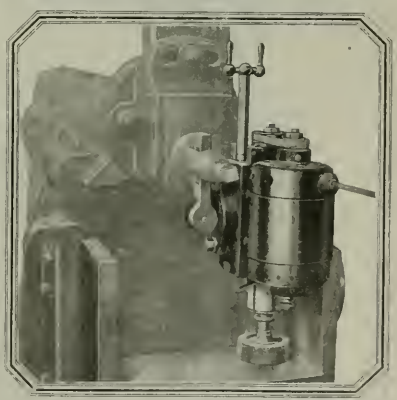
Motor Swivels to Five Positions

Set-ups are facilitated, time and trouble are saved by a special construction that enables the operator to swivel the motor to five different positions. This feature is of special importance on jobs where the surface to be ground is not easily accessible. By simply disengaging the index pin the motor may be swiveled so as to give easy access to even the most difficult grinding positions.



Grinder Reversible, End for End

The shank, which is at the center of the slide, permits turning the Grinder end for end without raising or lowering the center of the grinding spindle. The Dumore No. 3 Grinder is so compact that it can be used on any size lathe down to and including an 8″ lathe. On the other hand its rigid construction permits the use of wheels 5″ in diameter.



For further information write us or ask your dealer for a demonstration

2526 16th Street, Racine, Wis.

MULTI SPEED GRINDER DUMORE



A Zone of Real Production

And not only is this true of the battery of Steinle Heavy Duty Full Swing Side Turret Lathes shown on hub work above, but it is also true of those numerous other batteries of machines engaged in the production of such other automobile, truck or tractor parts as fly wheels, brake housings, axle housings, differential cases, pistons, piston rings, gear blanks, and similar parts—each machine a master producer—each location a zone of real production.

Why not send us your blue prints and let our Engineering Department determine what can be done on your own work.

AGENTS: Machine Tool Engineering Company, Singer Building, New York City; Cadillac Tool Company, Dodge Power Building, Detroit, Michigan; L. G. Henes, 75 Fremont Street, San Francisco, California, and Title Insurance Bldg., Los Angeles, California.

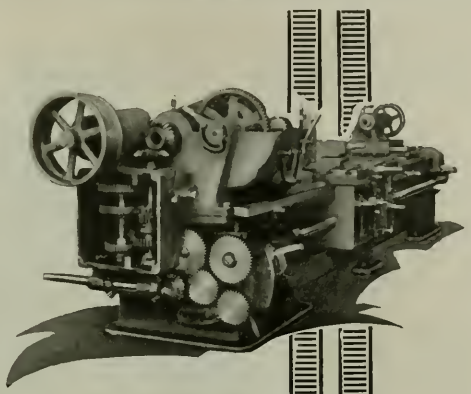
FOREIGN:. Leo. C. Steinle, 53 Victoria Street, London, Eng.

Steinle Turret Machine Co.

MADISON WISCONSIN, U. S. A.

You cannot escape these facts
They mean a better
Income for you

Most in production for the least amount of money—greater and more varied output from your plant without extra equipment. If you can achieve these things, then you are the man who is going to profit. You want



McCabe's "All-in-one" Lathe

If you ever believed that the maximum in lathe-building had been reached, one single look at this all-purpose-all-in-one McCabe will convince you that lathe-engineering has been outdone.

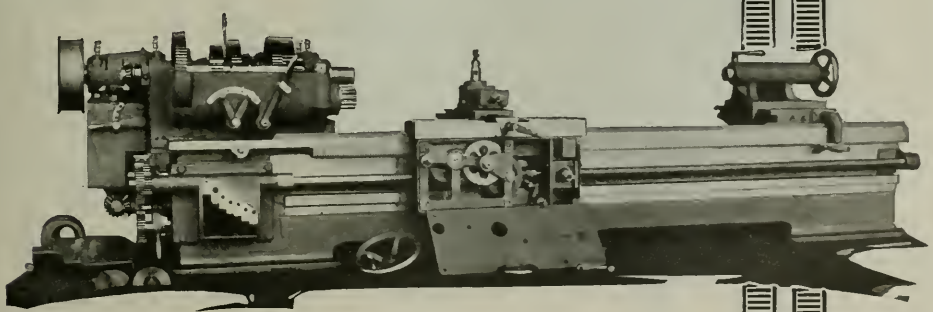
Unload responsibility on to the McCabe
Its shoulders are broader than yours

Here you have all the speeds, all the feeds, all the conveniences and advantages of all lathes, from 24″ to 40″. The McCabe carries all loads, all stresses. Great power with little effort—close accuracy with "unlimited" capacity, and with the same easy, simple and familiar controls you have been accustomed to. All this and more at a cost of two to three thousand dollars less than a group of machines, the range of which is no greater than this one McCabe.

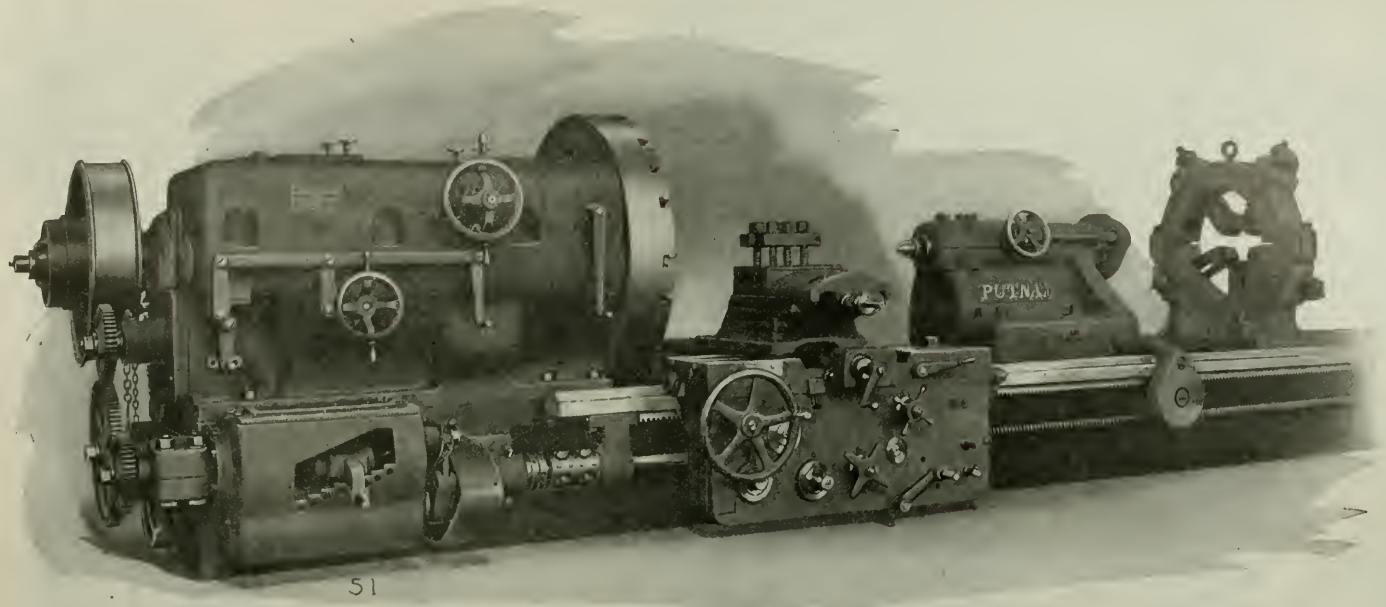
Tell your buyer you want this lathe, but don't specify McCabe simply because it is different, say you want a McCabe because it is better. All arguments are clinched with a McCabe demonstration.

J. J. McCabe Lathe & Machinery Corporation

149 Broadway **New York City**



Don't Buy Because IT'S DIFFERENT, But Because IT'S BETTER!



Putnam Machine Co. 60-in. Geared Head Lathe

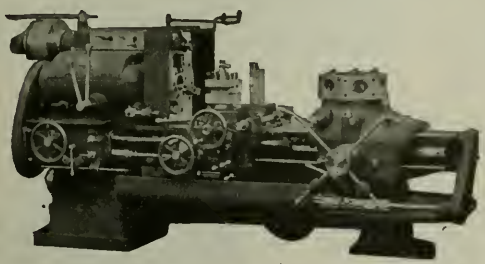
Also built in sizes 36-inch, 42-inch and 50-inch Swing

MANNING, MAXWELL & MOORE, Inc., 119 WEST FORTIETH ST. NEW YORK

BRANCHES: Chicago, Philadelphia, Boston, St. Louis, Pittsburgh, Cleveland, New Haven, Cincinnati, Buffalo, Detroit, Milwaukee, San Francisco, Seattle. Mexico City, Mexico. Yokohama, Japan.

PRODUCTION TURRET LATHES

STOCK DELIVERY



No. 9 Alfred Herbert Combination Turret Lathe.

Swings Over Bed	20″
Admits Through Spindle	3½″
Flange of Spindle to Face of Turret	48″
No. Spindle speeds Forward	16
No. Spindle speeds Reverse	16
No. Feeds to Turret Slide	18
No. Feeds to Carriage	9

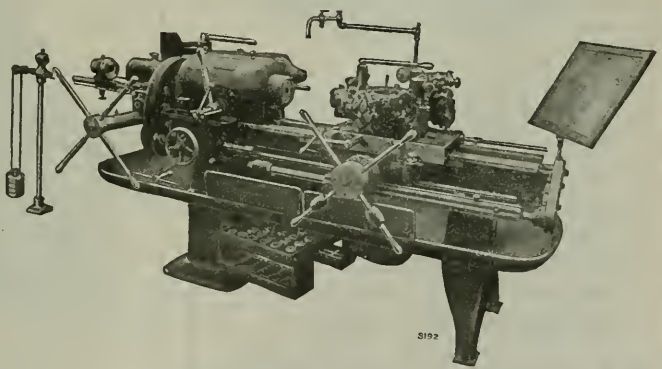
No. 9 Combination Turret Lathe

possesses not only the rigidity and power to remove metal at high speeds and coarse feeds, but also has and retains that exactness of alignment which enables it to take fine sizing cuts with consistent accuracy.

No. 1 Hexagon Turret Lathe

is built for bar work and constructed to permit large reductions at high speeds and feeds at one operation. It is especially adapted for quantity production where fine limits and high finish are desirable.

Bulletins No. 307-A and No. 309-A respectively contain full information and complete specifications of these machines.



No. 1 Alfred Herbert Hexagon Turret Lathe.

Largest Bar Admitted	1⅝″
Greatest Length Turned	27″
No. Spindle Speeds	8
No. Feeds	6

Production times will be furnished on receipt of dimensioned blueprints.

ALFRED HERBERT LTD.

54 Dey Street, New York **1-3 Jarvis Street, Toronto**

Head Office and Works: Coventry, England.
Other Branches and Associated Companies.

YOKOHAMA: 14 Yamashita-cho. OSAKA: 98, Sonesaki Kami. TOKIO: 13, Yamashita-cho, Kyobashiku. KOKURA: Osaki-Machi. Societe Anonyme Alfred Herbert, 47, Boulevard de Magenta, Paris; 39 Cours de la Liberte, Lyons; 178, Rue Barthelemy-Delespaul, Lille; 270, Calle de Mallorca, Barcelona. Societa Anonima Italiana Alfred Herbert, 42, Via Cajazzo, Milan. Alfred Herbert (India) Ltd., 13, British India Street, Calcutta; Standard Buildings, Hornby Road, Bombay. Societe Anonyme Belge Alfred Herbert, 35a and 35b, Rue de la Lacken, Brussels. C. E. Young, 57 George Street, North Circular Quay, Sydney.

Did You See The Cisco Motor Driven Geared Head 24-inch Lathe

at the Railway Master Mechanics' Convention, Atlantic City, in June, Spindle running one revolution in fifteen minutes at the welding exhibit of the General Electric Company?

Some lathe; some power. Very simply operated; very well designed; and with all its power, it is difficult to injure it. Repairs are few, if any.

We want you to know all about Cisco; the lathe with the pull, the lathe of simplified accuracy. Your neighbor has one and is well satisfied, and when he needs another lathe, he will buy a Cisco. Our catalogue gives you every particular and describes very thoroughly

The Best Lathe Built

THE CISCO MACHINE TOOL CO.

CINCINNATI **OHIO, U. S. A.**

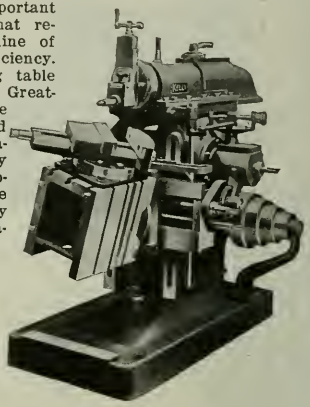
Makers of 14", 16", 18", 20", 24", 26" Engine and Tool Room Lathes, Cone Drive, Plain Motor Drive, Geared Head, Motor Driven Geared Head

A. R. Williams Mchy. Co., Ltd., Winnipeg, St. Johns, Toronto, Montreal and Vancouver, Can. Hendrie & Bolthoff Mfg. & Supply Co., Denver, Colo. Knight & Wall Co., Tampa, Fla. Westcoast Mchy. Co., Seattle, Wash. Cooperative Machinery Co., Cleveland, O. Harry Barney & C. W. Laughlin Mchy. Co., Pittsburgh, Pa. Manufacturers Selling Agency, Birmingham, Ala. C. E. Fales Mchy. Co., Detroit, Mich. Purinton & Smith, Hartford, Conn. F. H. Niles & Co., New York. Day Machinery Co., Buffalo, N. Y. The Morton Machinery Co., Philadelphia, Pa. Herbert R. Lowe, Providence, R. I. Dale-Brewster Mchy. Co., Inc., Chicago. Thompson Tool & Supply Co., Indianapolis, Ind. C. W. Frillman, Dayton, for Southern Ohio. Machineshop Equipment Corp'n., Boston, Mass. Crawford Mill Supply Co., Winston-Salem, N. C. Sullivan Hdw. Co., Anderson, S. C. Central Machine Tool Works, Ltd., London, England. Grimaldi & Co., Genoa, Italy. S. C. M. Reed Co., New York City for New Zealand, Tasmania, Java, Federated Malay States, India and Africa. R. L. Scrutton & Co., Sydney, N. S. W. Societe Internationale, M. D. M., Brussels, Belgium, for Belgium, France and Luxemburg. Alfred H. Schutte, Bilboa, Spain. Musee Du Commerce et de L'Industrie Internationaux, Paris, for the Balkans. Zayas Abreu Com. Co., Havana, Cuba.

Improved Kelly Shaper

None Better Regardless of Price

You can't buy greater accuracy, strength and durability than Kelly Crank Shapers provide no matter what you pay. Added to the old Kelly service formula are important new features that result in a machine of even greater efficiency. Note the tilting table and swivel vise. Greater convenience and increased range with capacity for heavy duty and fast production make the redesigned Kelly a popular machine.



ASK US ABOUT IT BEFORE YOU BUY SHAPERS

R. A. KELLY COMPANY

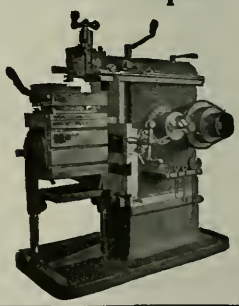
XENIA, OHIO, U. S. A.

Sellew Tool Room Crank Shapers

IDEAL FOR DIE WORK

Profitable for Manufacturing

Distinctive features include micrometer readings on all adjustments, Sellew Patented Outboard Table Support, universal adjustments of tables for planing compound angles, etc., and countershafts with two sets of tight and loose pulleys running in the same direction.



More Details?

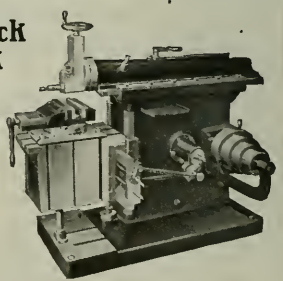
SELLEW MACHINE TOOL COMPANY

Pawtucket **Rhode Island**

Improved Back Geared Crank Shapers

Powerful, accurate machines, carefully proportioned with provision for ample adjustments easily and quickly made. Back gears run in oil. Eight speeds to ram.

Sizes 16", 20", 24".

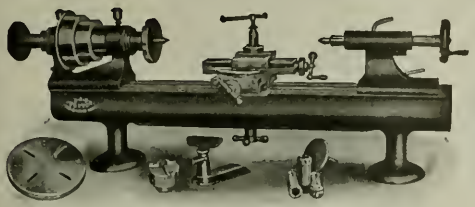


Send for our circular

THE OSBORNE & SEXTON MACHINERY CO.

COLUMBUS **OHIO, U. S. A.**

"POTTER PRECISION PAYS"—7" LATHE



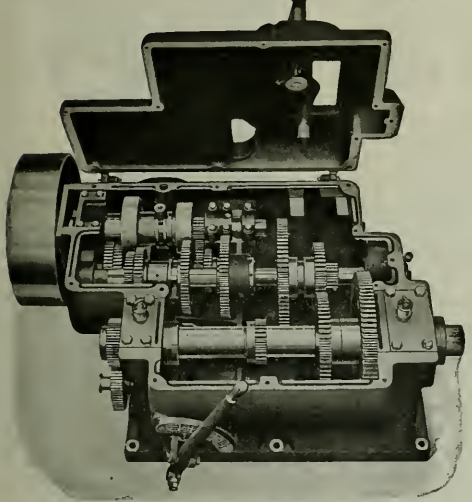
Catalog 9 for particulars

The Potter Precision Lathe is a fine job machine that works fast. Rigid construction, uniform accuracy and convenience for a wide range of operations through the use of suitable attachments are among its advantages. The machine is equipped with lever tail stock, double cross slide, large and small turrets, etc.; mills, cuts, threads, takes care of external and internal grinding; swings 7". It is both a tool room and manufacturing machine, economical and efficient in either service.

S. A. POTTER TOOL & MACHINE WORKS, 77 F. 130th St., New York City

Greaves Geared-Head Engine Lathe

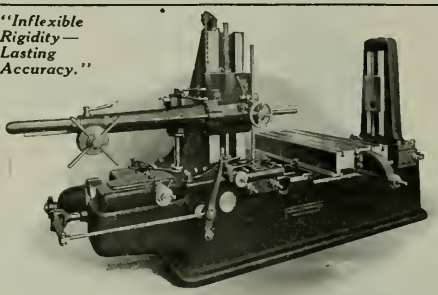
12 speeds in geometric progression obtained with sliding gears.



The cut shows the construction of the single pulley drive geared heads.

THE GREAVES MACHINE TOOL CO.
CINCINNATI OHIO, U. S. A.

"Inflexible Rigidity—Lasting Accuracy."



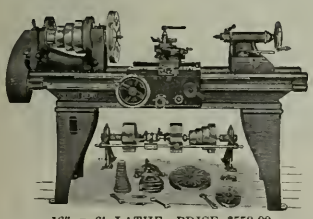
Blomquist-Eck Boring, Milling and Drilling Machines

Wide range heavy duty machines with provisions for delicate adjustments that enable them to perform extremely accurate operations satisfactorily and economically. The details will interest you. Send for Circular.

The Blomquist-Eck Machine Co.
1146 E. 152nd Street Cleveland, Ohio

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FOREIGN AGENTS: Gaston, Williams & Wigmore, Inc., France, Italy, Belgium, and Japan. Nielsen & Winther, Ltd., Norway, Sweden and Denmark. Buck & Hickman, United Kingdom of Great Britain. Garlock-Walker Machinery Co., Toronto, Canada. Andersen, Meyer & Co., Ltd., China.

SOUTH BEND LATHES



16" x 6' LATHE, PRICE $550.00

FOR THE MACHINE AND REPAIR SHOPS

13" Lathe.....	$385.00	18" Lathe.....	$735.00
15" Lathe.....	483.00	21" Lathe.....	900.00
16" Lathe.....	550.00	24" Lathe.....	1250.00

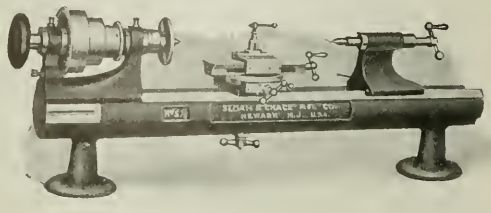
Price includes equipment as shown in illustration.
Made with straight or gap bed.

South Bend Lathes have been on the market fourteen years.

Free catalog mailed on request.
New York Office: 2½ Murray Street
Boston Office: 65 Oliver Street
Philadelphia Office: 33 N. Seventh Street

SOUTH BEND LATHE WORKS Established 1906 **420 Madison St., South Bend, Ind.**

SLOAN & CHACE No. 5½ BENCH LATHE



Accurate, generous proportions (7″ swing, 18″ between centers) enable it to handle a wide range of work.

Manufacturers of Precision Machinery, Bench Lathes, Drill Presses, Milling Machines, Gear and Pinion Cutters, Tools, Fixtures and Gauges.

Send for the Catalog listing all our machines

See our Exhibit at the International Machinery Exposition, Grand Central Palace, New York

SLOAN & CHACE MFG. CO., Ltd. 6th Ave., and N. 13th St., Newark, N. J.



Fenn Smooth-Running Tappers

Provided with sensitive friction drive which gives high speed for reverse—and more work with fewer taps. Fenn Tappers are strong, rapid, accurate machines, adapted for all classes of work up to 3/16″ diameter, economical to operate, easy on taps, durable, dependable—machines you'll like for their clean cut work.

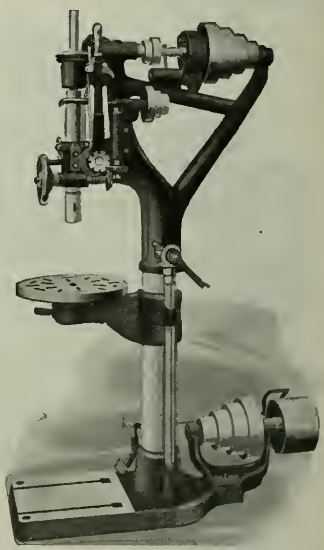
Details on request.

THE FENN MANUFACTURING CO.

HARTFORD CONN., U. S. A.

Cable Address "Fenn"—Western Union Code

HOOSIER DRILLS AND VISES

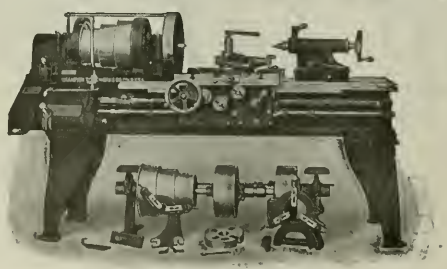


HOOSIER Drills are high class production machines. They are fast, accurate and have ample power. The large range of feeds and speeds adapts them to a great variety of operations. Square tables with oil rim can be furnished on all 16″ and 20″ drills. An actual test in your factory will prove our claims for the HOOSIER line.

Write for description and prices on drills and vises.

HOOSIER DRILLING MACHINE CO.

GOSHEN Dept. A. IND.



Sizes: 12", 14", 16", 18"

Write us for Catalog

CHAMPION

A Lathe for Today's Work

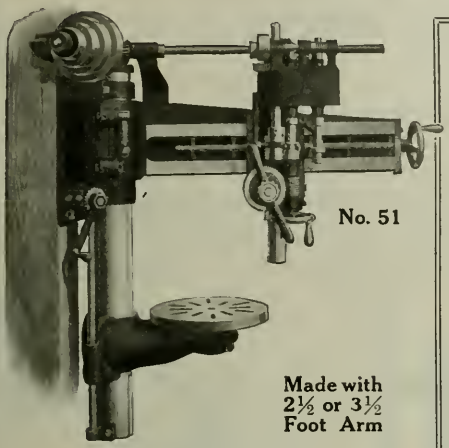
The quick change gears, the automatic stop in either direction, the friction cross and length feeds and the ability to drive high-speed cutting tools to their limit are the reasons why the "Champion" is a lathe for today's work, when greater production is necessary to the very life of the nation.

CHAMPION TOOL WORKS

4955 Spring Grove Ave. Cincinnati, Ohio

THE CANEDY-OTTO WALL TYPE RADIAL

A Machine Every Shop Needs

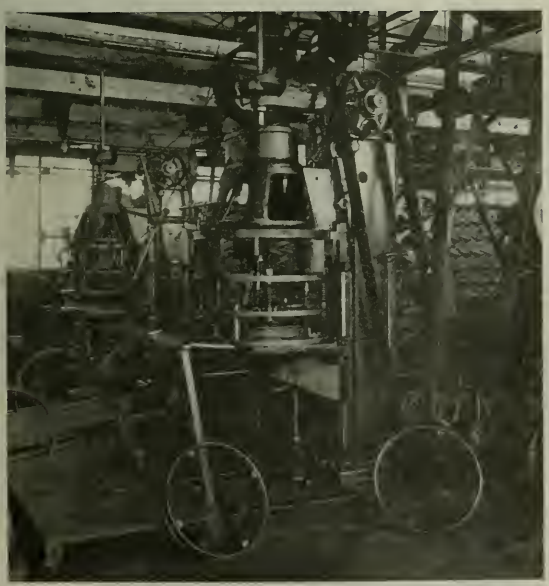


Details and Prices on Request

Big shops need this practical and convenient machine to handle the odd jobs—small shops, garages, boiler works and repair shops use it for practically all drilling and tapping. It is low in price, takes little space and combines all the advantages of stationary drills up to 30″ and floor type radials of equal capacity. Self-feed, automatic cut-off, quick return lever and other convenient features are the same as in our more expensive heavy duty floor type machines.

Carried in Stock by Leading Jobbers and Machinery Dealers Everywhere

CANEDY-OTTO MFG. CO., Chicago Heights, Ill.



PRODUCTION WITH ECONOMY — SPEED WITH ACCURACY

Drilling 700 Holes An Hour!

Here illustrated are the Fox Multiple Spindle Drills at Jaxon Steel Products Company, Jackson, Michigan, each machine drilling rims at the rate of 175 per hour, each rim having four $^{19}/_{32}$″ holes drilled in steel lugs ¼″ thick. These rims are used by General Motors Company and Ford Motor Co.

Have You a Drill That Can Do It?

"VARIABLE SPEEDS FOR DIFFERENT DIAMETERS"—ALWAYS AVAILABLE

Investigate "Fox Efficiency"—Write Today!

FOX MACHINE COMPANY

1812 W. Ganson Street
JACKSON, MICHIGAN

Formerly of Grand Rapids, Michigan

New York Office: Grand Central Palace

DOMESTIC AGENTS: Motch & Merryweather Mchy. Co., Cleveland; Somers, Fitler & Todd Co., Pittsburgh; Vonnegut Mchy. Co., Indianapolis; Badger-Packard Mchy. Co., Milwaukee. FOREIGN AGENTS: Selson Engineering Co., for England—New York City, 24 Stone Street.

HERCULES
POWER PRESS BROACH

"Two In One"

Think of it! A COMBINATION POWER ARBOR PRESS AND BROACHING MACHINE which has proven one of the best all around tools on the market today.



What It Does

Exceedingly Simple, Sturdy, Powerful and Convenient. Does with Exceptional Rapidity, and by Power, a large variety of operations requiring pressure, such as forcing arbors (mandrels) bushings, shafts or pins in or out of holes, seats into valves, linings into pumps, etc., straightening or bending, forming, sizing holes with hardened plugs, testing castings, sealing valves for testing, expanding babbitt bearings, etc.

An extremely efficient tool for Broaching any shaped hole, Square, Hexagon, Octagon or Oval. Four and Six Spline holes, also teeth on Gears and Racks, Key Seating, etc., etc.

Can you afford to be without it?

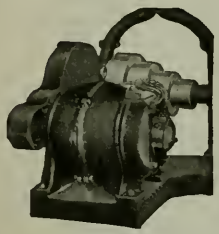
"The More It Is Used, The More New Uses Are Found For It"

HERCULES
MACHINERY CO.

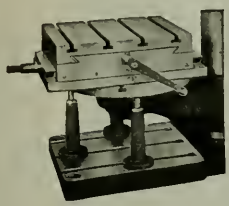
110 Woodbridge St.
DETROIT MICHIGAN

THE MECHANICS' DRILL

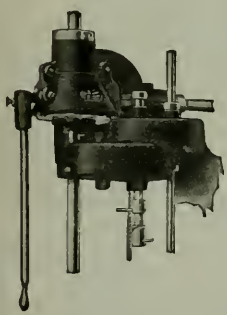
Just a Few of Their Important Points



Motor Drive Through Gears Direct to Lower Cone Shaft



Compound Table, Two Sizes 12" x 12" and 18" x 20"

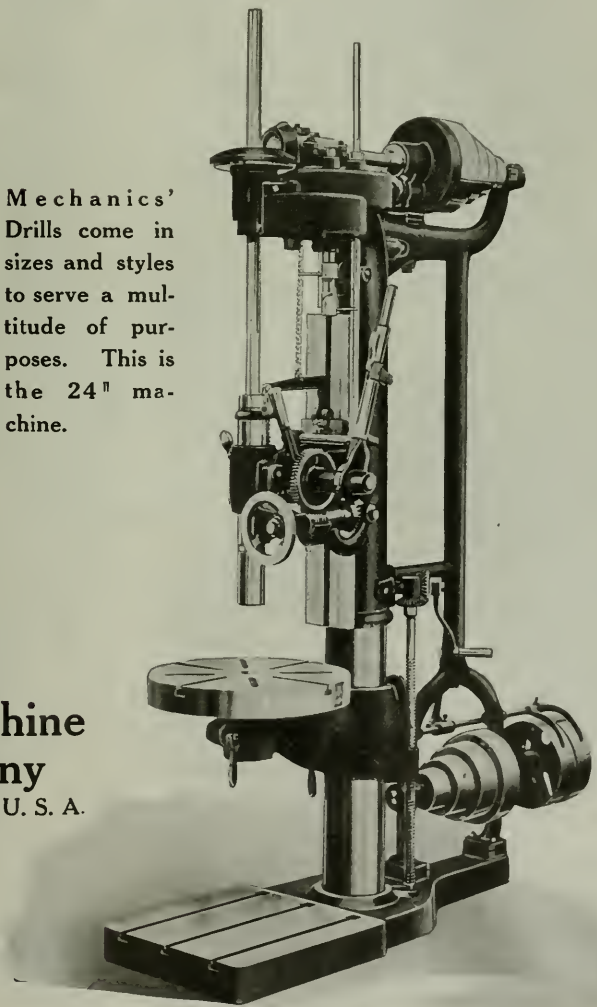


Geared Tapping Attachment

The exceptional scope, efficiency and power of Mechanics' Drills are characteristics best appreciated by their many users. Among the many points which call for particular notice are the drive, through four-step cone pulleys, improved enclosed back gear, and a correctly cut crown gear and pinion. Stationary head with takeup for wear on spindle sleeve is another useful feature. Eight-speed spindle has quick advance and return. Positive feeds are instantly available while machine is running.

A powerful and compact tapping attachment operates through positive steel clutches with quick return.

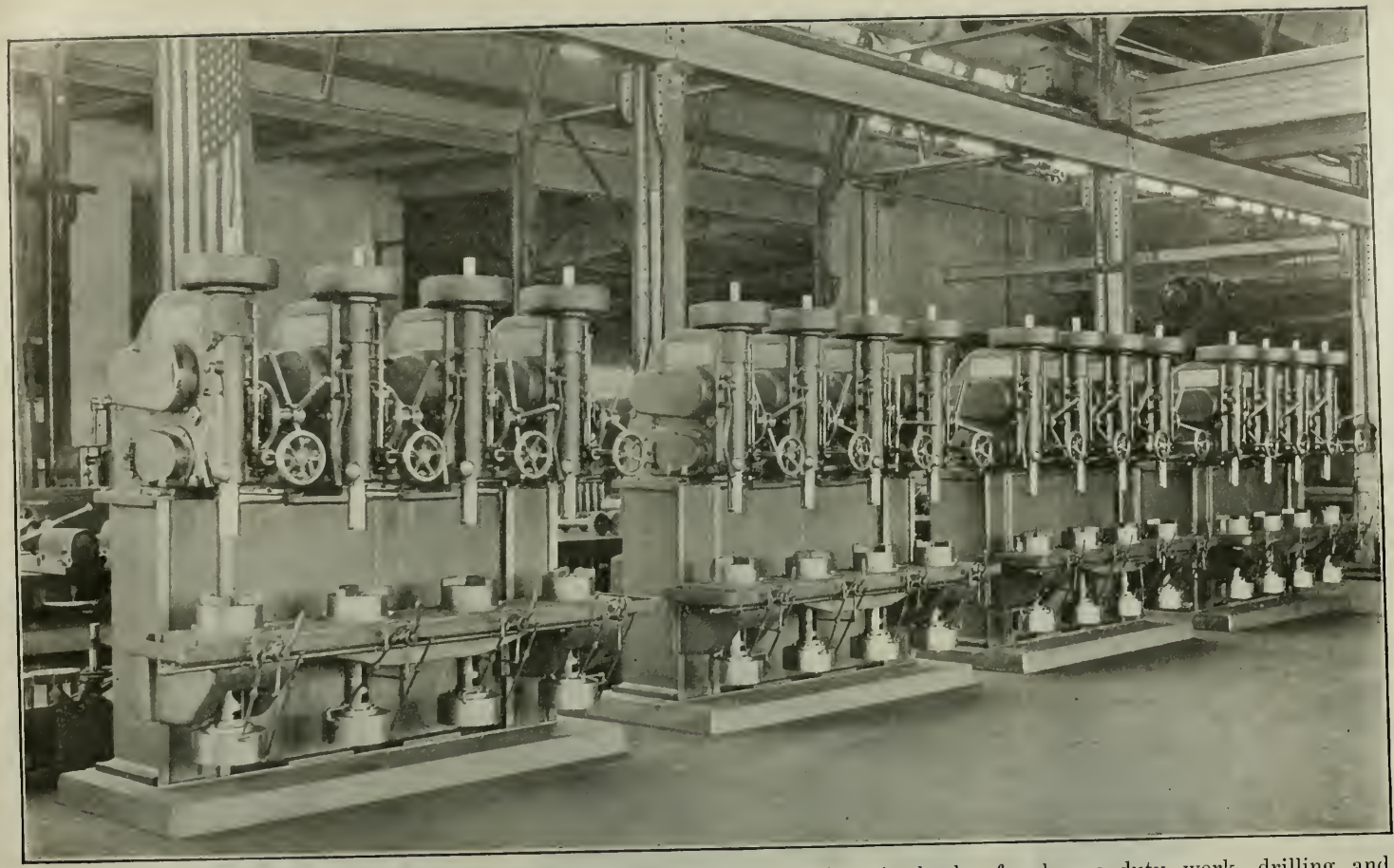
Mechanics' Drills come in sizes and styles to serve a multitude of purposes. This is the 24" machine.



Rockford Machine Tool Company

ROCKFORD ILL., U. S. A.

Ask for Booklet describing the full line.



BAKER DRILLS

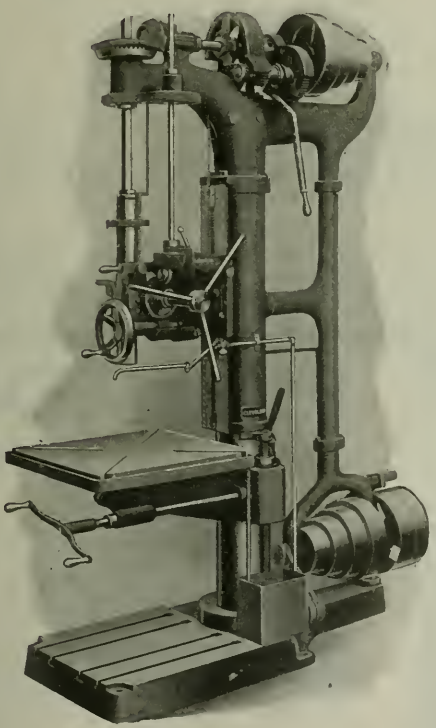
Equipped with quick acting air chucks for heavy duty work, drilling and reaming taper holes in drop forgings. (Part of one order from customer who already has over fifty machines).

If You Want PRODUCTION, ACCURACY and SERVICE Be Sure "IT'S A BAKER"

BAKER BROTHERS, Toledo, Ohio.

KERN DRILLING MACHINES

This 32" Machine Drills and Taps Holes up to 2½" Diameter in Solid Steel



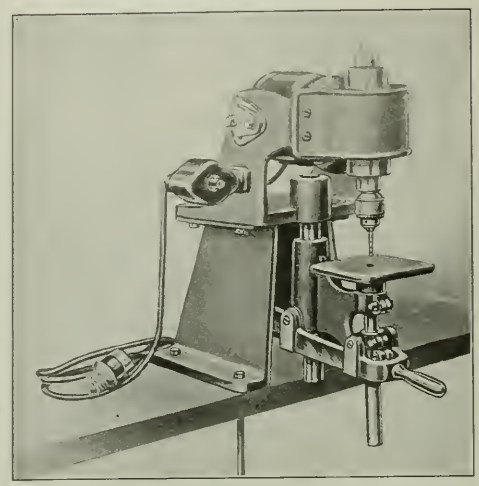
Positive geared feed, back gears and automatic stop are among the features that recommend this wide range, conveniently controlled upright drilling machine. Column is unusually large and well supported, and the head well gibbed and counterbalanced. Spindle is of special hammered steel with long bearing on sleeve, has a 10½" traverse and is equipped with quick return. Gears in the feed box on the sliding head are of steel—bronze bushed—and provide eight changes, from .006" to .048". Cone pulleys are 3" wide and drive pulleys 13" x 3½"—the speed of the lower shaft being 350 R.P.M.

This is a first-class machine—a machine with a well-established reputation as a profitable producer and the endorsement of master mechanics in many leading shops.

Complete description on request.

BUCKEYE DRILL & LATHE COMPANY
COLUMBUS OHIO, U. S. A.

Let Us Have Your Tapping Problem



"ANDERSON"

Spherical Friction Disc permitting variable tapping and reverse speeds.

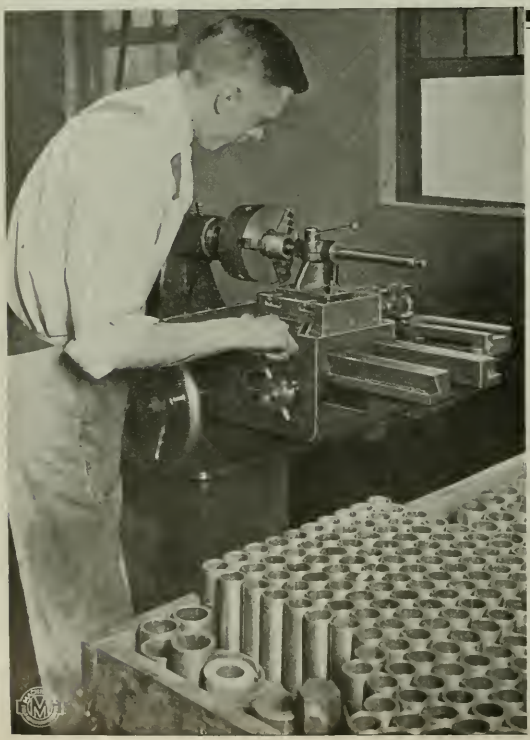
Geared Heads for tapping more than *one hole* at a time attached to spindle.

Dial Feeds, either plain or automatic, attached to table.

DIRECT MOTOR DRIVE
BENCH OR PEDESTAL

Send Sample or Print with complete information

FAIRBANKS-MORSE & CO.
Machine Tool Department
30 Church St. **New York City**



FISCHER
Oil Grooving Machine

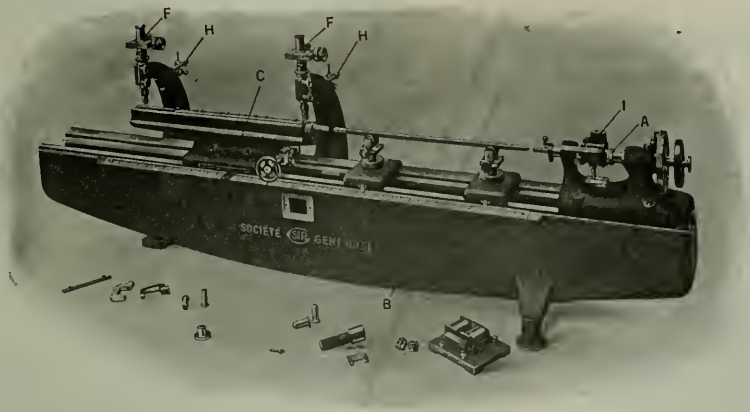


First Choice Here—and It Made Good
When the Buffalo Non-Ferrous Casting Co. (Buffalo, N. Y.,) started to manufacture bronze bushings, a Fischer Oil Grooving machine was one of the first pieces of equipment they bought. This machine—installed just two months when the photograph was taken—has been used for cutting all styles of oil grooves in bushings of various sizes to the unvarying satisfaction of the user.

Ask for details of this machine.

FISCHER MACHINE CO.
PHILADELPHIA **PA., U. S. A.**

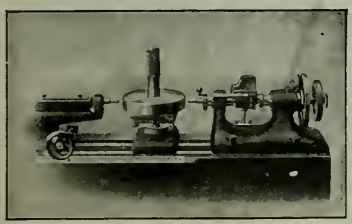
DOMESTIC AGENTS: Chas. A. Strelinger Co., Detroit, Mich. FOREIGN AGENTS: Coats Machine Tool Co., Ltd., 14 Palmer St., Westminster, London, Glasgow and Newcastle-on-Tyne. Aux Forges de Vulcain, Paris, France. Yamatake & Co., Tokyo, Japan. Henry Coe & Clerici, Milan, Italy. Allied Mchy. Co., Spain, Portugal and Switzerland. Ateliers Demoor, Belgium. Chr. A. Herstad, Norway, Sweden, Denmark and Finland.



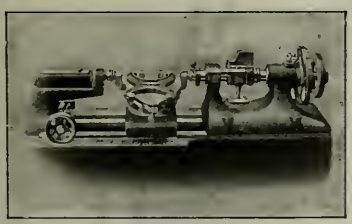
You Can Make Absolute Measurements Accurate to *.000005 inch* with the

SIP Universal Measuring Machine

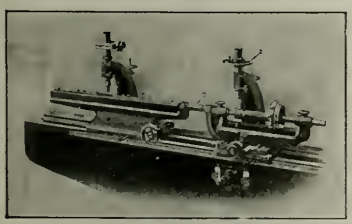
A Few of its Applications



Plug Gages over 4 in. Diam.



Snap Gages



Screws up to 4 in. Diam.

Made by
Societe Genevoise d'Instruments de Physique Geneva, Switzerland.

The Only Measuring Machine that Completely Eliminates the Personal Element

Three Sizes: 20-inch, 40-inch and 80-inch, with accessories for the Checking and Control of all forms of Standards and Gages, such as: Plug and Ring Gages, Snap Gages, Limit Gages, every element of Thread Gages and Screws, End Standards, Gage Blocks, etc.

The partial turn of an adjusting nut by hand instantly sets the machine for making EXTERNAL or INTERNAL MEASUREMENTS.

May also be used as a high-precision comparator.

Ask for Catalog No. 234

THE GOLDEN COMPANY

Exclusive Agents in the United States

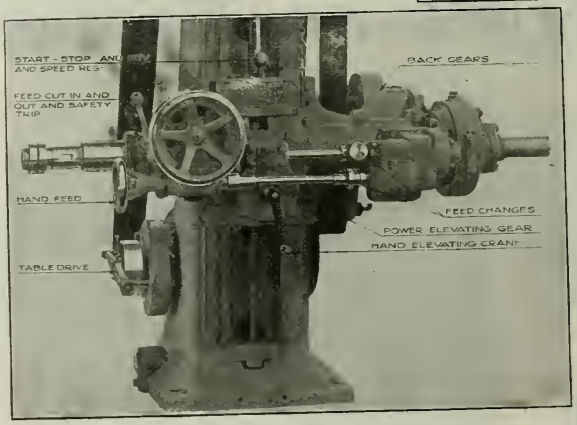
405 Lexington Avenue NEW YORK

Detroit Office: 66 West Larned Street.

AN ACCURATE HORIZONTAL DRILLING AND BORING MACHINE

Designed as a general utility tool, this machine can be quickly set for drilling tapping boring or facing operations on large or small work···

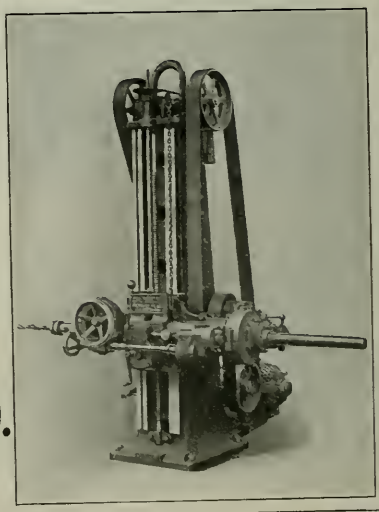




Control levers are few and are conveniently located. Power table traverse and spindle elevating gear prevents fatigue of operator····

Column may be used as a portable machine where work is too large for the table····

Write for complete information··



THE MILWAUKEE CRANE

MILWAUKEE ELECTRIC CRANE & MFG. CO.

MILWAUKEE, WIS.

ACME NUT TAPPING



Each Downward "Stroke" of the Spindle Threads Twenty-four Nuts

Tapping lock nuts for use in electrical apparatus is the regular job of this six-year-old Four-spindle Acme Nut Tapper in the Appleton Electric Company's shop at Chicago. Half-inch nuts were being tapped when the above picture was taken; output was 5,000 per hour, 45,000 per nine-hour day.

This production is made possible by the distinctively long and powerful "thrust" of the spindles and the fact that each spindle is provided with a counter-weight which facilitates handling and eliminates tap breakage, such as is common where the taps are started too suddenly in the nuts.

Acme Back-geared Nut Tapping Machines have quick-acting sockets and adjustable nut holders which can be loaded and unloaded with the machine running at full speed. Two sizes of work can be tapped at correct cutting speeds, or spindles can run at same speeds if desired.

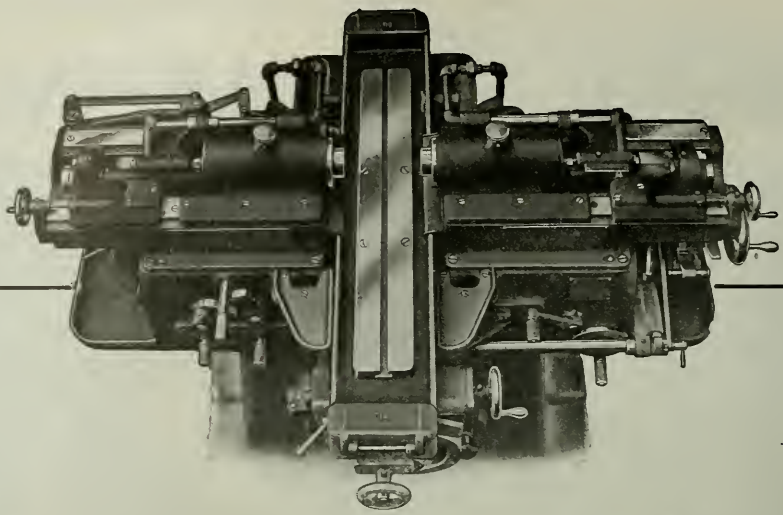


Catalog describes the whole line

THE ACME MACHINERY COMPANY

CLEVELAND OHIO, U. S. A.

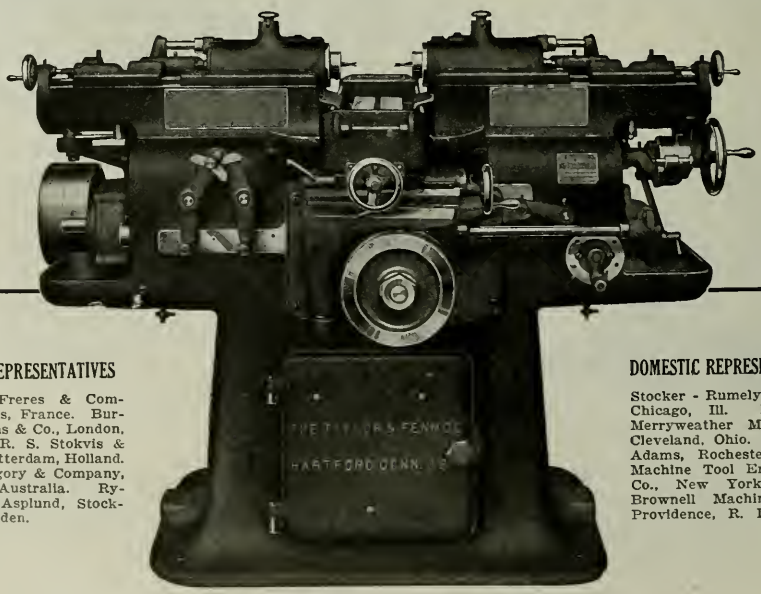
FOREIGN AGENTS: BURTON, GRIFFITHS & COMPANY, Ltd., London. GLAENZER & PERREAUD, Paris, France.



A New Spline Milling Machine

Driven direct from the main line shaft. Automatic in operation. Two spindles with simultaneous or independent feeds. Quick change speeds and feeds. Will mill grooves or cuts six inches long, one inch in width. Spindles have no overhang and cutters are rigidly held in chuck of special design. Cutting fluid is delivered in uniform constant pressure through the spindle to the point of the cutter. Many other new and special features. Circular on request.

THE TAYLOR & FENN COMPANY, Hartford, Conn., U.S.A.



FOREIGN REPRESENTATIVES

Fenwick Freres & Company, Paris, France. Burton Griffiths & Co., London, England. R. S. Stokvis & Zonen, Rotterdam, Holland. H. P. Gregory & Company, Sydney, Australia. Rylander & Asplund, Stockholm, Sweden.

DOMESTIC REPRESENTATIVES

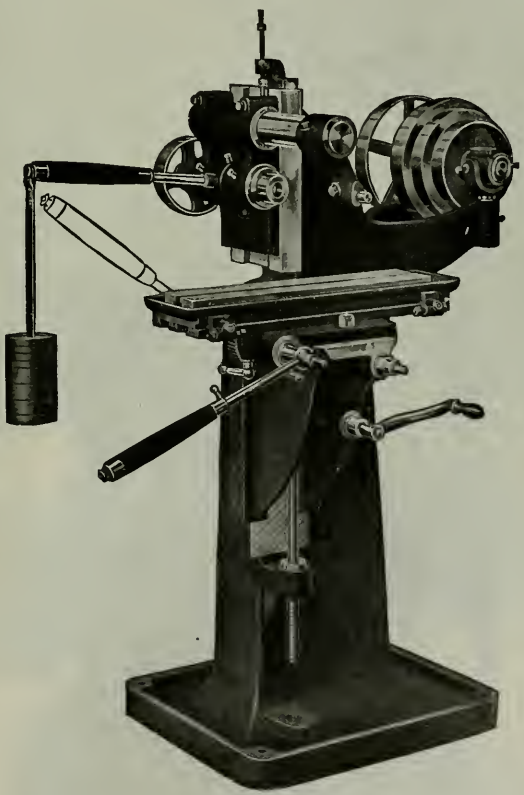
Stocker - Rumely - Wachs, Chicago, Ill. Motch & Merryweather Mchy. Co., Cleveland, Ohio. Ogden R. Adams, Rochester, N. Y. Machine Tool Engineering Co., New York, N. Y. Brownell Machinery Co., Providence, R. I.

"WHITNEY"

HAND MILLING MACHINE

THOUSANDS IN USE

Is invaluable in the LARGE FACTORY as no other design equals it for big production on interchangeable work, as proved by the thousands of these machines in constant use both here and abroad. One concern alone is using over 700 of these machines and many other concerns have over one hundred each.



Is invaluable in the SMALL SHOP as it will handle a wide variety of operations with convenience, accuracy and rapidity. Soon pays for itself.

PROMPT DELIVERIES

THE WHITNEY MFG. COMPANY

HARTFORD, CONNECTICUT

CHAINS KEYS AND CUTTERS HAND MILLING MACHINES

FOREIGN AGENTS: Burton, Griffiths & Co., Ltd., London; Fenwick Freres & Co., Paris; Rylander & Asplund, Stockholm, Sweden.

The Gabrielson Milling Machine

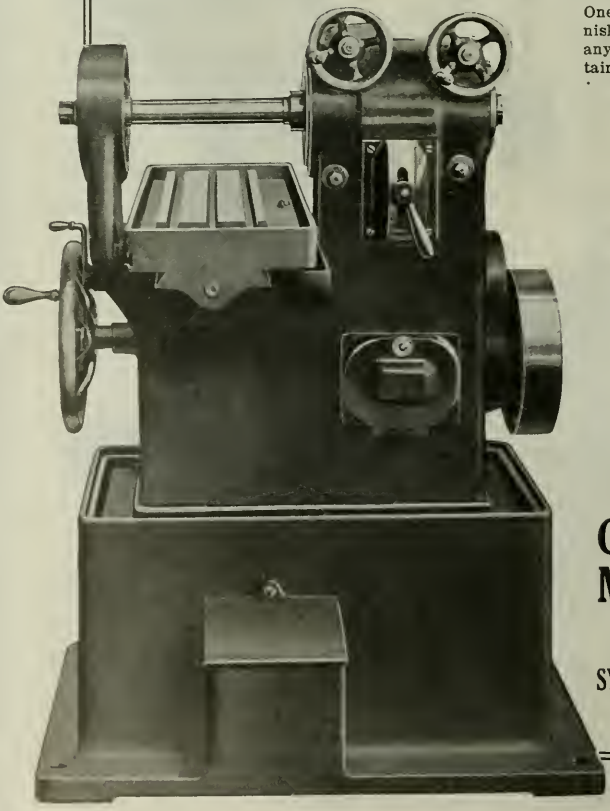
A Plain, Rigid Machine with a Practical Range for General Production

No one would hire a ten-thousand-dollar man and put him at an eighteen-dollar-a-week job, but many manufacturers use expensive universal machines day after day on a simple production job, because of the lack of plain machines sufficiently accurate to meet the demands of modern manufacturing methods.

The Gabrielson Milling Machine was designed to provide for this condition. Rigidity is its outstanding feature, so consistently developed that it takes heavy cuts without chatter and produces an excellent surface on finishing cuts.

Arbor support bearing is cast integral with the frame. Table has a working surface 34" by 7", and a longitudinal feed 31" in either direction. Spindle of steel—hardened, ground and lapped—runs in bronze bushings and is carried by a large eccentric sleeve allowing 1" vertical and ½" endwise adjustment. Both operated by hand-wheels graduated to .001".

One pair of gears regularly furnished provides two speeds, but any desired feed is readily obtainable through change gears.



This machine is made in three sizes—6", 9" or 12" between spindle and table. Details on request.

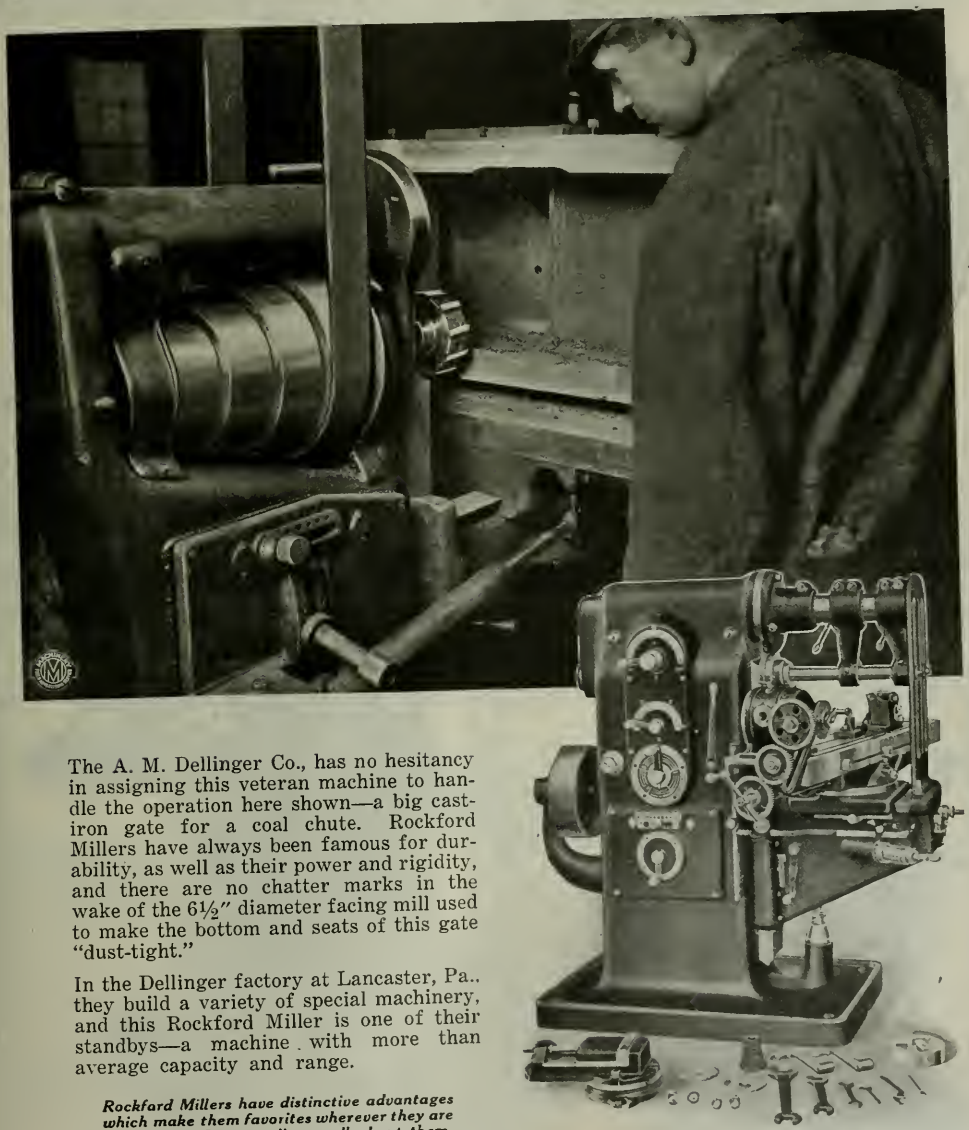
GABRIELSON MFG. CORP.

First Trust and Deposit Company Building

SYRACUSE, N. Y., U. S. A.

Milling Dust-tight Seats on a Nine-year-old

ROCKFORD MILLER



The A. M. Dellinger Co., has no hesitancy in assigning this veteran machine to handle the operation here shown—a big cast-iron gate for a coal chute. Rockford Millers have always been famous for durability, as well as their power and rigidity, and there are no chatter marks in the wake of the 6½" diameter facing mill used to make the bottom and seats of this gate "dust-tight."

In the Dellinger factory at Lancaster, Pa., they build a variety of special machinery, and this Rockford Miller is one of their standbys—a machine with more than average capacity and range.

Rockford Millers have distinctive advantages which make them favorites wherever they are installed. Let us tell you all about them.

ROCKFORD MILLING MACHINE CO.

ROCKFORD ILL., U. S. A.

FOREIGN REPRESENTATIVES: Great Britain, A. A. Jones & Shipman, Ltd., Leicester, England. France and Belgium, Louis Besse, Paris, France. Italy and Colonies, Societa Anonima Adler & Co., Milano, Italy. Scandinavia, Rylander & Asplund, Stockholm, Sweden, Spain and Portugal, Casamitjana Hermanos, Barcelano, Spain. Australia, Selson Engineering Co., Melbourne, Australia. Russia, M. Mett Engineering Co., Petrograd, Russia.

Briggs Milling Keyseats for La Crosse Tractors

"A Mighty Good Production Machine"



Is what they say of their Briggs Miller at the La Crosse (Wis.) Tractor Company's shop. When photographed this two-year-old machine was being used for milling 3/8" keyways 4" long in roller pinions for La Crosse Tractors.

Time is 2¼ minutes floor-to-floor, so it is not surprising to find the company "perfectly satisfied."

Briggs High Duty Millers are famous producers—powerful and accurate. Simple adjustments and conveniently located controls facilitate operation and, on certain classes of work, one man can handle a battery. More details on request.

GOOLEY & EDLUND, Inc.

CORTLAND N. Y., U. S. A.

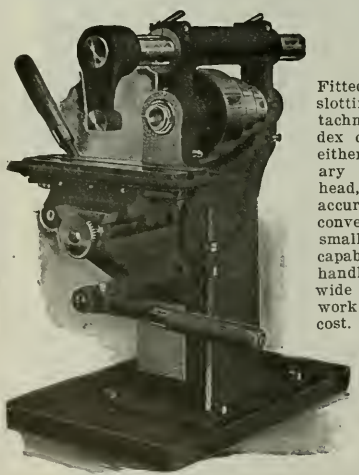
DOMESTIC AGENTS: Vaodyck-Churchill Co., New York and New Heven; Monarch Machinery Co., Philadelphia, Pa.; Lynd-Farquhar Co., Boston, Mass.; Syracuse Supply Co., Syracuse, Rochester, and Buffalo, N. Y.; Brown & Zortman Machinery Co., Pittsburgh, Pa.; English & Miller Machinery Co., Detroit, Mich.; Federal Machinery Sales Co., Chicago, Ill.; Vonnegut Machinery Co., Indianapolis, Ind.; Cleveland Tool & Supply Co., Cleveland, O.; Blackman-Hill-McKee Machinery Co., St. Louis, Mo. FOREIGN AGENTS: Burton, Griffiths & Co., Ltd., London, Manchester and Glasgow; Aodrews & George, Tokyo.

OVER-SEAS REPRESENTATIVE

ALMACOA ALLIED MACHINERY COMPANY OF AMERICA 51 CHAMBERS ST. NEW YORK, U.S.A. ALMACOA

Paris Turin Zurich Barcelona Petrograd

The Burke No. 3 Bench Milling Machine

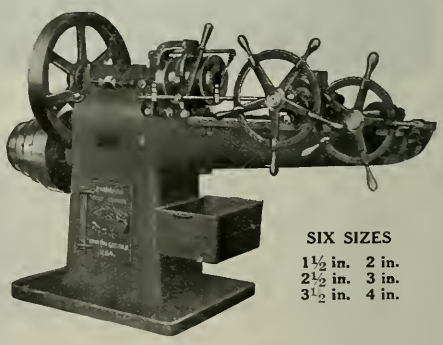


Fitted with slotting attachment, index centers—either stationary or tilting head, etc.; an accurate and convenient small machine capable of handling a wide range of work at low cost.

Catalogue lists full line of Milling Machines and attachments, also Drilling and Tapping Machines. Send for it.

The Burke Machine Tool Co.

516 Sandusky St. Conneaut, Ohio, U. S. A.



SIX SIZES

1½ in. 2 in.
2½ in. 3 in.
3½ in. 4 in.

It Took Twenty Years to Make this Bolt Cutter

Yes, this bolt cutter has been twenty years in the making—and each year has seen new improvements.

One of its many features is the adjustment which permits the machine while running to cut exact, over or under size bolts in an instant.

Complete Details on Request

THE UNIVERSAL MACHINE CO.

PIKE STREET BOWLING GREEN, OHIO

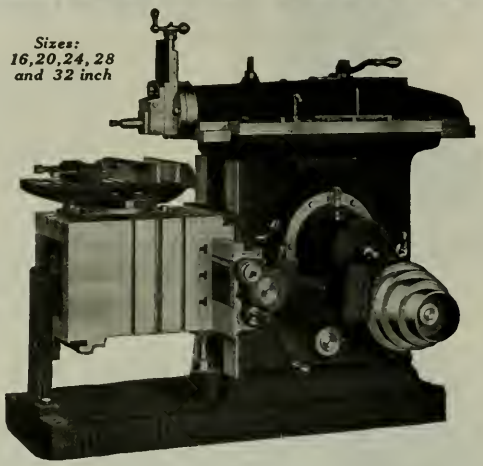
Columbia Shapers

Combine Operating and Construction Features of Unusual Merit

For instance, the quick-change feed. Is simple in design, strong and substantial and not liable to get out of order. Feed always takes place during return stroke —no danger of feeding into the work. Feed changes are easily made while machine is running by moving a handle convenient to operator. Graduations on feed box show amount of feed. A separate lever controls direction of feed. Hardened steel gears, bronze bushings, ample oiling facilities and careful workmanship insure durability.

Let us send you full details of this and other features

Sizes: 16,20,24,28 and 32 inch



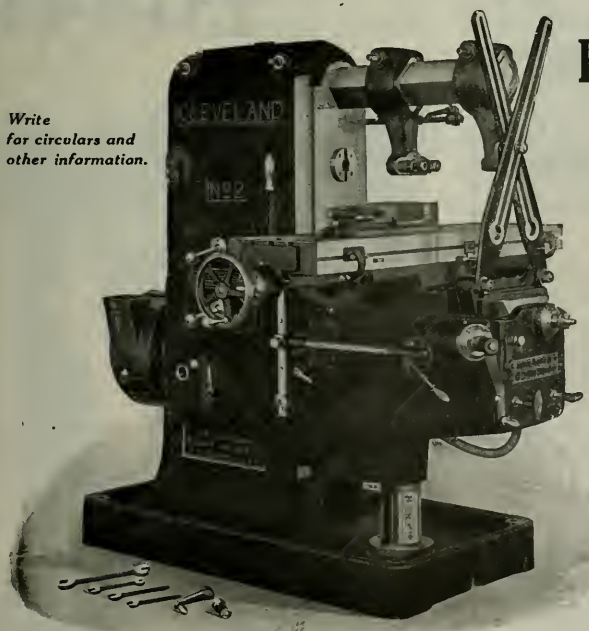
THE COLUMBIA MACHINE TOOL CO., Hamilton, Ohio

AGENTS: Manning, Maxwell & Moore, Inc., Main Office, 119 West 40th Street, New York. BRANCHES: Boston, Buffalo, Chicago, Cincinnati, Cleveland, Detroit, Milwaukee, New Haven, Philadelphia, Pittsburgh, St. Louis, San Francisco, Seattle.

CLEVELAND MILLING MACHINES

Plain and Universal

Write for circulars and other information.



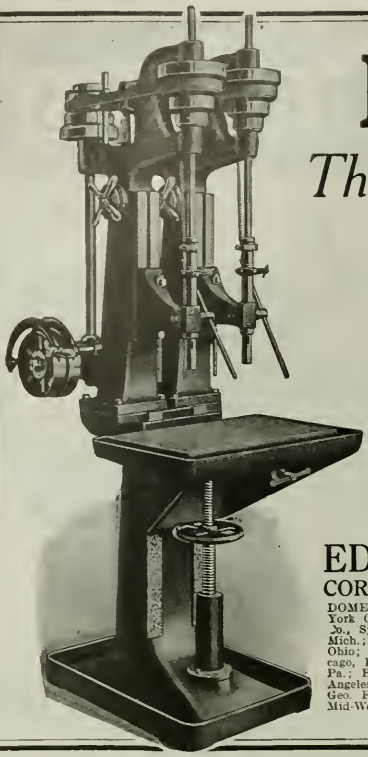
You know these machines and the high quality of their work. Made in the same plant, by the same men, with the same equipment as heretofore we can guarantee without hesitation that the same high standards will be maintained for both products and service.

The Clark-Mesker Co.

SUCCESSORS TO

THE CLEVELAND MILLING MACHINE CO.

CLEVELAND OHIO



EDLUND

The Peak of Drilling Efficiency

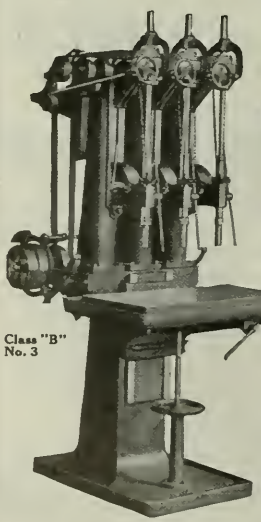
The peak is reached in Edlund Sensitive Drilling Machines. They are rigid, rapid, accurate, convenient, durable machines which have a proved record for economy. The Edlund No. 2 has one piece frame above base, extra size cone pulleys, 9″ bearing for quill, 16″ knee bearing on column, ball-bearings throughout, and four changes of speed are obtainable without stopping the machine. Idler takes up slack in belt.

Edlund machines are especially adapted for tool-room service or manufacturing equipment where extreme accuracy is required. Made with 1 to 6 spindles. Ask us about the machine you need.

EDLUND MACHINERY CO., INC.

CORTLAND Box 45 NEW YORK

DOMESTIC AGENTS: Monarch Machinery Co., Philadelphia, Pa.; Vandyck Churchill Co., New York City, New Haven, Conn.; Manning, Maxwell & Moore, Inc., Boston, Mass.; Syracuse Supply Co., Syracuse, N. Y., Rochester, N. Y., Buffalo, N. Y.; English & Miller Machinery Co., Detroit, Mich.; Cleveland Tool & Supply Co., Cleveland, Ohio; The M. D. Larkin Supply Co., Dayton, Ohio; Marshall & Huschart Machinery Co., Indianapolis, Ind.; Stocker-Rumely-Wachs Co., Chicago, Ill.; W. L. Romaine Machinery Co., Milwaukee, Wis.; Thompson Machinery Co., Pittsburgh, Pa.; Elliott & Stephens Machinery Co., St. Louis, Mo.; Herberts Machinery & Supply Co., Los Angeles, Cal., and San Francisco, Cal.; Garlock-Walker Machinery Co., Toronto, Canada; The Geo. F. Foss Machinery & Supply Co., Montreal, Canada; Aumen Machinery Co., Baltimore, Md.; Mid-West Machine Tool & Supply Co., Davenport, Iowa; Gunther-Plant Co., Minneapolis, Minn.



Class "B" No. 3

Drilling Machines

Henry & Wright Drilling Machines

Will do more drilling than ever during the reconstruction period.

Drilling millions of holes ¾″ and under in every conceivable kind of manufactured product. They are preferred because of their many advantages. Send for catalogue.

THE HENRY & WRIGHT MFG. CO.

HARTFORD, CONN.

OVER-SEAS REPRESENTATIVE

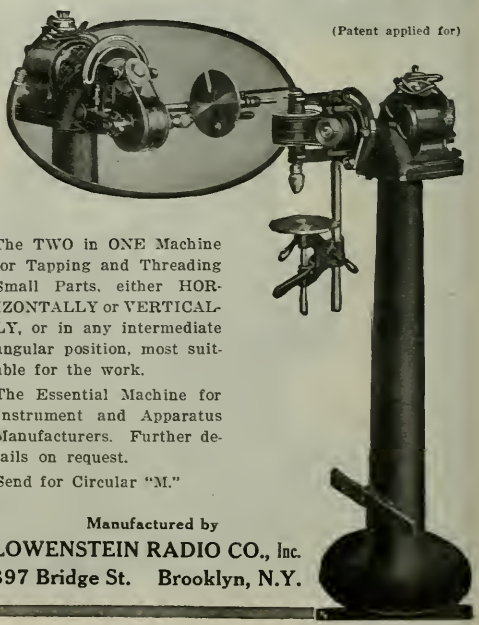
ALMACOA ALLIED MACHINERY COMPANY OF AMERICA ALMACOA

51 CHAMBERS ST. NEW YORK, U.S.A.

PARIS TURIN ZURICH BARCELONA

The UNIVERSAL TAPPER

(Patent applied for)



The TWO in ONE Machine for Tapping and Threading Small Parts, either HORIZONTALLY or VERTICALLY, or in any intermediate angular position, most suitable for the work.

The Essential Machine for Instrument and Apparatus Manufacturers. Further details on request.

Send for Circular "M."

Manufactured by

LOWENSTEIN RADIO CO., Inc.

397 Bridge St. Brooklyn, N.Y.



Monday Morning to Saturday Night

—Overtime, Too, If Needed—

Continuous Satisfactory Service

The Avey BALL BEARING DRILLING MACHINE

The Avey Drilling Machine Company

CINCINNATI, OHIO, U. S. A.

For Drilling Cast Iron Use Speedy, Sensitive

CARLTON RADIAL DRILLS

They are profitable producers and make speed on the finest drilling work. Accurate and delicate adjustments, sensitive, convenient controls make these machines especially valuable for manufacturing work.

Capacity 1" in cast iron; 2½', 3½', or 4' arm; belt or motor drive. Details?



The Carlton Machine Tool Co.

2994 Spring Grove Ave.

CINCINNATI, OHIO, U.S.A.

PROFITABLE EQUIPMENT



Jacobs Chucks used as regular equipment.

Winterhoff 10½" Bench Drills

This handy little drill is thoroughly satisfactory in either shop or factory. It is sensitive, efficient, easily operated and durable. Bearings are ball thrust, adjusted for wear and end play. Runs up to 2,400 R.P.M. Made with either motor or belt drive.

0" to ½" capacity. Prompt deliveries

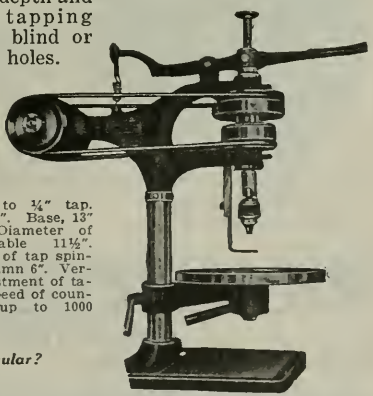
WINTERHOFF TOOL & MACHINE CO.

ELKHART INDIANA

TUTTLE TAPPERS

FOR SMALL TAPPING WORK

Light-weight machines, rigid, accurate and speedy. Made in bench and pedestal types for hand or foot lever operation. Equipped with automatic stop that can be set to the desired depth and makes tapping safe on blind or through holes.

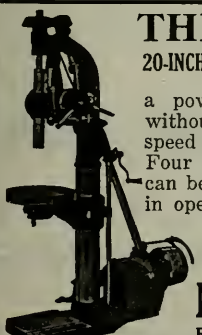


Capacity to ¼" tap. Height, 15". Base, 13" x 16". Diameter of swing table 11½". Clearance of tap spindle to column 6". Vertical adjustment of table 3". Speed of countershaft up to 1000 R.P.M.

Circular?

PARAGON GEAR WORKS

TAUNTON (Evans Stamping and Plating Co.) MASS.



THE LINDGREN

20-INCH HIGH SPEED ALL GEARED DRILL

a powerful machine, 5 speeds without back gear. Bearing in speed box fitted with ring oilers; Four change positive gear feed; can be changed while machine is in operation. Star handle.

New lubrication features. No leakage of oil.

Mechanics Tool Co.

ROCKFORD ILLINOIS, U. S. A.

THE LAST WORD IN



THE RICKERT-SHAFER

Reduced Tap Breakage Sev

These two photographs were taken in the plant of the Johnson Motor Wheel Company, South Bend, Indiana. One shows a Rickert-Shafer Tapping Machine tapping aluminum armature plates at the rate of 40 per hour. Each armature plate requires 24 holes, three different sizes, to be tapped. In other words, there are 960 holes tapped per hour by this machine.

Not only has the Johnson Motor Wheel Company found its Rickert-Shafer Tapping Machines very efficient, but with them tap breakage has been reduced 75 per cent.

RICKERT-SHAFER COMPANY

NEW YORK OFFICE: 50 CHURCH ST.

612 W. 12th Street **Erie, Pa., U. S. A.**

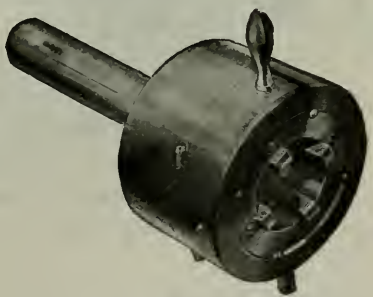
BRANCH OFFICES: 380 Rockefeller Bldg., Cleveland, Ohio; 117 N. Jefferson St., Chicago, Ill.; Bourse Bldg., Philadelphia, Pa.; 50 Church St., New York, N. Y.; 66 W. Larned St., Detroit, Mich.; 414 Elm St., Cincinnati, Ohio.

HREADING TOOLS



TAPPING MACHINE

enty-five Per Cent.



The second machine in this installation is tapping (brass) gasoline inlets in carbureters, 5/16"—24 threads per inch, ⅜" deep blind holes. There is one hole in each carbureter and production is 400 carbureters per hour.

Write for our interesting booklet on tapping machines and methods.

We Manufacture Die Heads Also

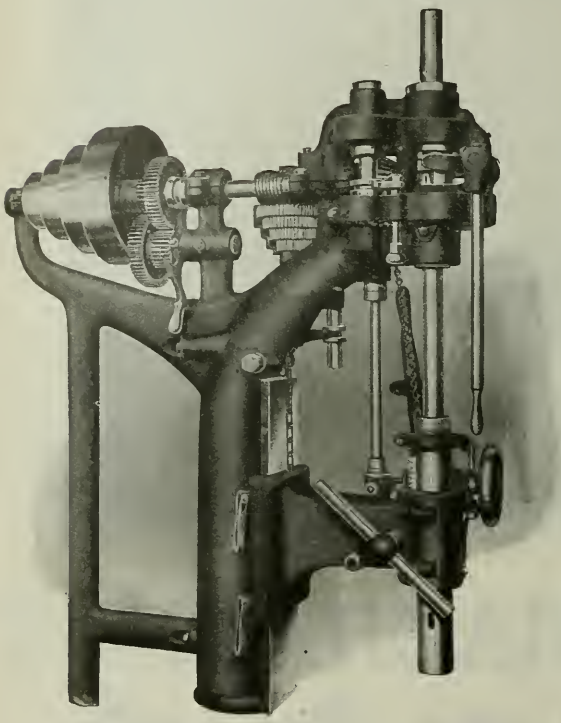
RICKERT-SHAFER COMPANY

NEW YORK OFFICE: 50 CHURCH ST.

612 W. 12th Street Erie, Pa., U. S. A.

AGENTS: Vonnegut Machinery Co., Indianapolis, Ind.; Stocker-Rumely-Wachs, Chicago, Ill.; Strong, Carlisle & Hammond, Cleveland, Ohio; Michigan Metal Supply Co., Detroit, Mich.; Peter Frasse & Co., New York, N. Y.

The Driller that saves



Hoefer Time-saver No. 1
The Tapping Attachment

90% would be a conservative estimate of the time and cost-saving of tapping on the same machine that does the drilling. And the Hoefer Geared Tapper only requires lowering or raising a small knobbed shaft to set the attachment in action or to disengage it.

Hoefer Time-saver No. 2
Changing Feeds

In our geared feed we have one of the most convenient and rapid arrangements in existence. Without leaving his position and on even the largest sizes of drillers the operator can instantly change the feeds while the drill is in action.

Hoefer Time-saver No. 3
Driving out the Drill

You don't have to use valuable time locating a spindle hole and a spindle sleeve hole and then aligning them before you can get the drift in to drive out the drill. The Hoefer way is simply to drive the drift into *one* hole and then knock out the drill.

These are a few of the outstanding Time-Savers of Hoefer Drillers. They illustrate one of the guiding principles of Hoefer design—to make a machine that will shorten the time on each job and help conserve the operator's energy.

HOEFER
FREEPORT

SALES ENGINEERS FOR HOEFER HEADS: Chicago, 621 Washington Blvd.; New York, 30 Church St.; Philadelphia, Bourse Bldg.; Buffalo, Ellicott Square Bldg.; Cleveland, Citizens Bldg.; Pittsburgh, Empire Bldg.; Detroit, 602 Kerr Bldg.; Milwaukee, Majestic Bldg.; Dayton, John M. Howett, 12 W. Second St.; St. Louis, Colcord-Wright Machinery & Supply Co.; Minneapolis, F. E. Seatterlee Co.; Montreal, Canadian Fairbanks-Morse Co. (head office).

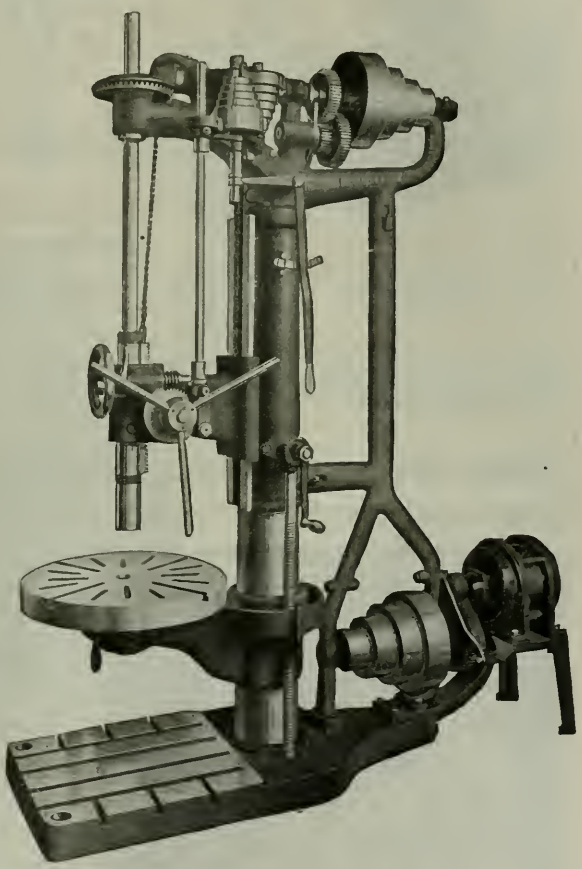
Time—and why

The big and little conveniences and time-savers on Hoefer Drillers also show another Hoefer characteristic—a *practical* driller designed by *practical* engineers closely in touch with operating problems and eternally plugging away to make a better machine.

And remember that saving time is only one of the strong points of a Hoefer Driller. It's built for accurate work, for hard service and for long use. And it meets all of these specifications, too—as any of the hundreds of satisfied users can tell you.

Whether you suspect that your drilling equipment is not fully up to the topnotch standard, or consider your drilling operations satisfactorily performed, it will be worth your while to make sure by taking advantage of Hoefer Consultation Service. It's offered without charge or obligation. If we can help you, we'll prove it, and if we can't, we'll say so frankly.

Write for catalog.



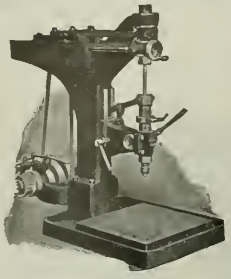
M'F'G CO.

ILLINOIS

SALES OFFICES FOR HOEFER DRILLERS: Baltimore, Aumen Machinery Co., 107 E. Lombard St.; Boston, Factory & Mill Supply Co.; Providence, Brownell Machinery Co.; New York, F. H. Niles & Co., Woolworth Bldg.; Philadelphia, Luster Machinery Co., 917 Arch Street; Syracuse, C. H. Wood Co.; Rochester and Buffalo, Ogden R. Adams; Pittsburgh, Metch and Merryweather Machinery Co.; Cleveland, Cleveland Tool & Supply Co.; Dayton, John M. Howett, 12 W. Second St.; Indianapolis, E. A. Kinsey Co.; Detroit, Cadillac Tool Co.; Chicago, Federal Machinery Sales Co., 12 N. Jefferson St.; Milwaukee, Badger Packard Machinery Co.; Minneapolis, F. E. Satterlee Co.; St. Louis, Colcord-Wright Machinery & Supply Co., Atlanta, Walraven Co.; Birmingham, Young & Vann Co.; New Orleans, Oliver H. Van Horn Co.; Seattle, Portland, Ore., San Francisco, Los Angeles, Eccles & Smith Co.; Montreal, Canadian Fairbanks-Morse Company, (head office) for all Canada.

IT PAYS TO SPECIALIZE

THE MACHINE THAT IS EXACTLY SUITED TO ONE JOB WILL NOT DO FOR SOME OTHERS



No. ½
Speed 12000 R. P. M.
No Vibration
No Heating

Specially designed for very light drilling where speed is the essential. Eliminates Twist Drill Breakages.

Get the Right Machine for Your Work

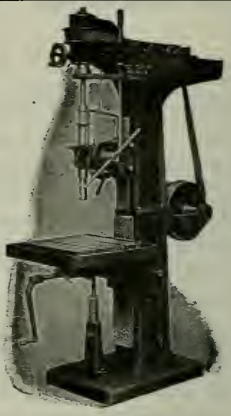
THERE ARE 8 OTHER SIZES AND TYPES OF

Avey

Ball Bearing Drilling Machines

Each Particularly Suited to Certain Classes of Work

These include: 4 sizes standard manufacturing type, 2 sizes—tool room, round table types and automatics. Let's talk it over. Give us your inquiries.



No. 3, Heavy Duty
Will drill holes ¾" to 1⅛" at highest speeds, assuring clean work

THE AVEY DRILLING MACHINE CO., CINCINNATI, O.



THE MORRIS RADIAL

is a Popular Machine in the Plants of Pump and Compressor Manufacturers

Quick positioning, speed, accurate work—all are important points in the drilling, boring, reaming, etc., of pump and compressor parts. That's what the Advance Pump & Compressor Co., Battle Creek, Mich., will tell you—that's why they use the Morris Radial Drill.

The Morris is shown here drilling 15/16" holes in "Advance" pump heads, work which it handles with both speed and precision. Write for Catalog.

THE MORRIS MACHINE TOOL COMPANY

CINCINNATI OHIO, U. S. A.

REPRESENTATIVES: Niles-Bement-Pond Company, 111 Broadway, New York City, N. Y., Boston, Mass., Chicago, Ill., Detroit, Mich., Philadelphia, Pa., Pittsburgh, Pa., Plainfield, N. J., St. Louis, Mo. Niles Tool Works Co., Cleveland, O., Hamilton, O. Pratt & Whitney Company, 16 Fremont St., San Francisco, Cal., Birmingham, Ala., Cincinnati, O. The John Bertram & Sons Co., 1002 C. P. R. Building, Toronto, Ontario, Montreal, Quebec, Dundas, Winnipeg, Manitoba. The Selson Engineering Co., Ltd., London, England and Turin, Italy. Messrs. Glaenzer & Perreaud, Paris, France. Henri Benedictus, Brussels, Belgium. The Taisho Trading Co., Ltd., Tokyo, Japan. A-B Sigfr. Andersson & Co., Malmo Sweden and Christiania, Norway.

A Hammond Radial, of Course

HAMMOND HIGH SPEED RADIAL DRILLING AND TAPPING MACHINES

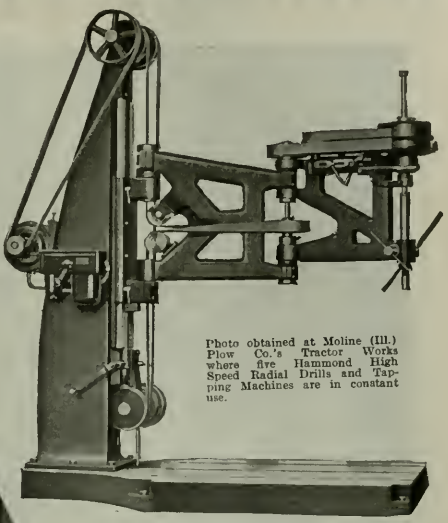
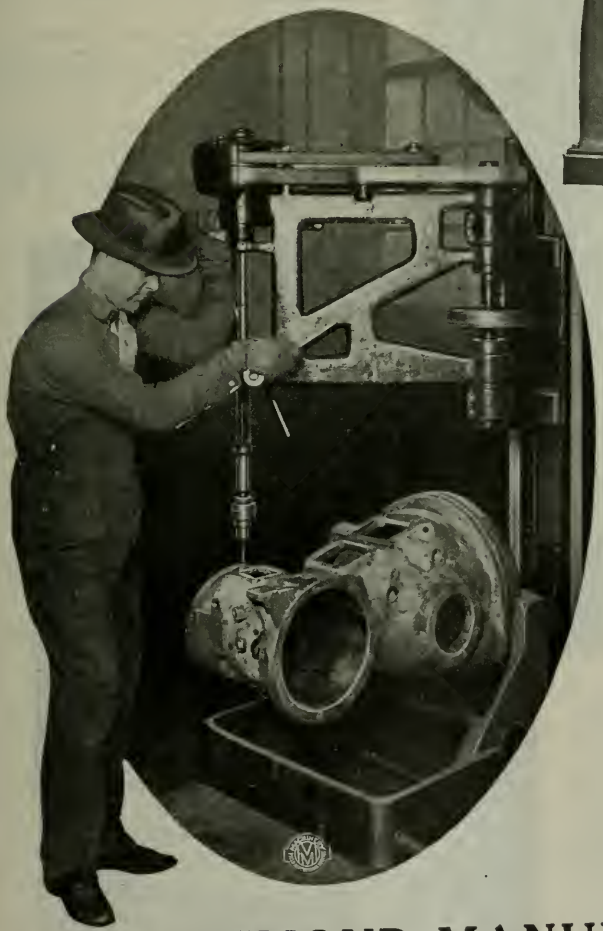


Photo obtained at Moline (Ill.) Plow Co.'s Tractor Works where five Hammond High Speed Radial Drills and Tapping Machines are in constant use.



Thirty-two Holes, Three Positions, Eight Minutes—Floor to Floor

The work is 300 lbs. cast-iron transmission cases, the operation as follows:

12 holes tapped ⅜", 16 U. S. standard, ¾" deep.
1 hole tapped for ⅛" pipe, Briggs standard.
2 holes tapped ½", 13 U. S. standard, 1" deep.
17 holes tapped $\frac{7}{16}$", 14 U. S. standard, 1" deep, blind.

The case is mounted on an indexing fixture and indexed twice during the above cycle of operations, which makes the output seem impossible to anyone not familiar with the speed and flexibility of Hammond Radial Drilling and Tapping Machines.

We'll be glad to describe them.

THE HAMMOND MANUFACTURING CO.

CLEVELAND OHIO, U. S. A.

FOREIGN REPRESENTATIVES: Fenwick Freres & Company, France and Belgium. Burton, Griffiths & Co., British Isles, Andersen, Meyer & Co., China. Andrews & George Company, Japan.

Minster Hi-Duty Drills



Show Accuracy, Range and Speed on a Wide Variety of Work in This Shop.

Houston, Stanwood and Gamble Company (Covington, Kentucky), specialists in the construction of heavy duty machines, use their Minster Drills on an ever-increasing range of work. Lack of suitable jigs and fixtures has limited the size of holes tapped to 4"—as soon as the necessary tools are completed the production manager expects to machine 6" holes without difficulty.

Versatile machines that meet production demands without difficulty, Minster Hi-Duty Drills add to the capacity of the plant in which they are used. Let us tell you more about them.

The photograph shows this Minster Drill drilling a 2½" hole in a 40-point carbon steel gear blank 9" in diameter and 2½" thick. The Drill is driven at a rate of 250 R.P.M., and the operation is completed in just two minutes.



THE MINSTER MACHINE CO.

MINSTER OHIO, U. S. A.

DOMESTIC AGENTS: Barbour, Love & Woodward, Inc., 149 Broadway, New York. Machine Tool Engineering Co., 149 Broadway, New York. Syracuse Supply Co., Syracuse, N. Y. Syracuse Supply Co., Buffalo, N. Y. Syracuse Supply Co., Rochester, N. Y. Monarch Machinery Co., Philadelphia, Pa. J. S. Miller Machinery Co., Pittsburgh, Pa. Saxer Machinery Co., Erie, Pa. Cleveland Tool & Supply Co., Cleveland, O. E. A. Kinsey Co., Cincinnati, O. E. A. Kinsey Co., Indianapolis, Ind. W. J. Baird Mchy. Co., Detroit, Mich. McMullen Machinery Co., Grand Rapids, Mich. W. M. Pattison Supply Co., Toledo, O. Federal Machinery Sales Co., Chicago, Ill. Federal Machinery Sales Co., Milwaukee, Wis. Colcord-Wright Mchy. & Supply Co., St. Louis, Mo. Herberts Mchy. & Supply Co., San Francisco, Cal. Herberts Mchy. & Supply Co., Los Angeles, Cal. Wilcken-Schenk Co., Seattle, Wash. Zimmerman-Wells-Brown Co., Portland, Ore. Savage & Winter Co., Pioneer Bldg., St. Paul, Minn. Manufacturers Selling Agency, Birmingham, Ala. Oliver H. Van Horn Co., Inc., 518 Camp St., New Orleans, La. FOREIGN AGENTS: Henri Benedictus, 133 Rue Du Progress, Brussels, Belgium. Coat's Machine Tool Co., 14 Palmer St., London, England, (110-112 W. 40th St., N. Y.). Pedro Merlini, Buenos Aires, Argentine, Quinones Hardware Corp., Havana, Cuba. R. S. Stokvis & Zonen, Inc., Whitehall Bldg.; 17 Battery Place, New York; France. CANADIAN AGENTS: Williams & Wilson, Ltd., Montreal, Quebec.

THE DEFIANCE HEAVY SERVICE DRILLING MACHINE



A few of the important features of this machine are:

It is entirely enclosed—permitting a gravity oiling system.

Roll-in gear mechanism for changing speeds.

Helical Gears for driving spindle.

Send for illustrated and descriptive matter covering this machine.



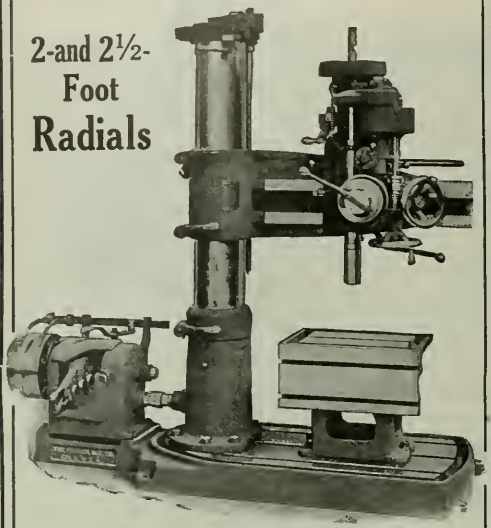
THE DEFIANCE MACHINE WORKS

DEFIANCE, OHIO, U. S. A.

NEW YORK LONDON

FOSDICK

2-and 2½-Foot Radials



Powerful, Well-built Machines With a Reputation for Speed

All geared, high speed radials, liberally supplied with ball bearings and phosphor bronze bushings, conveniently controlled and amply lubricated. No countershaft is required. A simple, positive speed box furnishes 12 speeds without stopping the machine—ample for drills from ⅜" carbon to 2½" high speed steel, and for boring up to 5"—with but one speed at the pulley. Back gears, located on the head between the spindle driving gears and the reverse friction, are shifted by a single lever in front of head.

You'll want to know more about these machines. Let us send details and test sheets of actual performances.

The Fosdick Machine Tool Co.

CINCINNATI OHIO, U. S. A.

AGENTS: Biggs-Watterson Co., Cleveland, Ohio. Colcord-Wright Mchy. & Supply Co., St. Louis, Mo. Eccles & Smith Co., San Francisco, Cal., Los Angeles, Cal., Portland, Oregon. Fairbanks Co., New York City, N. Y., Hartford, Conn., Albany, N. Y. Barbour, Love & Woodward, New York City, N. Y. E. A. Kinsey Co., Cincinnati, Ohio, Indianapolis, Ind. Homer Strong, Rochester and Buffalo. Peninsular Machinery Co., Detroit, Mich. H. A. Smith Mchy. Co., Syracuse, N. Y. Swind Machinery Co., Philadelphia, Pa. Somers, Fitler & Todd Co., Pittsburgh, Pa. (radials only). Stocker-Rumely-Wachs Co., Chicago, Ill.; Milwaukee, Wis. Taylor Machinery Co., Boston, Mass. A. R. Williams Mchy. Co., Ltd., Toronto, Ont., Canada. Burton Griffiths & Co., Ltd., London, England. Fenwick Frerea & Co., Paris, France. Wynmalen & Hausmann, Rotterdam, Holland. Rylander & Asplund, Stockholm, Sweden. Wilh. Sonesson & Co., Malmo, Sweden, Copenhagen, Denmark. Alfred Herbert, Ltd., Tokyo, Japan. R. L. Scrutton & Co., Sydney, Australia.

FOSDICK

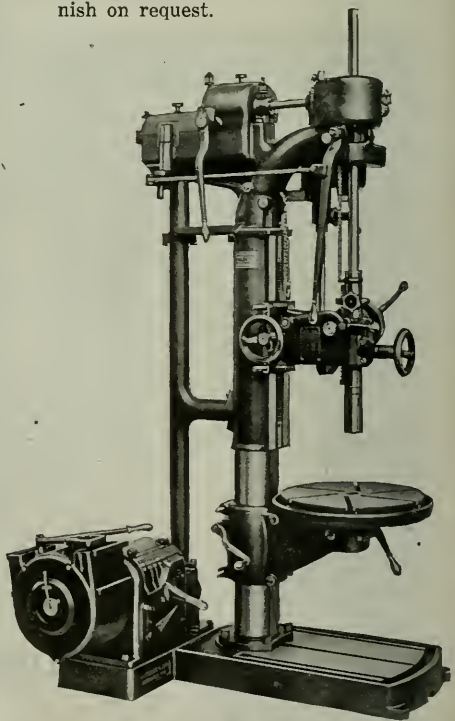
Upright Drilling Machines

Higher production standards necessitate higher grade machines, and this exceptionally well made drilling machine is the logical solution of many modern drilling problems.

The friction tapping mechanism, for example, provides six times the usual tapping power, and permits withdrawing tap at four times entering speed.

There is only one speed at the pulley, but an ample supply of speeds for drilling up to 2½" is available without stopping the machine.

Positive depth gauge, automatic trip, quick return, provision for feeding tools by hand without disengaging the power feed are among the features described in our new catalog, which we'll be glad to furnish on request.



The Fosdick Machine Tool Co.

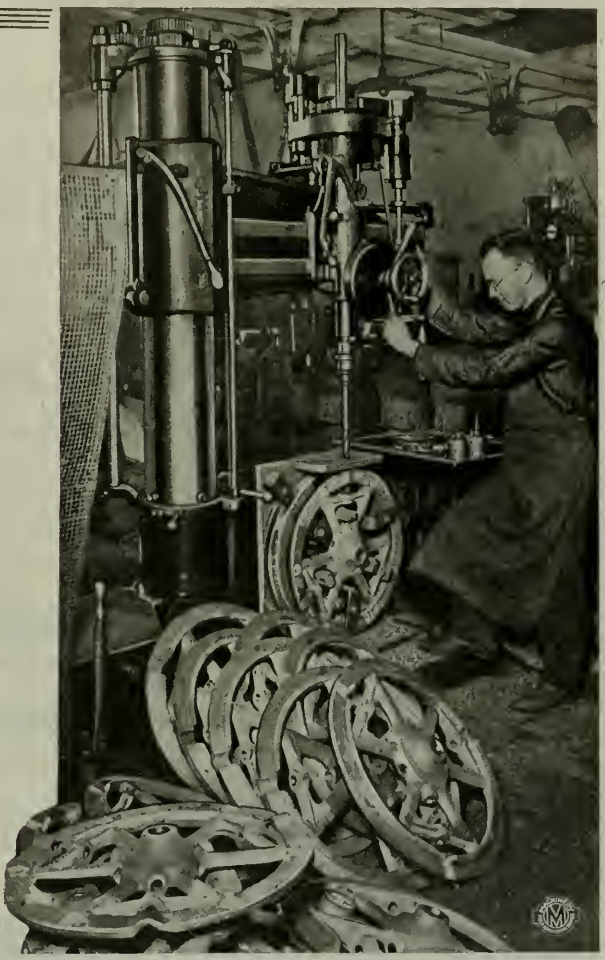
Cincinnati, Ohio

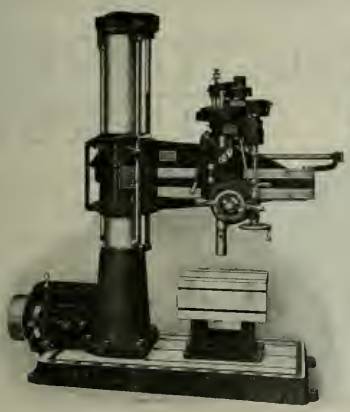
Drilling Ring Gear Centers

on the

MUELLER RADIAL

Six holes are drilled in each ring gear center — two on each of three center lines. An indexing jig is used to locate the holes, which are 7/8" diameter. The power and convenience of the Mueller Radial Drilling Machine make this a real production job. Output is seven completed ring gear centers—42 holes—per hour, including handling, clamping and indexing time.





It was because of its reputation for "getting out the work" that this three-year-old Mueller Radial was assigned to this job. The reason, also, for the purchase of another "Mueller" soon after the first was installed in the La Crosse (Wis.) Tractor Company's shops.

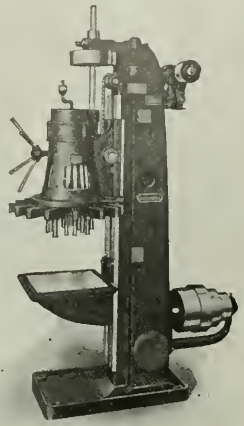
The power of the Mueller Radial centers in its patented one-piece column, reinforced its full length with four internal webs, and the long bearing of the arm on the column.

Exclusive operating conveniences and other features well worth investigating will be fully described on request.

THE MUELLER MACHINE TOOL CO.

RADIAL DRILLS AND LATHES

Cincinnati Established 1902 Ohio, U. S. A.



"A Machine of Compound Energy!"

That's the way one superintendent described a "Harrington." And he hit the nail on the head.

Harrington Multiple Spindle Drills are *crammed brimfull with energy.* They take the place of any number of ordinary "one-hole-at-a-time" drills.

HARRINGTON

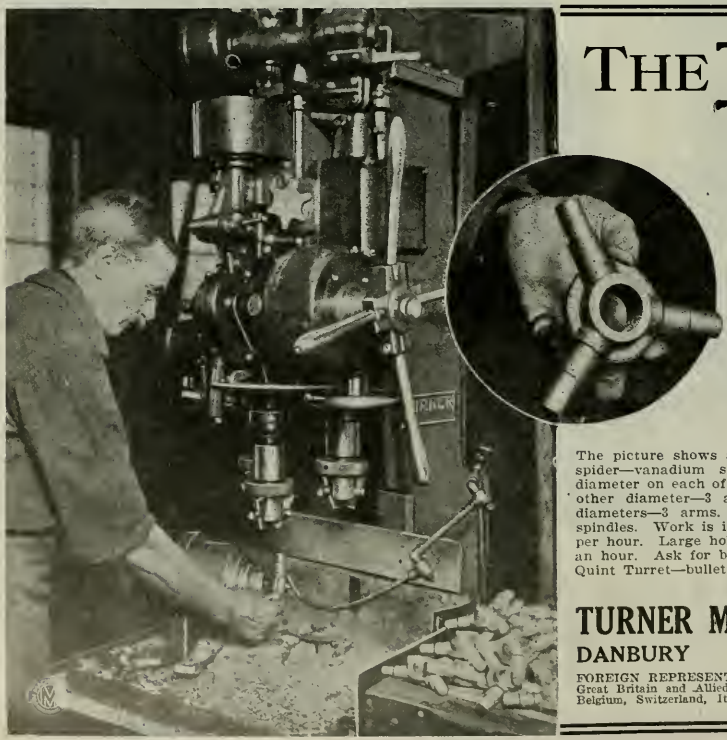
Multiple Spindle Drills

are accurate, speedy and powerful. They save floor-space, man-power and time. Their installation means *immediate* increased production.

Write for interesting Machine Tool Bulletin to-day.

EDWIN HARRINGTON, SON & CO., Inc.

PHILADELPHIA, PA.



THE TURNER TURRET

The Turner Turret is in reality a vertical turret lathe with many natural yet unusual and distinctive advantages.

The Turner Turret performs all operations at one setting of the work, and affords a convenience and adaptability uncommon to the lathe. Particularly valuable in production of duplicate parts.

The picture shows a Turner Turret on a differential spider—vanadium steel—(1) rough hollow mill one diameter on each of three arms (2) rough hollow mill other diameter—3 arms (3) finish hollow mill both diameters—3 arms. Simple touch on lever indexes spindles. Work is indexed 9 times. Production is 12 per hour. Large hole—drill, ream, face both sides, 50 an hour. Ask for bulletin IPT. Also builders of the Quint Turret—bulletin IPQ.

TURNER MACHINE COMPANY

DANBURY CONNECTICUT, U. S. A.

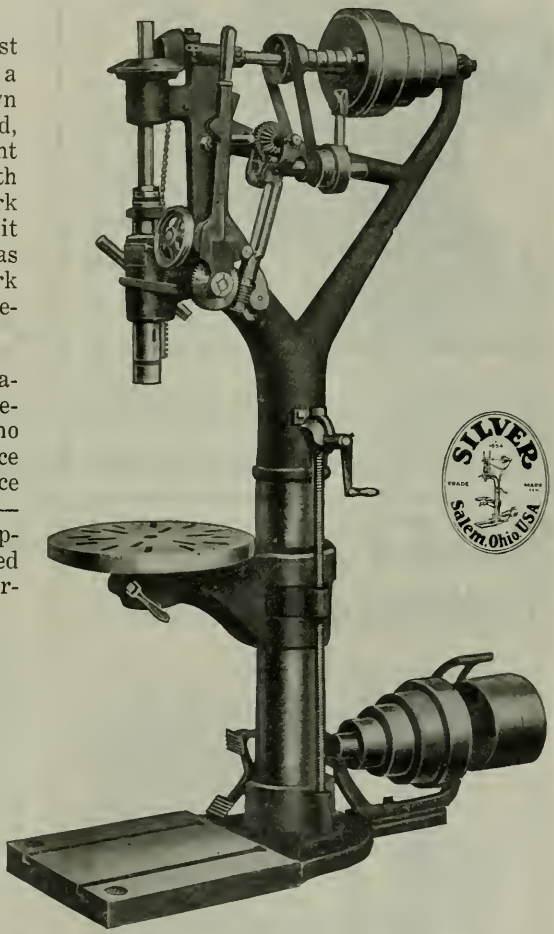
FOREIGN REPRESENTATIVES: Burton, Griffiths & Co., Ltd., for Great Britain and Allied Machinery Company of America for France, Belgium, Switzerland, Italy, Spain, Portugal.

Do machines get hard usage in your plant?
Then you will appreciate the story of

"SILVER DRILLS IN SERVICE"

The first machine set up in the first machine shop of the A. E. F. was a Silver 20″ Drill of the type shown here. It ran "Spattered with mud, drenched with rain, frozen at night and thawed by day, lubricated with any oil available——, used for work beyond its capacity or for which it was never designed," as long as it was needed; "it produced accurate work with speed——gave no trouble, required no repairs nor ever failed."

Such treatment for a high grade machine tool has never before been recorded—but necessity here left no time for care. There is no chance that the most careless shop practice would make demands such as these—yet the fact that this Silver 20″ upright Drilling machine "shouldered through without a grunt" is important to every machine tool buyer.



Silver Drills, rapid and accurate, ready for any emergency and rarely in need of repairs are made in 20″ and 25″ sizes—set up singly or in gangs. Described in our machinery catalog No. 63.

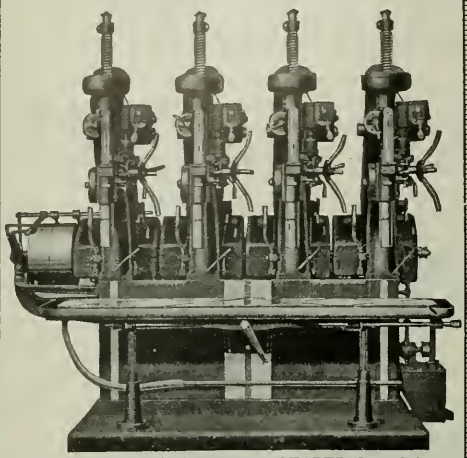
Our booklet "Silver Drills in Service" is yours for the asking; an interesting record of an interesting time, it is well worth reading—and keeping. May we send it to you?

THE SILVER MFG. COMPANY

385 Broadway SALEM, OHIO

London Paris Brussels New York Genoa Sydney Cape Town

Strictly A High Production Machine Tool



It is our 24-in. Self Oiling ALL GEARED Box Column Gang, independent geared speeds and geared feeds—eight changes of each on each spindle; also Multiple Disc Clutch Drive. Great power, speed and productive capacity. Send at once for catalog "M."

Barnes Drill Co., 814 Chestnut St., Rockford, Ill.
Inc., 1907

AGENTS FOR GREAT BRITAIN: Burton, Griffiths & Co., Ltd., London, E. C. FRANCE: R. S. Stokvis & Fils, Paris. JAPAN: Roku-Roku Shoten, Tokio. ITALY: Alfred Herbert, Ltd., Milan. SPAIN: American Machinery Syndicate, New York, Barcelona, Madrid, Seville, Bilboa, Gijon, Santander. NEW SOUTH WALES: R. L. Scrutton & Co., Sydney. BELGIUM: G. & F. Limbourg Freres, Brussels.

Rockford Horizontal Drilling Boring and Tapping Machine

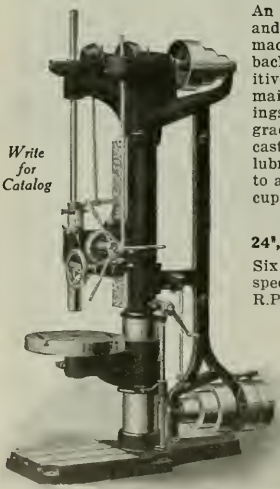
No machine in this field brings a more practical combination of strength, rigidity, endurance, accuracy and speed to its work than does the Rockford.

It has the advantage of close alignments, delicate adjustment and enormous pulling power which make it the choice for a wide range of work. It is especially adapted for the production of automobile and similar parts and is equally at home machining fine jigs.

Write for details.

THE ROCKFORD DRILLING MACHINE Co. · ROCKFORD · ILL., U.S.A.

SIBLEY HEAVY PATTERN SLIDING HEAD Drilling Machine



Write for Catalog

An unusually heavy and powerful upright machine with double back gearing and positive geared feed. All main drive shaft bearings fitted with a high grade anti-friction die cast bearing. Ample lubrication is assured to all vital points by oil cups and reservoirs.

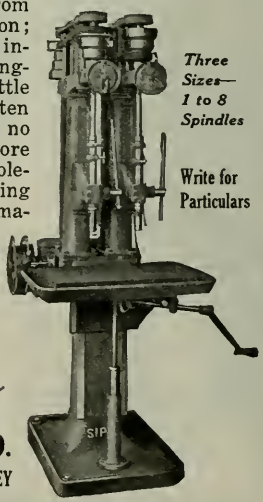
Manufactured in 24', 26' and 28' swing.

Six changes of spindle speed from 29 to 495 R.P.M. with four feeds to each speed, all selective, and 38" travel of head and table on column give exceptional capacity and range. Full description on request.

Manufactured by
SIBLEY MACHINE COMPANY
8 TUTT ST. SOUTH BEND, INDIANA, U. S. A.

Sipp Drilling and Conservation

Waste motion eats into production. Therefore waste motion is eliminated from the Sipp Drill Press, conserving the operator's energies for the special business of turning out work. Every move is made from the natural position; speed changes are instantaneous; changing belts is a little matter of about ten seconds. There's no simpler, faster, more accurate, less troublesome way of drilling than with Sipp machines.



Three Sizes— 1 to 8 Spindles

Write for Particulars

ITS A TRADE MARK SIPP

THE SIPP MACHINE CO.
PATERSON NEW JERSEY

SPEED — ACCURACY — CONVENIENCE

Demco DRILLS

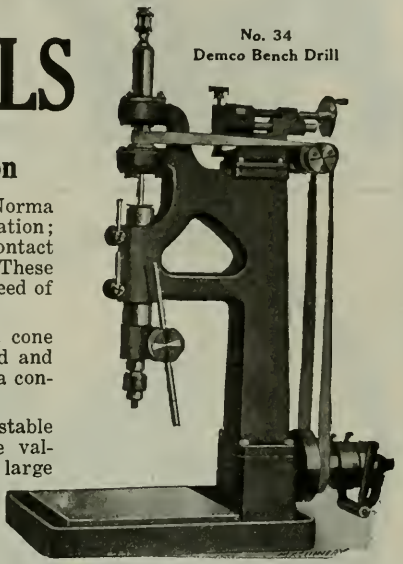
For Economical Precision Production

Heavy, carefully balanced construction insures rigidity; Norma Annular Ball Bearings throughout insure ease of operation; special automatic belt-take-up which keeps the belt in contact with the pulley at all times, insures a constant drive. These features enable Demco Drills to be run at a maximum speed of 12,000 R.P.M. practically without vibration.

Speed changes are quickly made by shifting belt on a cone pulley. Lubrication is provided by means of sight feed and spring oilers; belt-shifting is accomplished by means of a conveniently placed hand lever.

All Demco Drills are provided with the Demco Adjustable Quill Bracket and an improved Depth Gage, and are valuable in the production of extremely accurate work in large quantities.

For details of No. 34 and No 36 (Floor Type) Heavy Model Drills send for our circular.



No. 34
Demco Bench Drill

DEMCO MACHINE TOOL COMPANY
CLEVELAND OHIO, U. S. A.

Milwaukee Drill Presses



Standard equipment where power, speed and accuracy are in demand. Simple, convenient, and economical.

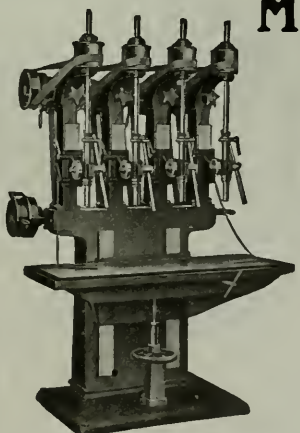
Complete description of Milwaukee Drill Presses on request.

Machine shown drills to center of 21¼" circle.

Richards Machine Co. 3417 VLIET STREET MILWAUKEE, WIS.

High-Grade Ball-Bearing

Sensitive Drilling Machine



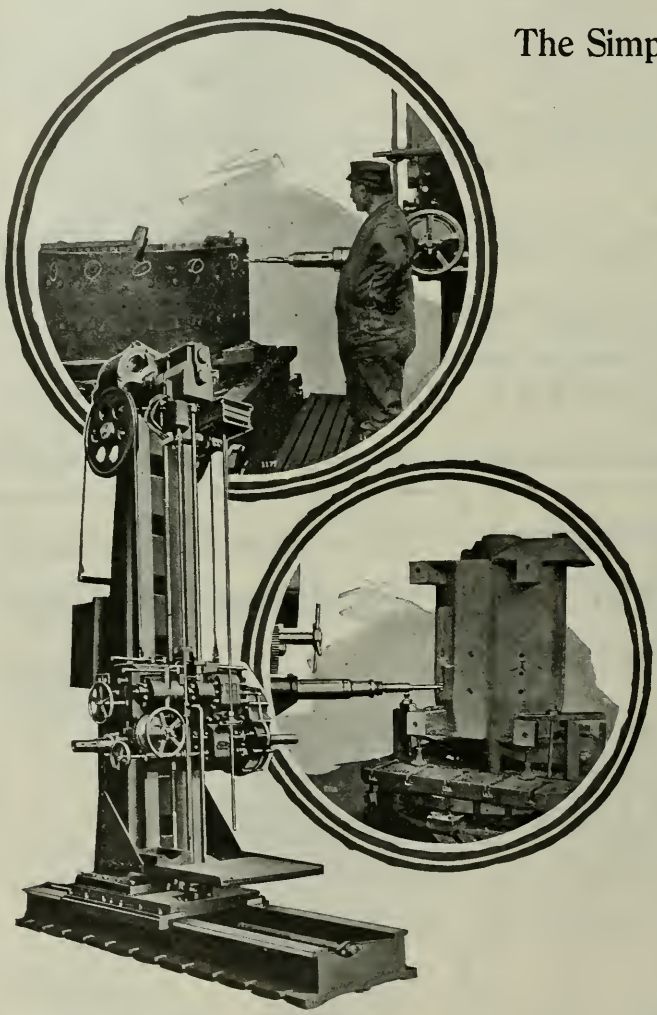
With One to Four Spindles, With ⅞" capacity

MANUFACTURED BY

FRANCIS REED COMPANY
43 Hammond Street Worcester, Mass.

P&H (HORIZONTAL) drilling and boring machines

CRANES - HOISTS - MONORAILS



The Simplicity of Efficiency

Machines, equipment, methods that are "just right" usually seem almost elemental in their simplicity—the highest degree of efficiency is reached where every waste motion, every superfluous part is eliminated. Accurate work and economical handling methods—prime necessities in the development of P&H Cranes, Hoists and Monorail systems—are assured by the horizontal boring and drilling machines and accessories developed by us to handle the heavy unwieldy pieces that make up our products.

The simplicity of these machines, their compact design and operating conveniences make them valuable equipment everywhere. Used with a work table mounted on a standard gage track (permitting the work to be transferred from one machine to the other without resetting) and such accessories as the turn table, offset drill arm, and facing head, their range and capacity are tremendously increased.

P & H Horizontal Drills and Boring Machines are made in two types and several sizes. Our Bulletin 214 describes these machines and their efficient accessories. May we send it?

PAWLING & HARNISCHFEGER CO.

MILWAUKEE Established 1884 WISCONSIN

50 Church Street, New York; 704 Stephen Gerard Building, Philadelphia; 926 Whitney Central Building, New Orleans, La.; 47 Fidelity Building, Pittsburgh, Pa.; 1241 Monadnock Block, Chicago, Ill.; Pittock Block, Portland, Ore.; 1125 Central Building, Los Angeles, 821 Monadnock Bldg., San Francisco.

GRANT RIVETING

7,800 Rivets per Hour
Real Time!



THIS Grant Riveter is working under almost ideal conditions of course, but even so, to the uninitiated the riveting speed must seem almost too good to be true.

The work on which this record is made is riveting Turbine Rotors at the Coppus Engineering Co., Worcester Plant. The Rotor comes to the operator assembled ready for riveting, all his time and attention are given to the actual operation.

Not only has the Grant Riveter sped this work from 520 rivets per hour (previous production by hand riveting), but the quality of the work has been greatly improved and manufacturing costs decreased.

Grant Rivets—tight and loose—insure durability and lasting satisfaction; Grant Riveters guarantee low manufacturing costs. Ask us about these machines.

GRANT MFG. & MACHINE CO.

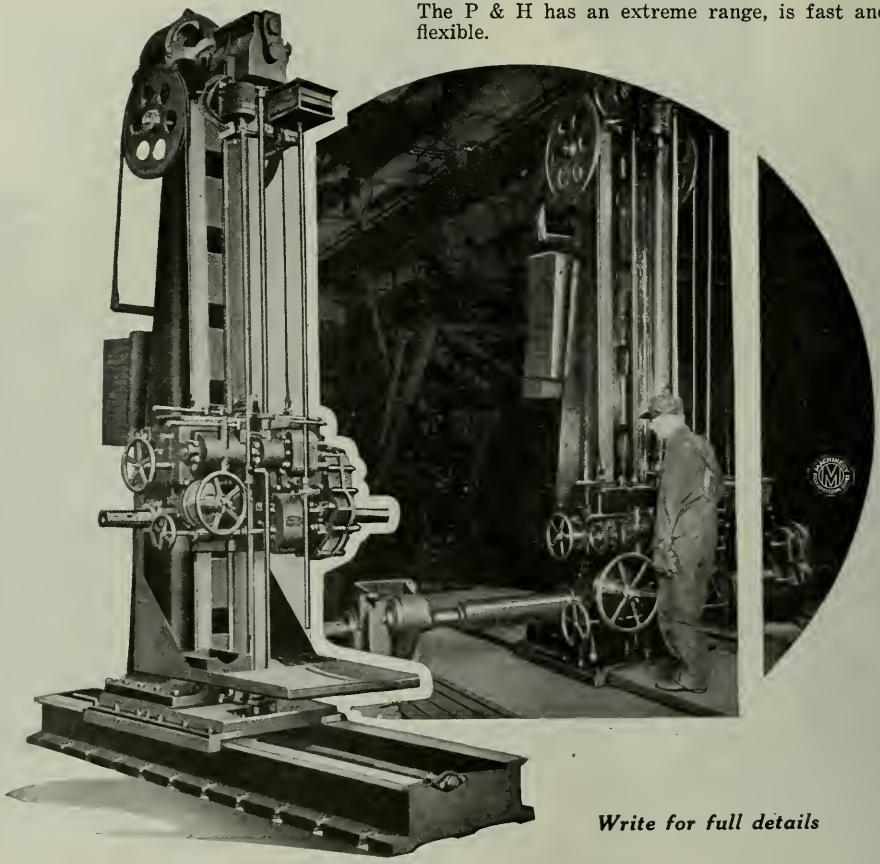
Bridgeport N.W. Station Conn., U. S. A.

P & H Horizontal Boring and Drilling Machines

Higher Standards—Greater Speeds on Many Important Operations

"A most satisfactory machine for our purposes," says the superintendent of the Ingersoll Milling Machine Co., Rockford, Ill. Remember that more than usual demands on equipment are made in this plant, and that no machine is kept if it doesn't pass every test. The P & H, however, filled the bill in every particular. Here it is boring a quill bearing for the saddle of an Ingersoll Milling Machine. Hole is 5¾" diameter, 19" long. The work is within 5 minutes of completion, and the man had been on it 1½ hours.

The P & H has an extreme range, is fast and very flexible.

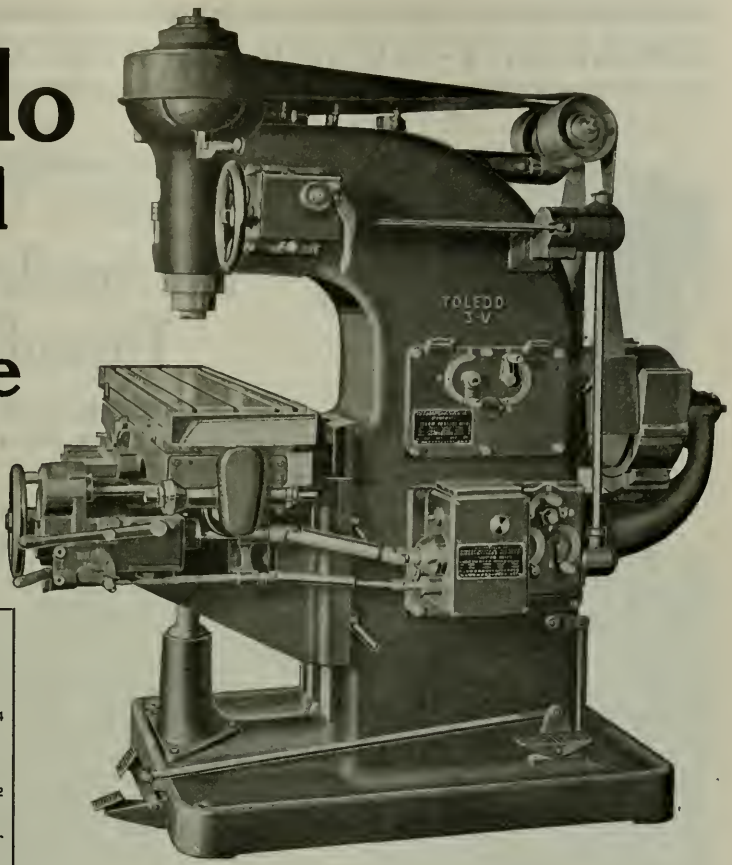


Write for full details

DALE-BREWSTER MACHINERY CO., Inc.

543 W. Washington Blvd., Chicago 56 Lafayette St., New York

Toledo Vertical Milling Machine



Specifications:

RANGE
Longitudinal Feed *46 inches.
Cross Feed *14 inches.
Vertical Adjustment (Knee) *14 inches.
Spindle Adjustment *6½ inches.
*Power Feeds.
Max. Throat Distance 19 inches.
Max. Distance Spindle to Table 22 inches.
Net Weight 7000 lbs.
Sixteen Feeds .004 to .710 per revolution of spindle.
Sixteen Speeds 18 to 411 R.P.M.

GET TOLEDO MILLING FACTS DON'T TAKE ANYTHING FOR GRANTED

There is an old man up in Michigan who wound his clock every night for twelve years before he found out it was an eight-day clock. That old man is the type who takes things for granted—and fails to investigate.

Is that the way you buy milling equipment? Do you take it for granted that your present installation is the best the market offers, or do you know all about the Toledo Vertical Milling Machine?

If you don't know the Toledo Vertical Milling Machine then you owe it to yourself and your business to get first-hand information on what it will do in boosting your production, cutting manufacturing costs and reducing overhead. The marked improvements in the new Toledo Vertical Miller are the result of years of engineering research and achievement, and of a careful study of the user's practical needs.
There are numerous other reasons why—write for them.

THE TOLEDO MILLING MACHINE COMPANY

TOLEDO OHIO, U. S. A

SMALLEY-GENERAL PERFORMANCES



Interchangeable Threads Costing Too Much?

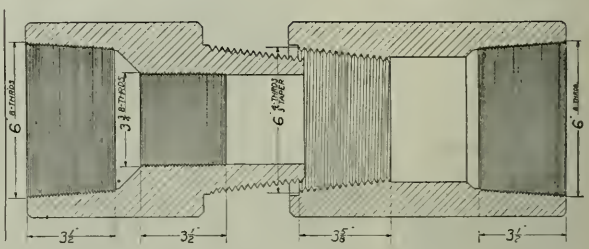
The Smalley-General Thread Miller

Will Help You Out As It Has Many Others

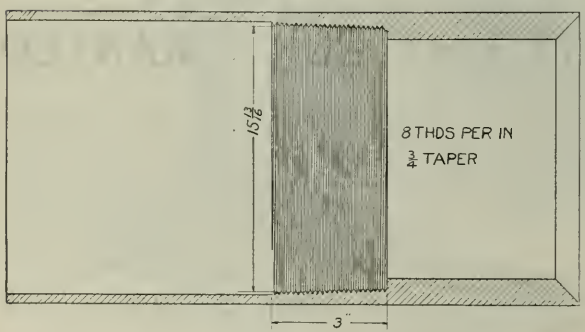
For Example—

The pin and box, of which a sketch is here shown was threaded in a lathe in an hour and a half. On a Smalley-General Thread-miller furnished with a suitable hob floor-to-floor time on each piece dropped to six minutes. Material is .20 Carbon Steel; thread is 3¾″ diam., 4″ long, 6-pitch U. S. S., with 3″ taper per foot. Milling speed is 4½″ per minute and a hand-operated screw chuck is used.

If it were desired to face the surfaces where pin and box come together true with the thread to provide the proper spacing for the feeler, the suitable speed could be instantly obtained.



The drive-shoe detailed below furnishes another typical Smalley-General triumph. The thread is 16¼″ diameter, 3″ long, 8-pitch Briggs Standard taper. Material is .55 Carbon steel, an air collet chuck is used and a 7″ milling feed. Seven minutes floor-to-floor completes this operation which took 36 minutes on the lathe.



Smalley-General Thread Millers

Mill internal or external, right- or left-hand, straight or tapered threads in quantity, with unparalleled speed and economy.

Smalley-General Thread Millers will be sold only with the approval of our Engineering Department. A guaranteed production estimate will be furnished with each machine. In case a machine should fail to perform and produce according to our guarantee, the purchaser will have the unquestioned right to cancel the sale.

SMALLEY-GENERAL COMPANY, Inc.

SMALLEY PLACE BAY CITY, MICH.

This Woodward & Powell Planer

Is Roughing and Finishing Machine Beds at an Average of One per Hour

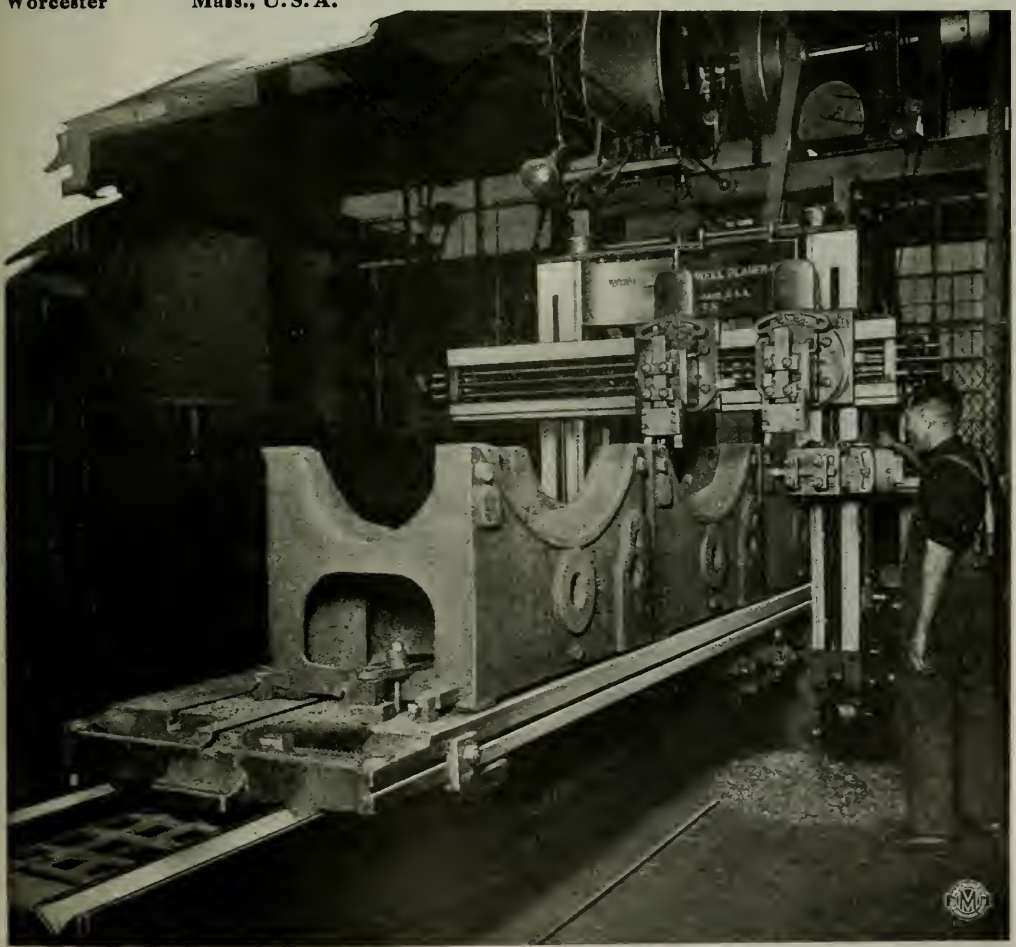
The Gleason Works, of Rochester, New York—builders of powerful, accurate machines—use this big Woodward & Powell for heavy planing of all descriptions.

The photograph shows it roughing and finishing beds for bevel gear planers—three heads and five tools working simultaneously finish an average of three beds in three hours without taxing the machine. Accurate work, careful construction, easy accessibility of all working parts and quick, smooth, convenient operation make Woodward & Powell Planers popular in all shops where quality *plus* production is the rule.

WOODWARD & POWELL PLANER COMPANY

Worcester Mass., U.S.A.

Standard and Heavy Types
Belt or Motor Drive



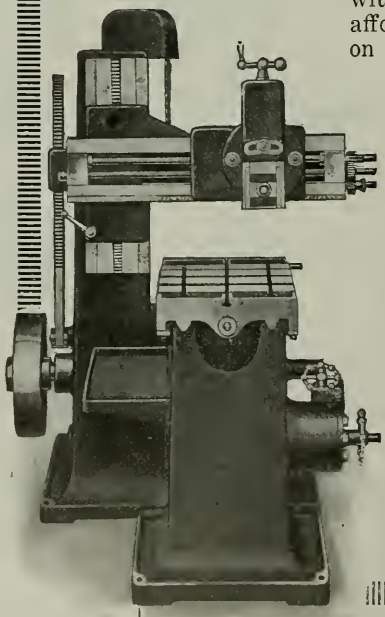
A Machine You'll Want to Own

The Coulter Tool Room Open Side Planer

Like the handyman of the "good old days," the Coulter Toolroom Planer accomplishes a wide variety of odd jobs which standard toolroom equipment lacks the power, speed or capacity to handle to advantage—bridges the gap between shaper and planer and fills an important and well-recognized need in the modern toolroom.

Combining the accuracy of the planer with the speed and convenience of the shaper, this machine has sliding gears equipped with S. K. F. Ball Bearings, easily shifted to provide four speeds of table for each length of stroke—a suitable speed for every class of work and metal, from fine steel dies to heavy brass fittings.

The advantages of the open side are obvious, also the convenience of the large, carefully gibbed table, equipped with three tee-slots and the rigidity afforded by the ample sliding surfaces on cross rail and column.



Material is of the best throughout and workmanship such as to place it unreservedly in the toolroom class. Principal dimensions include Table, 46½" by 17½"; center to center of ways, 11"; length of saddle on cross-rail, 14"; diameter of swivel head, 10"; height from table to floor, 36"; cross rail traverse, 20"; table traverse, 24". Complete description in circular—sent on request.

THE AUTOMATIC MACHINE COMPANY

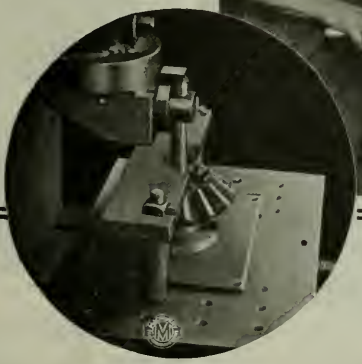
BRIDGEPORT CONN., U. S. A.

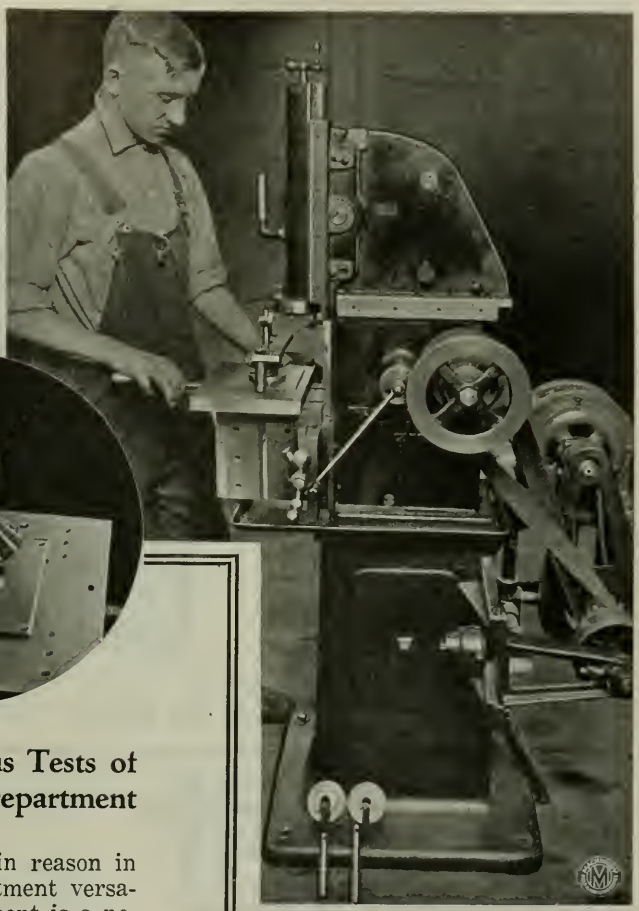
OVER-SEAS REPRESENTATIVE

ALMACOA ALLIED MACHINERY COMPANY OF AMERICA 51 CHAMBERS ST. NEW YORK, U.S.A. ALMACOA

PARIS TURIN ZURICH BARCELONA

The RHODES COMBINED SHAPER AND SLOTTER





Passes the Strenuous Tests of the Experimental Department

For keeping costs within reason in the experimental department versatile machine tool equipment is a necessity. And this is where the Rhodes combined Shaper and Slotter fits. It has a wide field of usefulness, being equally efficient in both vertical and horizontal planes. It comes equipped with a rotary table and vise.

Used in the plant of the Sampson Tractor Company, Janesville, Wisconsin, for numerous keyseating, slotting and light shaping jobs, this "Rhodes" is always busy, and the foreman of the experimental department is more than pleased with the performance.

Photograph shows the "Rhodes" cutting a ¼" x 3/32" keyway in a grey iron mitre pinion for a corn picker. This pinion is 1" face, and is bored to ⅞" through a hub 2" in depth.

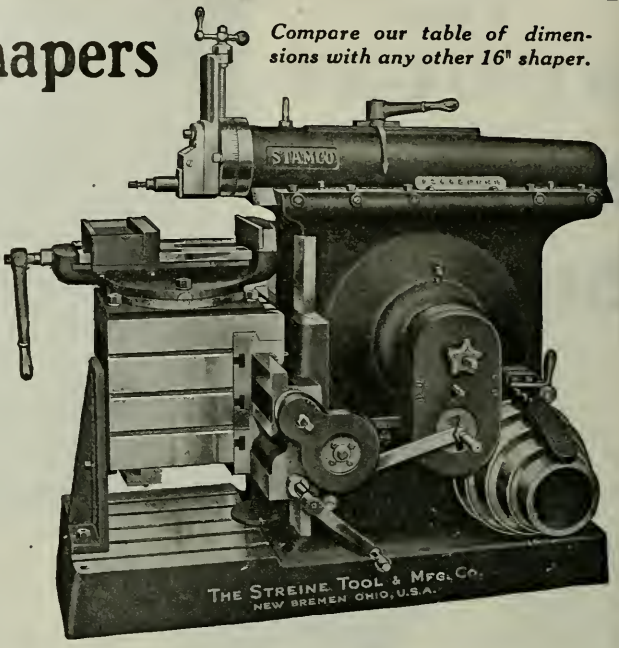
The Rhodes Combined Shaper and Slotter operates in two planes: horizontal and vertical. It is either a 7" shaper or a 3½" slotter at will. The "Rhodes" is two machines in one at the price of one. Write for full particulars.

The Rhodes Mfg. Co.
Hartford Dept. 101 Connecticut

Stamco Shapers

Compare our table of dimensions with any other 16" shaper.

Base is of extended type.
Column of extra depth and width having lower center of gravity.
Bull Gear Bearing is cast solid in frame having bearing surface of 205 square inches.
Bull Pinion and Intermediate Gears are assembled in unit same as in planer construction.
Machine Pulley rotates in sleeve bearing.
Rail is fastened to dovetailed slide same as in milling machine construction.
Ram is extra long and also has a dovetailed slide.
Saddle designed with narrow guide.
Table is hooked over saddle thus relieving table bolts of thrust.
Table Elevating Screw is of Telescopic construction.
Feed can be varied or reversed instantly without stopping machine.



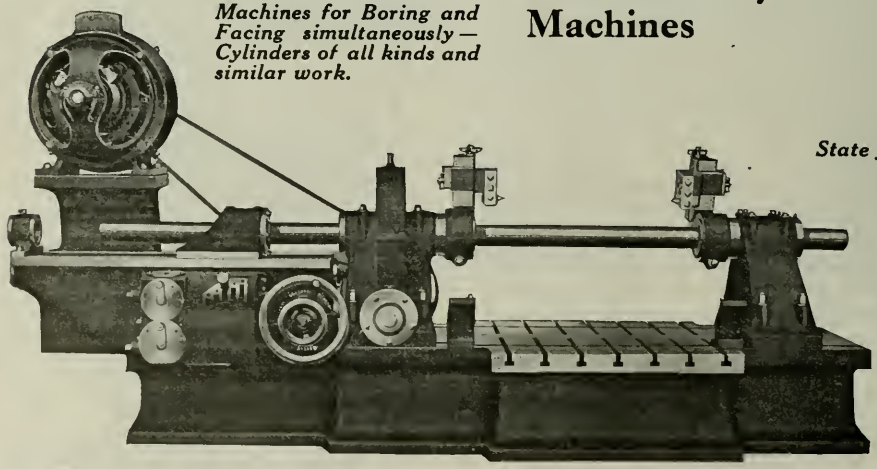
THE STREINE TOOL & MFG. CO., New Bremen, Ohio

Barrett

For Thirty-Eight Years—Builders of "BARRETT" Horizontal Cylinder Boring Machines

Machines for Boring and Facing simultaneously—Cylinders of all kinds and similar work.

State your requirements



BARRETT MACHINE TOOL CO., Meadville, Pa., U. S. A.

Automatic Screw Driving

With a Reynolds Magazine-fed Machine Saves Time and Labor

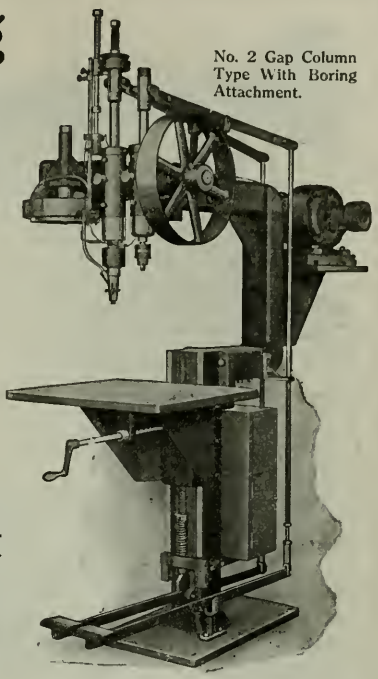


In one-third the time it takes your most experienced hand worker to accomplish the same task, an unskilled boy can drive screws or bolts of any three consecutive sizes accurately to any desired depth with the Reynolds Screw Driving Machine, and produce a more ship-shape and accurate job into the bargain.

Screws are dumped loose into a hopper and sorted and fed automatically. Release is by foot-lever which leaves the operator's hands free to position the work and an average of 800 to 1,200—sometimes 2,000—screws per hour is readily obtained.

This machine is indispensable where screws or bolts are set in large quantities. It increases output and lowers assembling costs to a degree well worth investigating.

Give us dimensions over all of your work and gauges and lengths of screws or bolts used, and we'll recommend the "Reynolds" best adapted for the job and furnish details and estimated production.

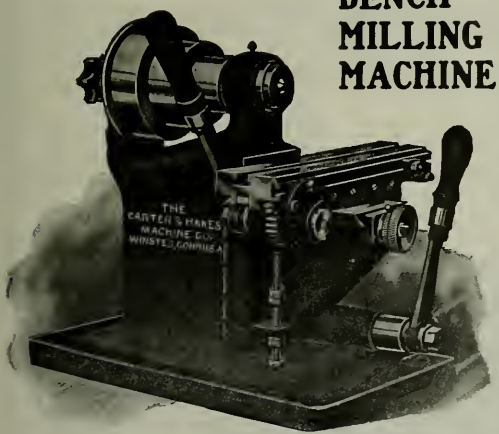


No. 2 Gap Column Type With Boring Attachment.

THE REYNOLDS MACHINE CO.

MASSILLON Dept. M OHIO, U. S. A.

BENCH MILLING MACHINE



For Small Work in Large Quantities

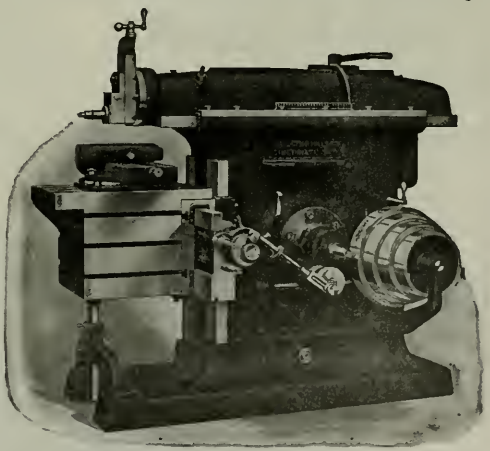
This machine is built with the same care as our larger millers; it is accurate and right in every particular; highly profitable on a wide variety of small work. Can be had with floor column if desired. Ask for complete description.

THE CARTER & HAKES COMPANY

Sterling Place WINSTED, CONNECTICUT

WE CONFINE OURSELVES TO BUILDING

Shapers Exclusively

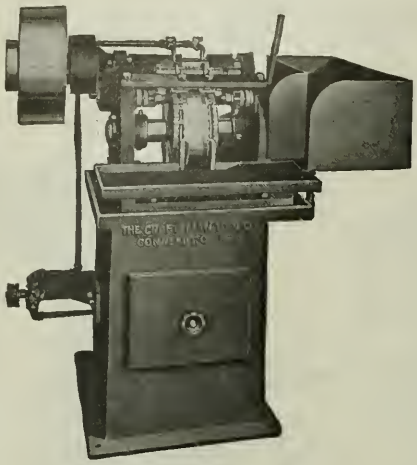


Crank Sizes: 12, 14, 16, 20, 25, 28 and 32 inch
Either Cone Driven or through Speed Box

The Smith & Mills Company

CINCINNATI OHIO, U. S. A.

FOREIGN AGENTS: G. & F. Limbourg Freres, Brussels, Belgium; Burton, Griffiths & Co., Ltd., London, England; Van Rietschoten & Houwens, Rotterdam, Holland; Reid Brothers (Johannesburg) Ltd., Johannesburg, South Africa; J. Lambercier & Co., Geneva, Switzerland; Zurich, Switzerland; V. Loewener, Copenhagen, Denmark; Christiania, Norway; Stockholm, Sweden; H. P. Gregory & Co., Sydney, N. S. W., Rene Berndes Co., Havana, Cuba; Horne Company, Ltd., Tokyo, Japan; Daniele Stussi, Milan, Italy.



Craftsman Rotary Miller No. 2

Send parts or prints for production estimates

CRAFTSMAN
Continuous Rotary Miller

It Cuts Slots on Small Parts

What are you manufacturing? Make a mental picture of its parts—any small slotting? How do you do it?

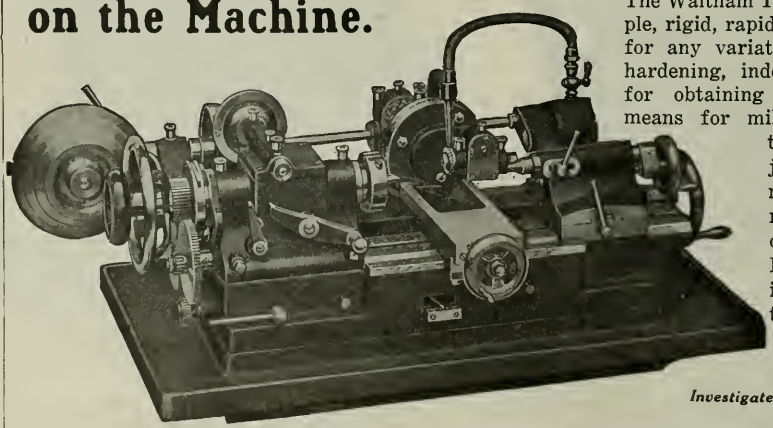
And now consider the Craftsman Continuous Rotary Miller. It cuts slots on nuts and other small parts in bulk.

Revolving chuck consisting of three steel plates can be adapted to hold a wide range of styles and sizes of parts. Look into this proposition—do it now.

THE CRAFTSMAN TOOL COMPANY
CONNEAUT OHIO, U. S. A.

The Milled Thread Leads for Quality. Its Cost Depends on the Machine.

One of the most dependable and economical thread millers in use is the reliable "Waltham," designed and constructed to handle the finest class of work—standard and special taps, thread gauges, etc.



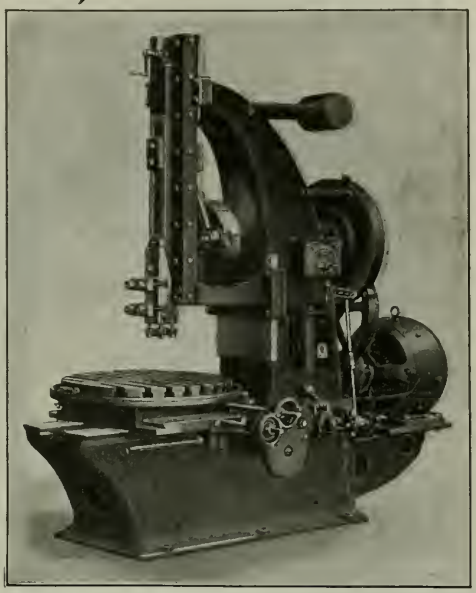
The Waltham Thread Miller is simple, rigid, rapid; has compensation for any variation of the lead in hardening, index of 12 divisions for obtaining multiple threads, means for milling square sided threads and for adjusting cutter to match threads already cut. Can be operated in battery. Ideal manufacturing, experimental or tool-room machine.

Investigate Waltham Advantages

WALTHAM MACHINE WORKS, - Newton Street, Waltham, Mass.
Small Thread Millers, Gear Cutters and other Small Automatic Machines

William Sellers & Co., Incorp. Philadelphia, Pa.

LABOR SAVING MACHINE TOOLS



Sellers Slotters

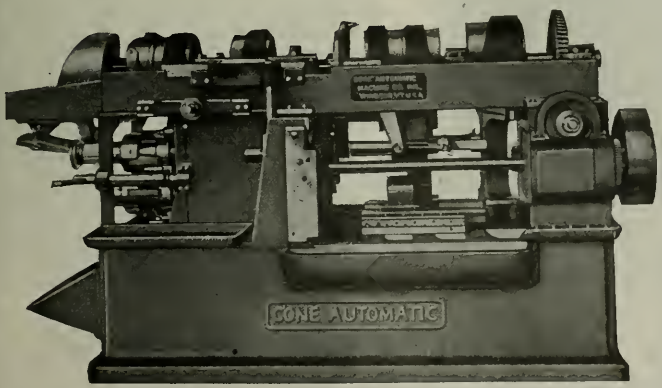
have automatic rotary, cross and longitudinal feeds, also easy hand adjustment. Bearing for slotting bar is adjustable to suit height of work, and may be brought down close to table, affording firm backing to tool. All sizes have spring relief tool apron. They are easy to handle, and the grouping of operating levers and controlling apparatus affords the greatest convenience of manipulation, thus securing maximum output. The construction and workmanship insure accurate product and durability.

SHAFTING, INJECTORS DRILL AND TOOL GRINDERS

Output and Cost Tell the Story of this Machine

The Cone Four Spindle Automatic

The outstanding points in which this machine differs from others make it a notably rapid, economical producer of screw machine parts up to 3½" x 7". Box type, double bed construction provides for the cam shaft to be carried by the upper bed, and the machine spindles and tool slides by the lower. All movements are obtained by flat cams bent to fit cam drums, independently adjusted, which permits increased production by tooling in duplicate. Control is arranged with unusual consideration for operating convenience. Finished work is at all times in plain sight, and there is a special arrangement for automatically deflecting the work and removing the chips without interfering with the operator.



Spindles are of hardened steel and run in phosphor bronze bearings, main drive shaft is hardened and ground and equipped with Hyatt Roller Bearings.

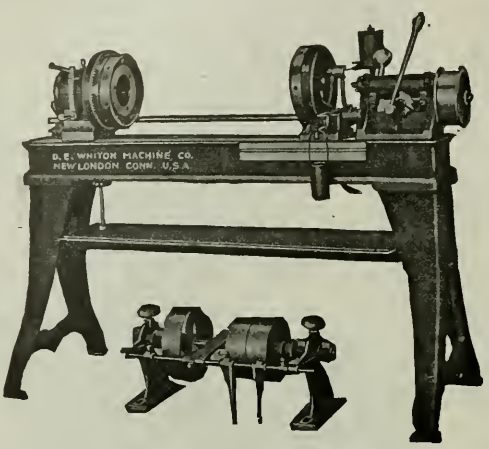
Details and production records on request.

Cone Automatic Machine Co., Inc.

Windsor Vermont, U.S.A.

Agent for Michigan Territory:
J. C. Austerberry, 65 Shelby St., Detroit, Michigan.

THE WHITON
Revolving Centering Machine



For Accurately Centering Finished Shafts

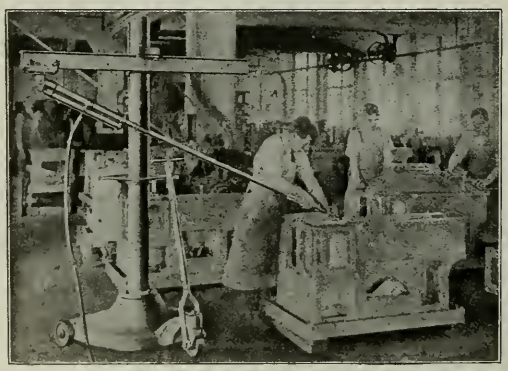
The cut shows new **Revolving Centering Machine**—a large size of the well-known machine of this type. It is heavier throughout and has capacity to center shafts up to 5 inches in diameter.

Constructed same as the smaller machine and embodies all the special features.

Circulars and prices sent upon application.

The D. E. WHITON MACHINE CO.
NEW LONDON, CONNECTICUT, U. S. A.

Increase Production Without Touching the Payroll



Let us send you booklet "Doing It With Air." Write

Install the Anderson Pneumatic Scraper

The above heading is nothing more nor less than a simple statement of fact. When you install the Anderson Pneumatic Scraper you can either put your men on work other than scraping, getting the same results as you do now, or you can do considerably more scraping. The Anderson Pneumatic Scraper supplies the power, that's all. The men lose none of their skill.

THE ANDERSON BROS. MANUFACTURING CO.
1910 Kishwaukee St. ROCKFORD, ILL.

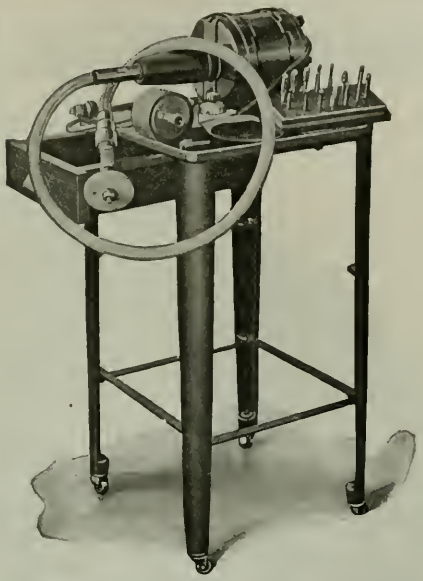
Anderson Pneumatic Scraper

Of Interest to Die Makers, Pattern Makers, et al.

A compact, portable Grinding and Scraping Outfit which recommends itself to busy workmen because of its durable construction and practical, and convenient range of equipment.

It consists of ½ H. P. bench type motor with cone connection and a 7/16″ sheathed shaft, a ball bearing hand piece, 5″ emery wheel, complete assortment of emery burrs in a neat wooden box, and a sanding drum abundantly supplied with emery bands.

Motor is mounted on a base and equipped with snap switch and cord. Table is furnished extra at a nominal price.

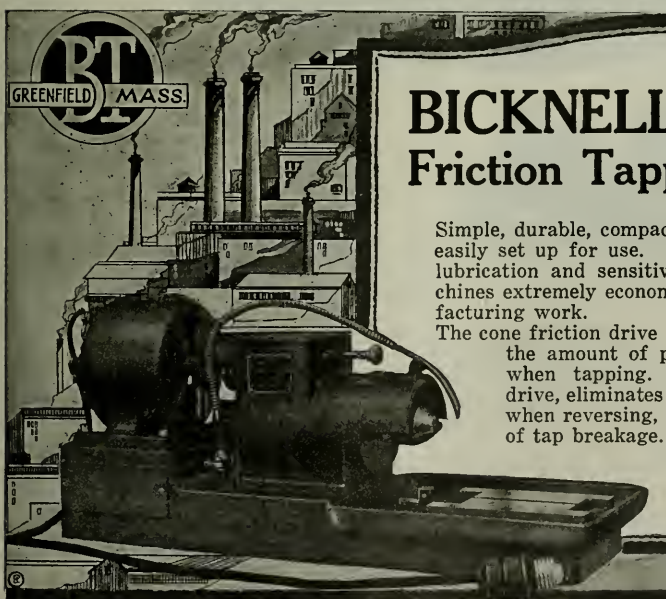


Complete description and quotations on request

THE HERGI MFG. CO., 250 Fifth St. BRIDGEPORT, CONN.

Manufacturers of Portable Electric Tools

Foreign Representatives: GOODCHILD & PARTNERS, Ltd., London, England; ATLANTIC-BALTIC CO., Ltd., Copenhagen, Denmark



BICKNELL-THOMAS
Friction Tapping Machines

Simple, durable, compact—completely equipped and easily set up for use. Careful construction, ample lubrication and sensitive controls make these machines extremely economical for use in small manufacturing work.

The cone friction drive is automatically adjusted by the amount of pressure put on the spindle when tapping. This insures a sensitive drive, eliminates the sudden strain on the tap when reversing, greatly reducing the danger of tap breakage.

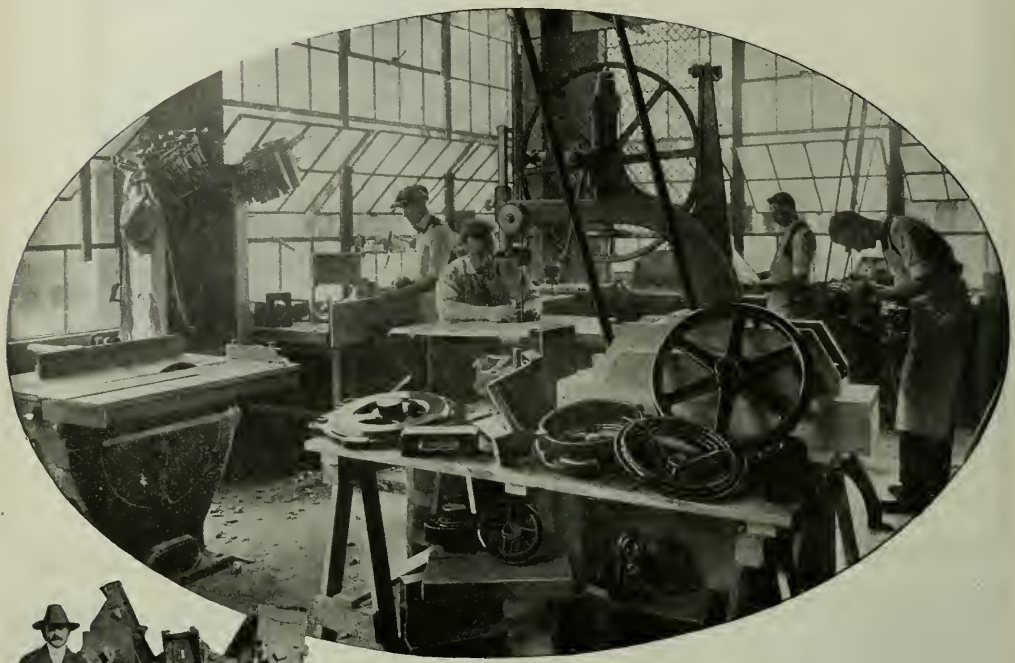
Capacity 0″ to ¼″ taps, size 23″, weight 65 pounds with motor. May we give you further details?

BICKNELL-THOMAS COMPANY, Greenfield, Mass.

CHICAGO REPRESENTATIVE: H. S. Huncke, 15 N. Jefferson St. PACIFIC COAST REPRESENTATIVES: The Chas. A. Dowd Sales Co., 320 Market St., San Francisco. FOREIGN AGENTS, CANADA: The Jas. Buckley Co., St. Nicholas Bldg., Montreal. ENGLAND: Goodchild and Partners, Ltd., London, W. C.

"Oliver" Wood Working Machines

In a Busy Pattern Room





The accompanying illustrations are published through the courtesy of the Mehl Machine Tool & Die Company, of Roselle, N. J., in whose pattern department they were taken.

The larger picture shows a complete installation of "Oliver" Wood Working Machines—in daily use for the past seven years in the pattern department of the Mehl Machine Tool & Die Company, which specializes in fine toolwork—jigs, fixtures, dies, gages and special machines. The small view represents part of one order recently delivered by this company and serves to show that its pattern requirements are no small item.

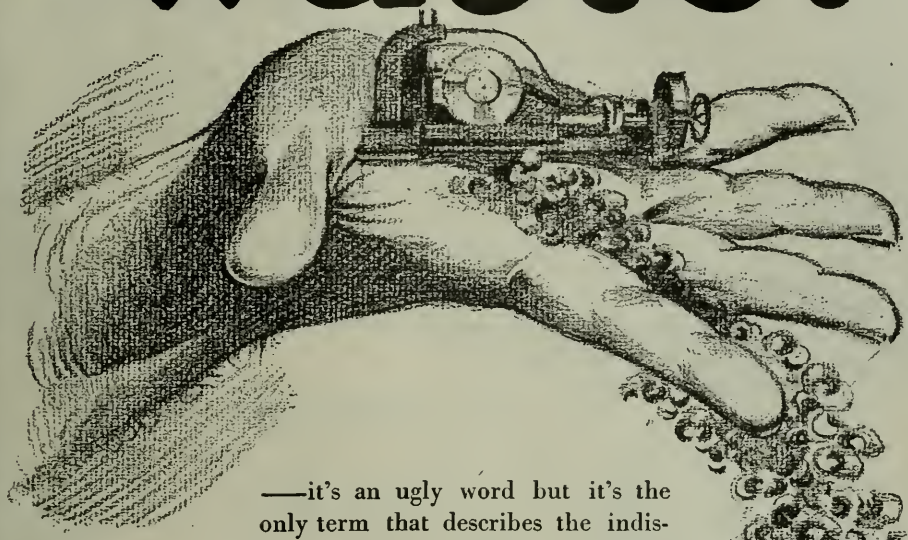
"Oliver" Machines have given "excellent satisfaction" in this shop and the proprietors not only have "no complaints to offer," but are very enthusiastic in recommending "Oliver" products.

"Oliver" Pattern Shop Machinery meets all up-to-date requirements. They are simple, well made machines of large scope and with many practical and exclusive advantages—serviceable machines with a reputation for maximum output and low maintenance cost.

Details of whole line on request.

OLIVER MACHINERY CO., Grand Rapids, Mich.

-waste!



——it's an ugly word but it's the only term that describes the indiscriminate use of rotary cutting-off saws with steel at present prices.

The heaviest Starrett Hack Saw made—a blade that does the work a half-inch rotary is often used for—is but .065 inch thick.

Compare its "kerf" with that of the rotary and the saving isn't hard to see.

If you're a hack saw user you need a copy of the Starrett Hack Saw Book. Sent free with Catalogue No. 21 D, upon request.

To get the most out of every box of Starrett Blades, you need the Starrett Hack Saw Chart D sent free on request.

THE L. S. STARRETT CO.

The World's Greatest Toolmakers
Mfrs. of Hack Saws Unexcelled
ATHOL, MASS.

STARRETT HACK SAWS CUT QUICKER LAST LONGER — STARRETT TOOLS

42-55

Starrett Hack Saws

"Cut" versus "Hack"

The difference between trying to chop off a two-days' growth with a pair of scissors and gliding over your face with a smooth, keen-edged razor:

The same principle applies to cutting metal. Which explains why a Napier Metal-Cutting Machine is now taking the place of two or three power hack machines in all large factories where metal cutting is done.

This change was necessitated during the War when speed and maximum production counted most.

It is necessitated now, when accuracy, finish and low metal-cutting costs figure prominently.

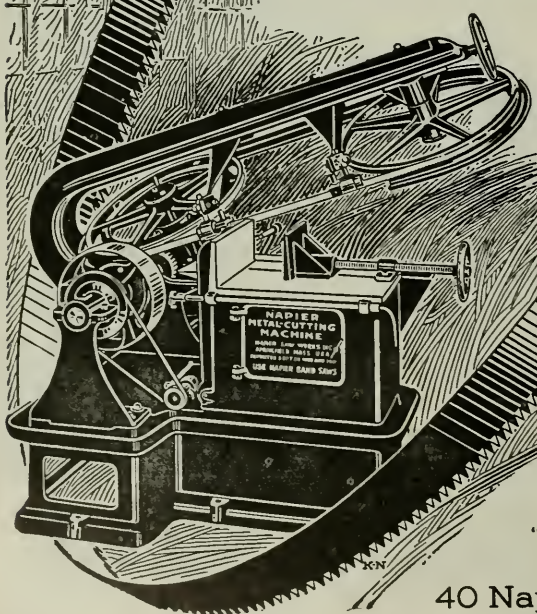
The Napier CUTS—with a continuous, one-way movement. There is no "hacking" back and forth. That is why it can use a thinner blade. A thinner blade means a big saving of metal.

This saving of pounds of steel per cut has caused many manufacturers to adopt the Napier Metal-Cutting Machine on this one count alone.

The Napier runs through the hardest tool steel, the softest machinery steel or cast iron, with equal ease. It always works smoothly, steadily and FAST. No vibration—no lost motion—no lost time.

The NAPIER Metal-Cutting Machine is built to "stand up." It is strong, rugged, enduring—a high-grade, dependable machine tool. Cuts any size up to 10 x 10 inches, round or square, and takes only 4 x 6 feet of factory room. Belt or motor-driven. Weight, 1550 pounds.

Descriptive Booklet Gladly Sent Upon Request



METAL
SAW & MACHINE CO., INC.

Sole Manufacturers of

"NAPIER" METAL CUTTING MACHINE
AND "NAPIER" BAND SAWS

40 Napier St., Springfield, Mass.

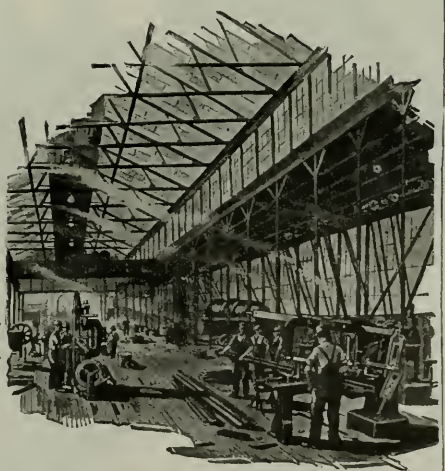
ATKINS SILVER STEEL SAWS



The Chemical Analysis

In the making of crucible steel it sometimes happens that there is what are known as "off ingots"—the mixture not being correct. However, with our modern laboratory equipment we have the facilities for detecting any variation from the Atkins standard for "Silver Steel." We subject each plate to minute chemical analysis and physical inspection.

Our metallurgists know what constitutes the "Silver Steel" formula, and there is no deviation from it, hence you can depend upon Atkins Saws, because they are uniform in quality and efficient to the highest degree.



Ask for latest catalog.

E. C. ATKINS & CO., Inc.

Established 1857 *"The Silver Steel Saw People"*

Home Office and Factory: INDIANAPOLIS, IND.

Canadian Factory: HAMILTON, ONTARIO

Machine Knife Factory: LANCASTER, N. Y.

Branches carrying complete stocks in the following cities:

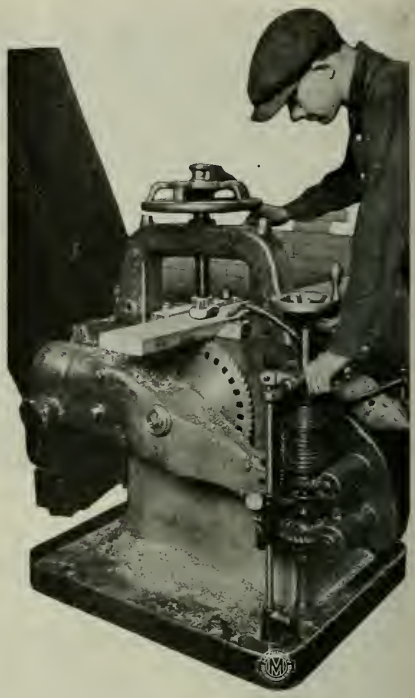
Atlanta, Chicago, Memphis, Minneapolis, New Orleans, New York City, Portland, Ore., San Francisco, Seattle, Paris, France, Sydney, N. S. W., Vancouver, B. C

LEA-SIMPLEX Cold Saws

Insure Maximum Production

The working principle is original and practical, cutting action easy and powerful, and construction simple—all of which insure economical operation and a high rate of production with minimum wear on the saw blade.

This photograph—taken at the J. H. Williams Company's Buffalo plant—shows clearly how the upward cut of the saw permits the chips to fall away without clogging the work—a feature that helps insure maximum service between grinds.



The details are interesting—may we send them?

Made by Earle Gear & Machine Company, Philadelphia

Distributed Exclusively By

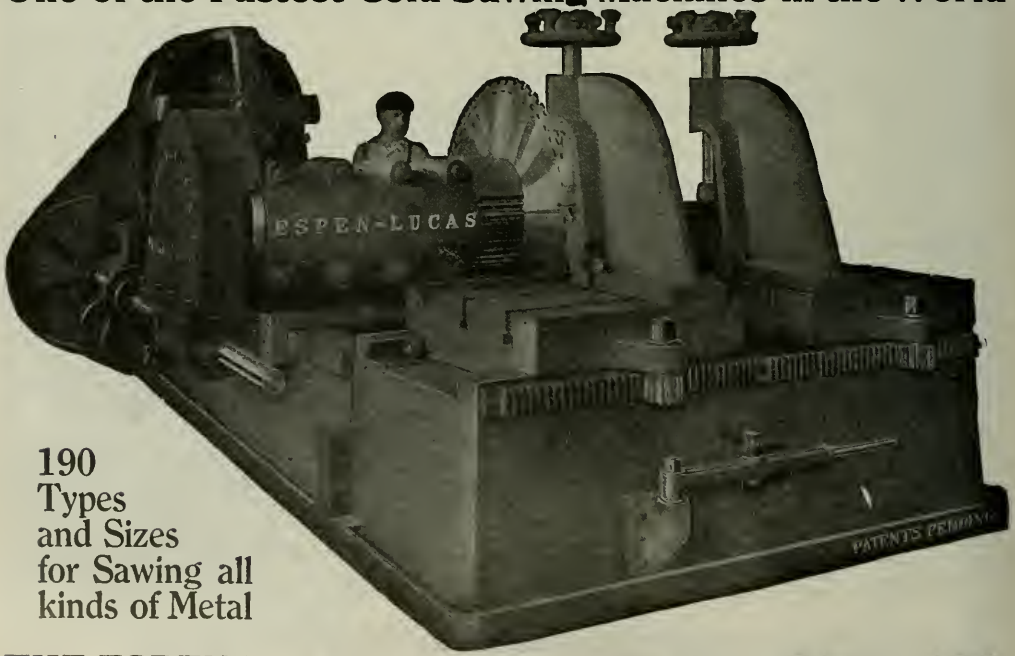
The FAIRBANKS Company

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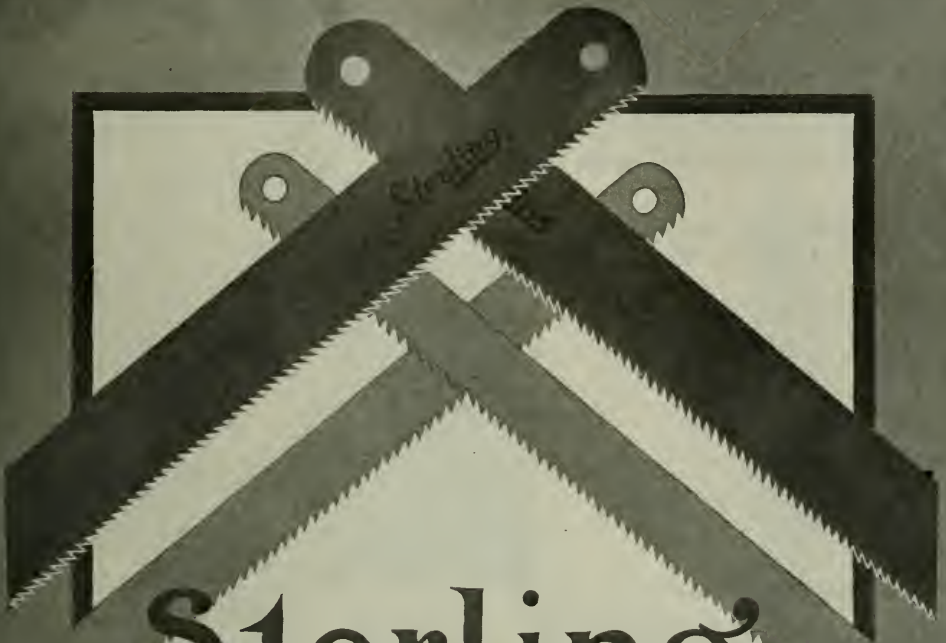
FAIRBANKS O.K.

One of the Fastest Cold Sawing Machines in the World



190 Types and Sizes for Sawing all kinds of Metal

THE ESPEN-LUCAS MACHINE WORKS, Front and Girard Avenues **PHILADELPHIA, PA.**



Sterling
Hack Saw Blades

Twenty years of service have so built up the reputation of Sterling Hack Saw Blades that our greatest business asset is the goodwill of our many patrons.

This goodwill it has been our constant endeavor to sustain, so that in specifying "Sterling" the purchaser of hack saw blades, wherever he buys them, is assured of the utmost from his investment.

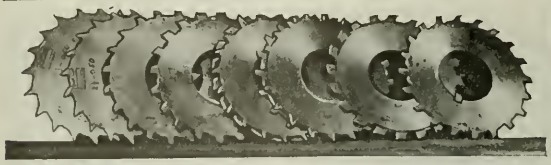
Sterling Hack Saw Blades, Frames and Machines. Ask for them everywhere

DIAMOND SAW & STAMPING WORKS

357-361 Seventh Street

BUFFALO N. Y., U. S. A.

MACHINERY

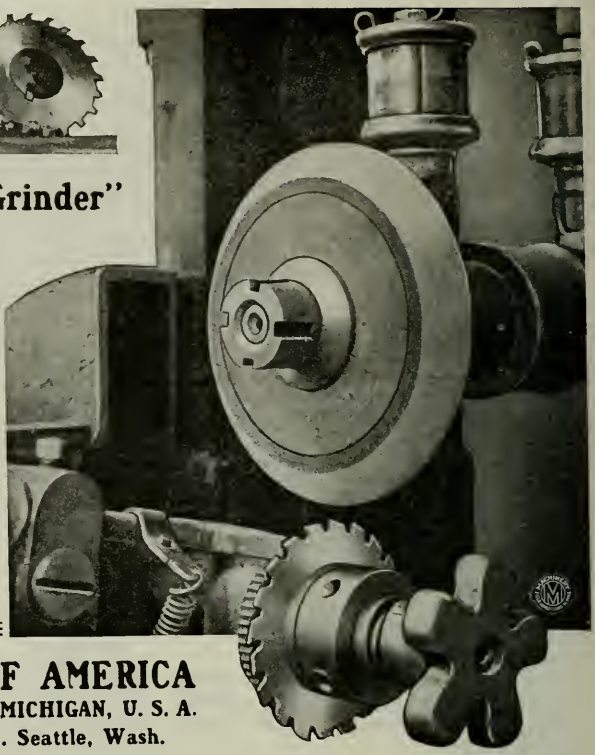


"Twice as Fast as a Cutter Grinder"

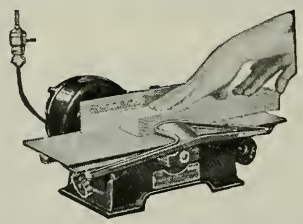
The No. 10 Automatic Saw Sharpening Machine

This machine has made an important place for itself in the cutter grinder department of the Remy Electric Co., at Anderson, Ill. Here it not only keeps seven or eight sizes of slitting saws in condition, but also does a variety of special work impossible to handle on any other cutter grinding machine.

It works twice as fast as the average cutter grinder, and its automatic indexing feature leaves the operator free to attend other machines. We shall be glad to tell you more about it.



MACHINERY COMPANY OF AMERICA
BIG RAPIDS MICHIGAN, U. S. A.
Pacific Coast Office: 304 First Ave., So. Seattle, Wash.



Save the Wasted Steps!

Take the machine to the job instead of wasting time taking the job to machines.

Do the work at the bench on WALLACE Bench Planers, Jointers and Saws —saves hand work also.

J. D. Wallace & Company
1421 W. Jackson Blvd. Chicago, Ill.

The
HIGLEY
COLD METAL SAW
Catalog furnished by
Vandyck Churchill Co.
New York Philadelphia New Haven

BARNES
SAWS FOR METAL
BAND MANUFACTURED BY HACK
DETROIT W.O.BARNES CO. MICHIGAN

PITTSBURGH SIMPLEX SAWS
Have Correctly Designed Teeth
STRONG—SIMPLE—TIME-SAVING—TROUBLE PROOF
The Pittsburgh Saw & Manufacturing Co.
Pittsburgh Penna., U. S. A.

GOODELL-PRATT
1500 GOOD TOOLS



Hack-Saw Blades

IT is on the job that Goodell-Pratt Hack-Saw Blades prove their true worth. Thousands of mechanics know how well they stand the grind of severe work day in and day out. This is because Goodell-Pratt Hack-Saw Blades are made to meet actual working conditions — not to pass freak tests.

Only the finest hot-rolled tool steel goes into Goodell-Pratt Hack-Saw Blades. This steel is tempered with the greatest care. For general use they are made with 14 teeth to the inch for sawing iron or steel rods or bars; with 20 or 24 teeth to the inch for sawing brass or heavy tubing; with 32 teeth to the inch for sawing thin steel tubing; and with 8, 10, or 12 teeth to the inch for use in heavy power machines.

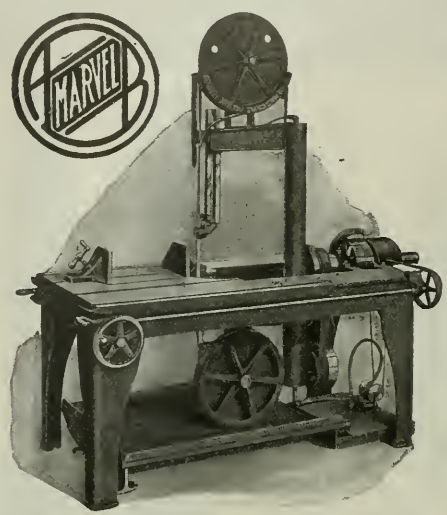


These hack-saw blades live up to the Goodell-Pratt standard of quality. Just as in the manufacture of every other one of the 1500 Goodell-Pratt Tools, nothing is spared which would in any way improve these hack-saw blades.

A complete pocket catalog showing these hack-saw blades and the other 1500 Goodell-Pratt Tools will be sent on request.

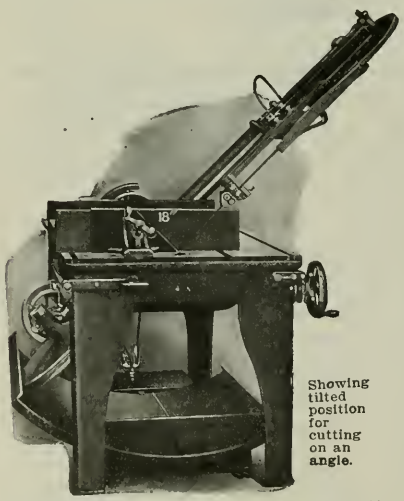
GOODELL-PRATT COMPANY Greenfield, Mass., U.S.A.

The Marvel No. 8 Metal Band Saw



A well-built, serviceable and convenient metal cutting band saw. The saw blade mount is unusually rigid, and may be tilted and locked at any angle up to 45 degrees. The saw blade has double guide rollers in dust-proof cases.

A machine you should know—
may we send you the details?



Showing tilted position for cutting on an angle.

Specifications—Capacity of throat—depth 18", height 20". At 45 degrees—depth 18", height 14". Saw blade 14'8". Floor space 36" by 6½'. Catalogue?

ARMSTRONG-BLUM MFG. CO.
343 N. Francisco Avenue Chicago, Illinois, U. S. A.

SIMONDS SLITTERS and SLOTTERS



Used in Machine Shops Everywhere

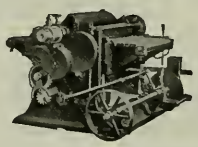
Write for Catalog and Prices

Simonds Slitting Saws are used in many metal working shops as universal saws. They are made of high-grade semi-high-speed steel and stand up to the work. Our screw slotting saws are also in big demand in machine shops and kindred industries.

SIMONDS MANUFACTURING COMPANY
FITCHBURG *"The Saw Makers"* **MASS.**

CHICAGO, ILL. NEW ORLEANS, LA. MONTREAL, QUE.
NEW YORK CITY SAN FRANCISCO, CAL. MEMPHIS, TENN.
PORTLAND, ORE. VANCOUVER, B. C. SEATTLE, WASH.
LOCKPORT, N. Y. LONDON, ENGLAND ST. JOHN, N. B.

Crescent Wood Working Machinery



is popular because the machines are durable and always please our customers. The time will come when you will need additional equipment to help you speed up production so you had better get a little ahead of your requirements and ask for catalog today describing band saws, jointers, saw blades, planers, planers and matchers, disk grinders, swing saws, post borers, shapers, variety wood workers, hollow chisel mortisers, universal wood workers, table cut off saw.

THE CRESCENT MACHINE CO.
56 MAIN STREET **LEETONIA, OHIO**

Improved Anderson Balancing Ways



They are made in the following sizes

Swing	Greatest Distance Between Standards	Capacity in Lbs.
20 in.	20 in.	1,000
40 "	30 "	2,000
60 "	30 "	2,000
72 "	66 "	5,000
96 "	88 "	10,000

Manufactured by
ANDERSON BROS. MFG. CO., 1910 KISHWAUKEE STREET ROCKFORD, ILL.



Nos. 1, 2 and 5

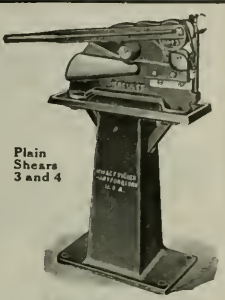
CUTTING REMARKS

HERCULES SHEARS AND ROD CUTTERS

Are manufactured in six sizes to meet the demand of a quick action tool to speed up production. Cuts rods leaving ends without burrs and minimum distortion—ready to thread.

No. 0 cuts 1/16" flats and under.
No. 1 cuts 3/16" flats and under.
No. 2 and 3 cut ¼" flats and under.
No. 4 and 5 cut 5/16" flats and under.

No. 0 cuts rods ⅛" 3/16", ¼" and under.
No. 1 cuts rods ⅛", ⅜", ½" and under.
No. 2 cuts rods ⅜", ½", ⅝" and under.
No. 5 cuts rods ½", ⅝", ¾" and under.



Plain Shears 3 and 4

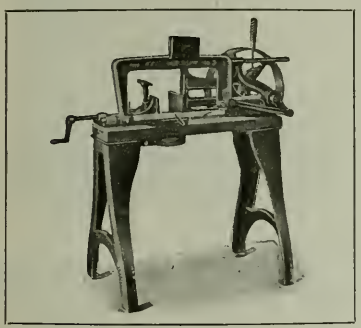
Send for Shear Catalog

Manufactured and For Sale by

W. M. & C. F. TUCKER,

HARTFORD, CONN., U. S. A.

FOREIGN AGENTS: Fenwick Freres & Co., Paris, France; Alfred Herbert, Ltd., Yokohama, Japan; Farmer & Co., London, England.



Q & C Hack Saws

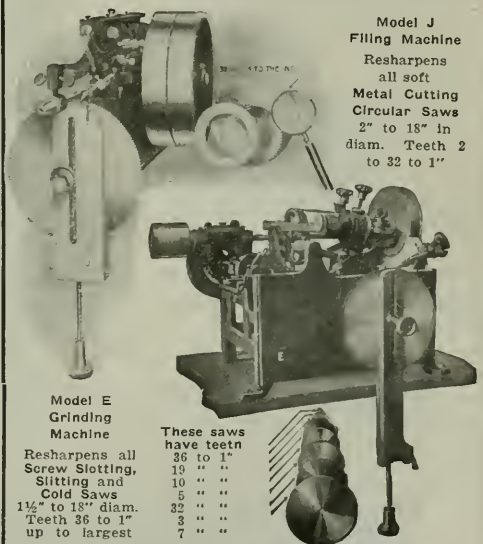
Known the world over

Made in three sizes. For sale by Machinery Dealers, Jobbers and Hardware Stores. Write for descriptive booklet.

HANNA ENGINEERING WORKS

1763 Elston Avenue Chicago, U. S. A.

Automatic Machines for Sharpening Metal Cutting Circular Saws



Model J Filing Machine

Resharpens all soft Metal Cutting Circular Saws 2" to 18" in diam. Teeth 2 to 32 to 1"

Model E Grinding Machine

Resharpens all Screw Slotting, Slitting and Cold Saws 1½" to 18" diam. Teeth 36 to 1" up to largest

These saws have teetn
36 to 1"
19 " "
10 " "
5 " "
32 " "
3 " "
7 " "

The Wardwell Mfg. Co.

Specialty Manufacturers

Combination Band Saw Filing and Setting Machines, Circular Saw Filers, Hack Saw Grinders, Metal Cutting Band Saw Grinders, etc.

108 HAMILTON AVE. CLEVELAND, OHIO

EXPANDED METAL SAFETY GUARD CO.

14th St. and Vernon Ave. Long Island City, N. Y.

The highest type of engineering and construction service in the design, manufacture and intallation of

MACHINE GUARDS

SCREENS OF ALL KINDS

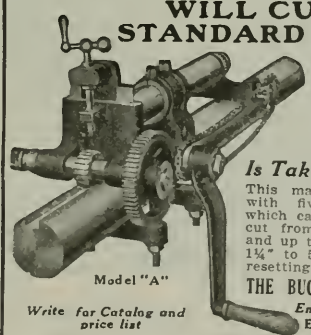
Chicago Perforating Co.

2445 West 24th Place

Tel. Canal 1459 CHICAGO, ILL.

Perforated Metal Machinery Guards

WILL CUT ANY STANDARD KEYWAY



Model "A"

The important feature of this machine is its portability; instead of taking the work to the machine, the Bucher-Smith Portable Keyseater

Is Taken to the Work

This machine is furnished with five milling cutters which can be ganged up to cut from ¼" to 1¼" wide and up to 12" long in shafts 1¼" to 5" diameter without resetting.

Write for Catalog and price list

THE BUCHER-SMITH COMPANY

Engineers and Machinists

EAST LIVERPOOL, O.

THE "RACINE" HIGH SPEED METAL CUTTING MACHINES



The combination quick change vise grips the work close to the saw blade and enables the operator to cut short pieces accurately *at any angle;* automatic stock feed saves labor. The draw cut action of the saw with the positive lift on the non-cutting stroke saves saw blades. Convenient, economical machines for accurate metal cutting.

Use The "RACINE" H. S. Tungsten Power Blades with these machines. "Standard the World Over."

RACINE TOOL & MACHINE CO., RACINE, WISCONSIN

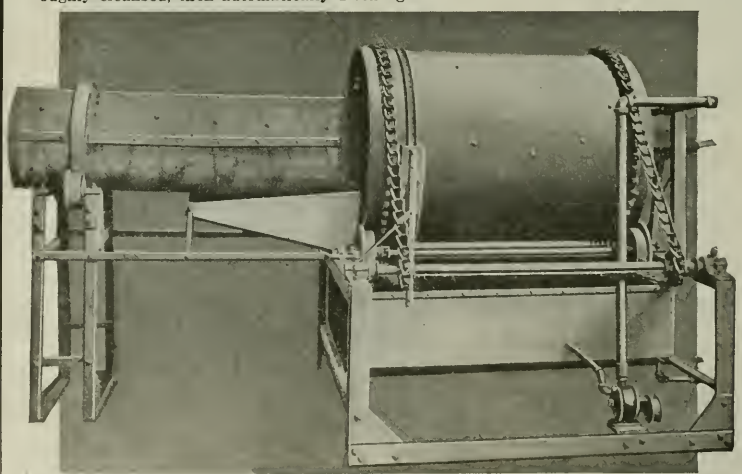
250 Fifteenth Street

It's Hard to Get Men to Work Over Steaming Dipping Tanks

Ideal Metal Cleaning Machinery Proves a Faithful Servant

It is a steady, consistent performer—good, sturdy machinery that never "tires," "loafs," or "lets down." Replaces human labor, works quickly, and there's no danger of delicate work being damaged.

Here's the process: the material is held in a drum—kept in contact with the cleaning compound until thoroughly cleansed, then automatically discharged.



For Removing Heavy Grease From Stampings

and other foreign substances that are found on a wide range of parts, use our dependable BATCH PROCESS MACHINERY.

For Delicate Parts

that must be treated carefully, you can rely absolutely upon our CONTINUOUS PROCESS MACHINES. Specially designed for delicate work—they clean, rinse and dry.

Get in touch with us NOW and we will forward Valuable Information.

The Ideal Concrete Machinery Co., Colerain Avenue Cincinnati, Ohio

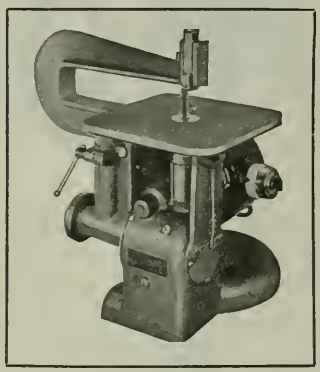
OLIVER

(OF ADRIAN)

Sawing, Filing and Lapping Machine



The Skilled Diemaker Knows Its Value



The skilled diemakers in the plant of the Gem City Machine Co., Dayton, O. fully appreciate the assistance of the Oliver Sawing, Filing and Lapping Machine. No longer called upon to do arduous filing and sawing by hand they are able to give full scope to their skill, and the fine die work done by this concern is a real tribute to the "Oliver".

Observe the ease with which the man in the photograph forms the 24 small irregular openings in the armature punching. Imagine how long it would take to do this work without an "Oliver" by the tedious and tiring hand method.

The "Oliver" is a time and money saver appreciated equally by the skilled mechanic and the man in the private office.

Write for catalog.

OLIVER INSTRUMENT COMPANY

ADRIAN MICHIGAN, U. S. A.

A Complete Heat-Treating Family

TRADE-MARK

WHEN you buy a suit of clothes you don't go to one tailor for a coat, another for the vest, and a third for the trousers. You pick out a good tailor and let him make the complete suit—one particularly to fit your personality.

Similarly there is no need to "shop around" when you wish to install heat-treating equipment. Buying a furnace here, a tank there and your instruments some other place gives you an "odd-lot" department.

The S-C-H line of furnaces is not merely a line of one or two furnaces for a narrow field of uses, but consists of seventy-five furnaces which cover every known need in heat-treating.

With these furnaces are carried every accessory and instrument required by a modern heat-treating plant. The line is complete from the largest furnace to the smallest wire dipping basket.

A Catalog, 12-M, which describes the full line of 75 S-C-H furnaces, together with special information on any kind of heat-treating, is yours for the asking.

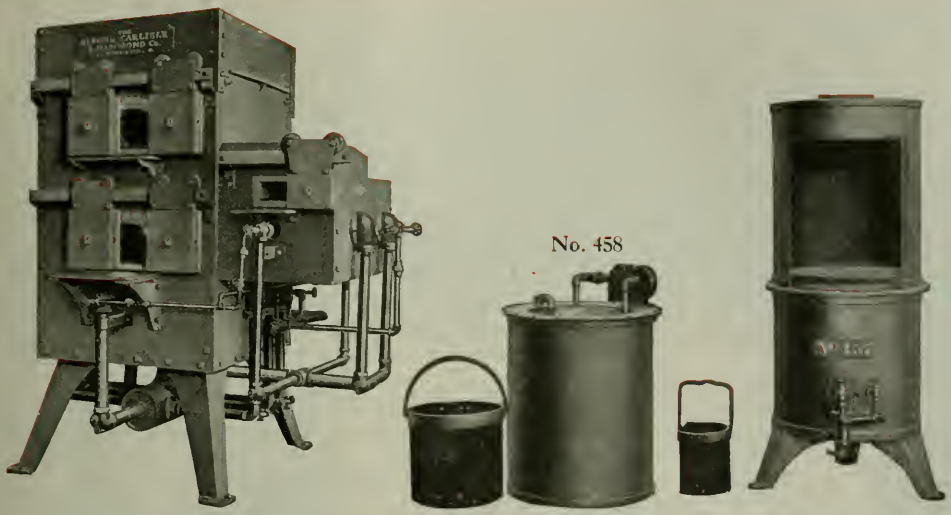
The Strong, Carlisle & Hammond Company

Cleveland, Ohio

BRANCHES:

Boston Chicago Detroit
New York Philadelphia Pittsburgh

SCH INDUSTRIAL FURNACES



A Complete Tool Room Outfit

S-C-H Furnace No. 55-A shown at left above is the most practical tool-room furnace made. Will handle either high-speed or carbon steel. The upper oven is for pre-heating, the lower for final heating. The small oven at right will handle 60% of all tool-room work, while the large heating oven will take care of the other 40%. Back of the small oven is a lead pot. The walls are 9″ thick and have an extra course of insulating cork brick in addition to the regular course of No. 1 fire brick, making it a very cool oven for tool rooms where the space is small. Can be arranged for either oil or gas fuel.

Oil Cooling Tank No. 458 will handle all pieces usually handled in the tool room. It consists of two tanks, the inner holding the oil, the outer containing water and a cooling coil. The oil is pumped by a motor driven pump through the cooling coil. By regulating the flow of water the oil can be held at any desired temperature. It is a compact, self-contained unit.

S-C-H Furnace No. 457 is an Oil Temper Drawing Furnace, which completes the installation. The burners can be adjusted to maintain any given degree of heat for any desired length of time. This feature makes it possible to temper the articles with uniformity, and to draw the temper to any desired color.

The above complete outfit will give perfect satisfaction in every way. Low in fuel consumption, accurate temperatures, easy and positive control, uniformly even results—these points make it an ideal installation.

SCH INDUSTRIAL FURNACES

ANNOUNCING
Wright-Fisher Standardized Drilling & Reaming Bushings

WRIGHT-FISHER Standardized Bushings are instantly ready to use without additional grinding and lapping. Worn standardized bushings are simply removed and replaced *out of stock*.

No delay. No time loss. No fussing. No trouble. No mistakes. No guess work. No ruined bushings in the making. No expensive toolmakers required to produce bushings.

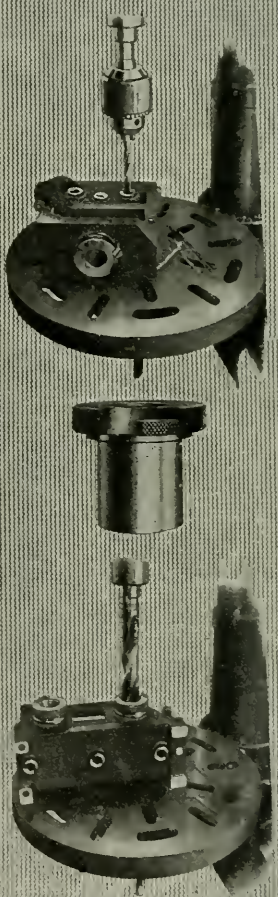
Made as perfect as it is possible for bushings to be—out of highest grade tool steel with metalurgical control of heat treatment, uniform hardness and long wearing qualities are fixed and definite.

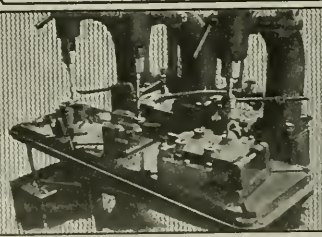
Every bushing held to exacting limits ensuring positive interchangability.

In reaming and drill jig operations Wright-Fisher Standardized Bushings obviously spell increased production, accuracy, decreased costs. Specify them when designing or purchasing your drilling or reaming equipment.

Unlimited Stock In All Sizes Ready Always for Immediate Delivery

Let us send you our Bushing Data Sheets for all types of Standardized Drilling and Reaming Jig Bushings.





WRIGHT-FISHER BUSHING CORPORATION
Main Office and Warehouse
East Grand Boulevard at Woodward
DETROIT
Branch Offices and Stock Rooms in Principal Cities

SHOP MATHEMATICS

By Erik Oberg, Editor of MACHINERY

Franklin D. Jones, Associate Editor of MACHINERY

Thousands of Draftsmen, Toolmakers, Designers and Foremen have wanted just such a book for a long time. MACHINERY'S new book "Shop Mathematics" shows clearly and practically how to solve all the usual problems met with in construction of machinery and tools. It is simply written. Rules and formulas are illustrated by examples from shop and toolroom practice. It gives you a grasp of all essential mathematics for your work, and a firm foundation for further advancement in manufacturing and engineering practice.

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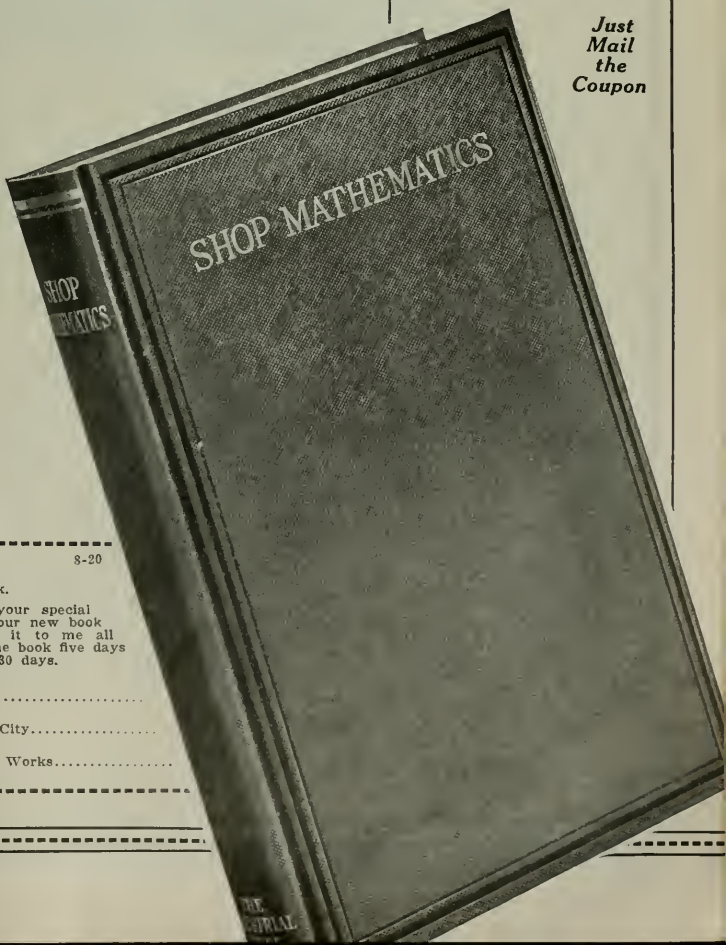
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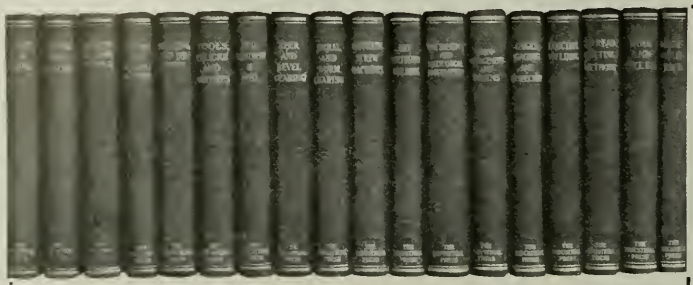
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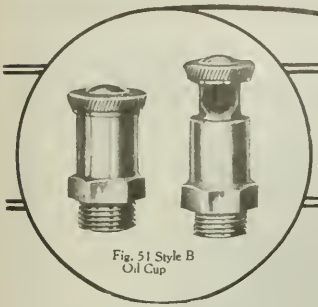
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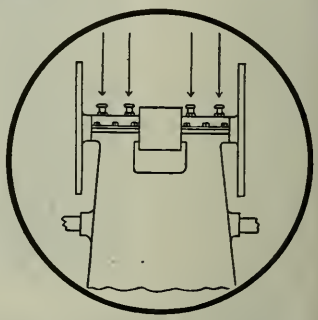
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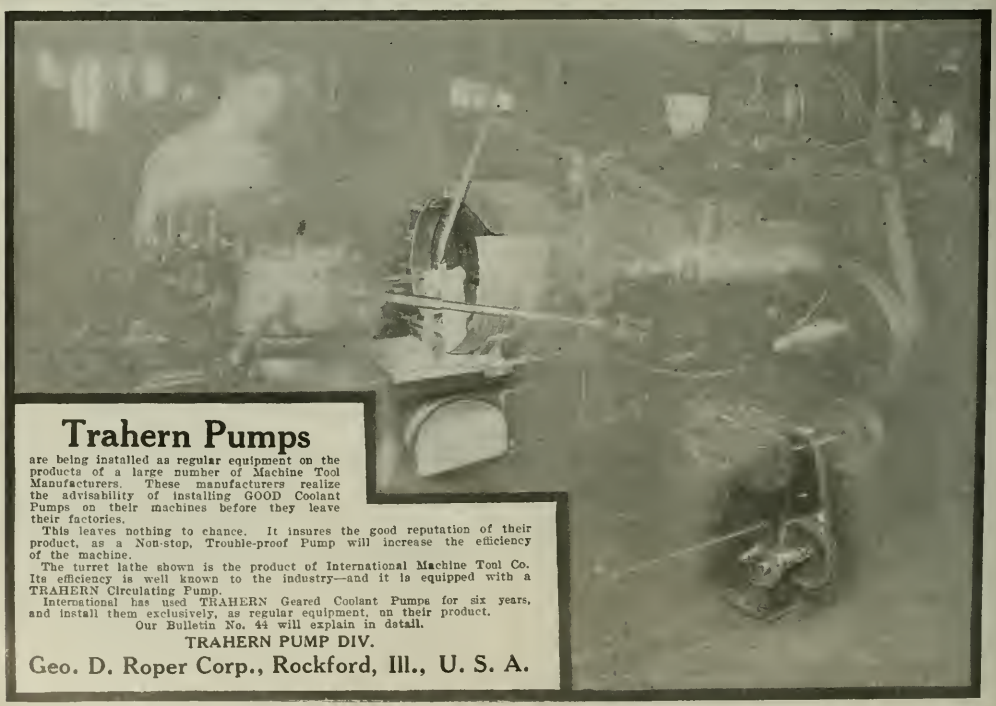


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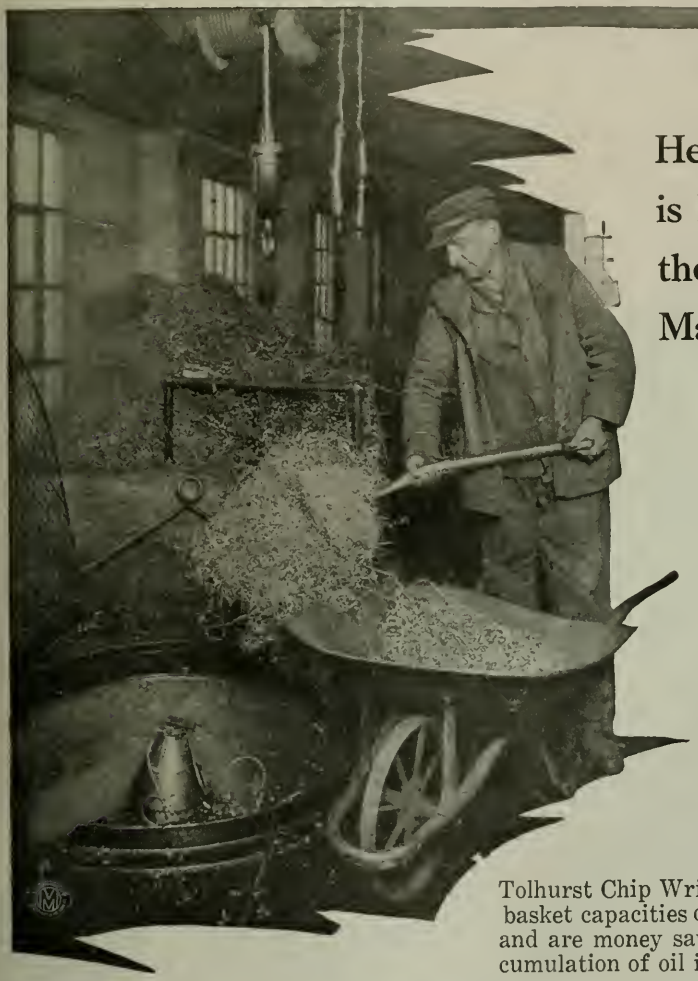
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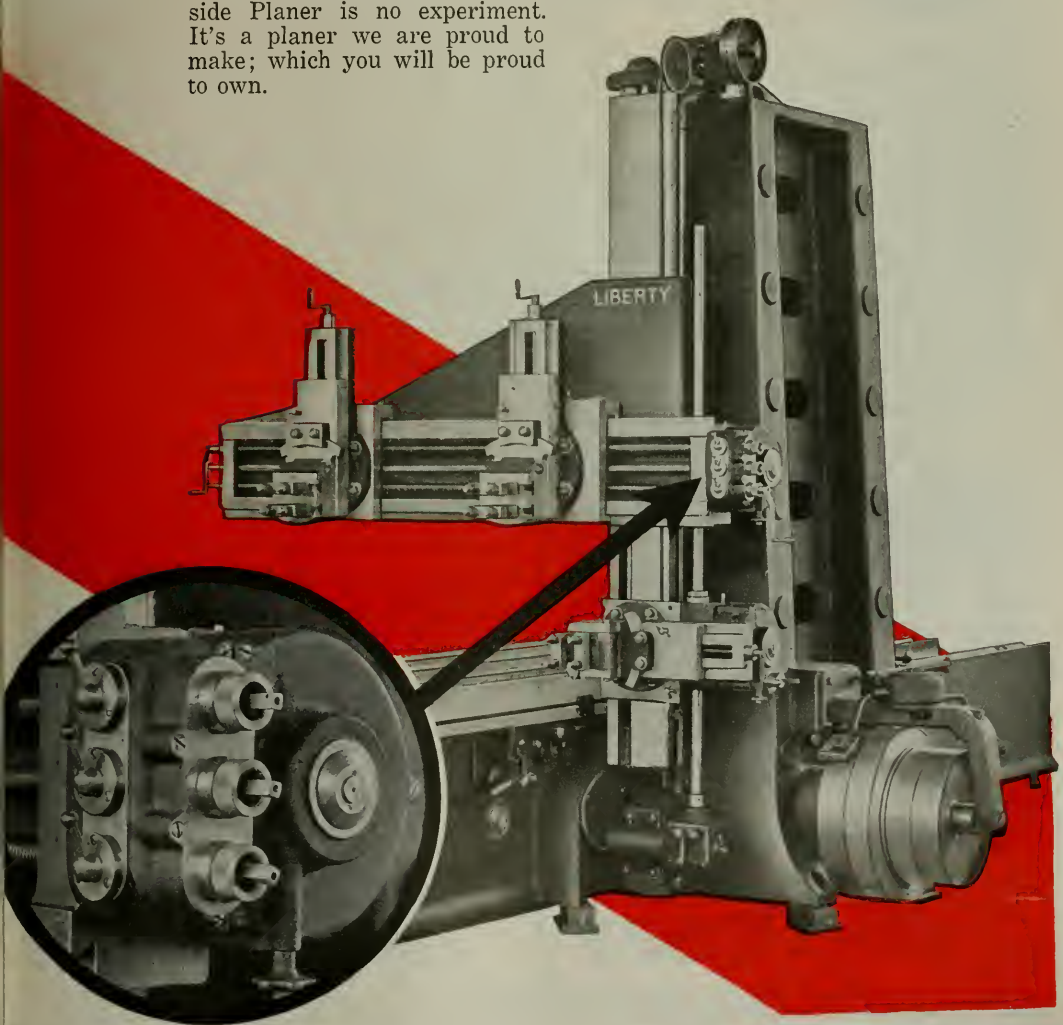
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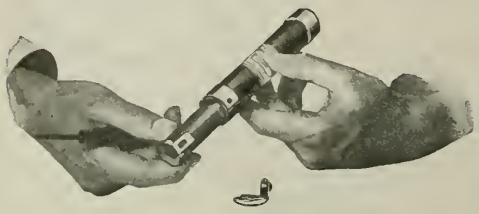
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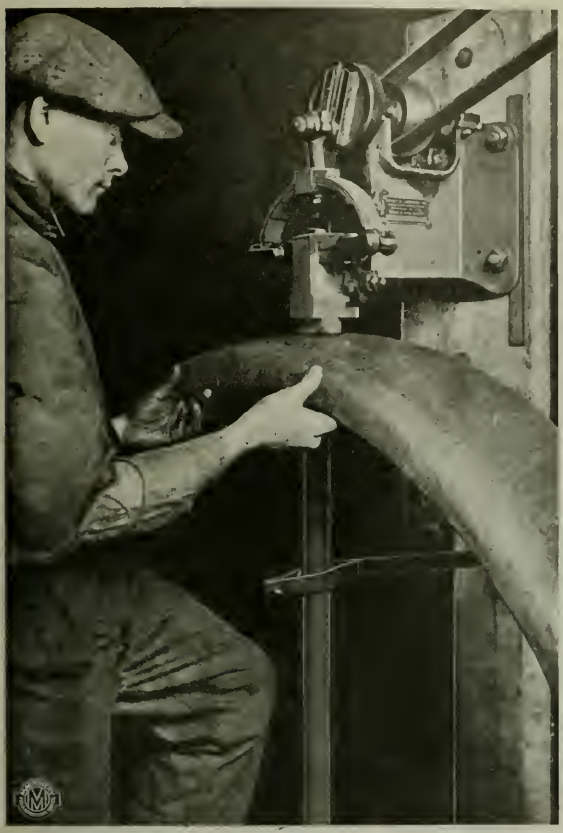
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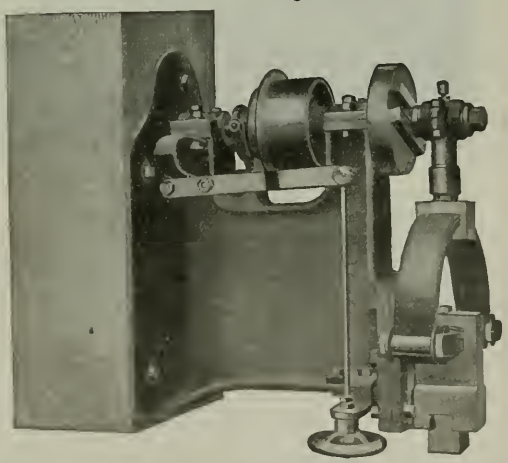
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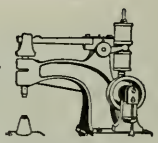
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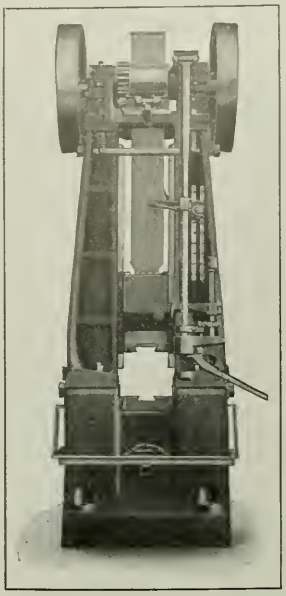
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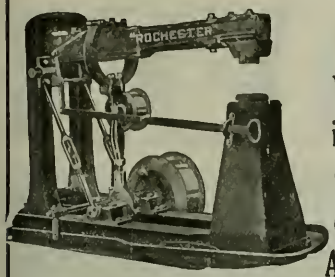


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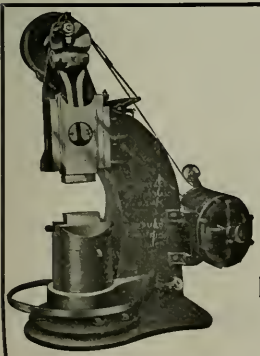
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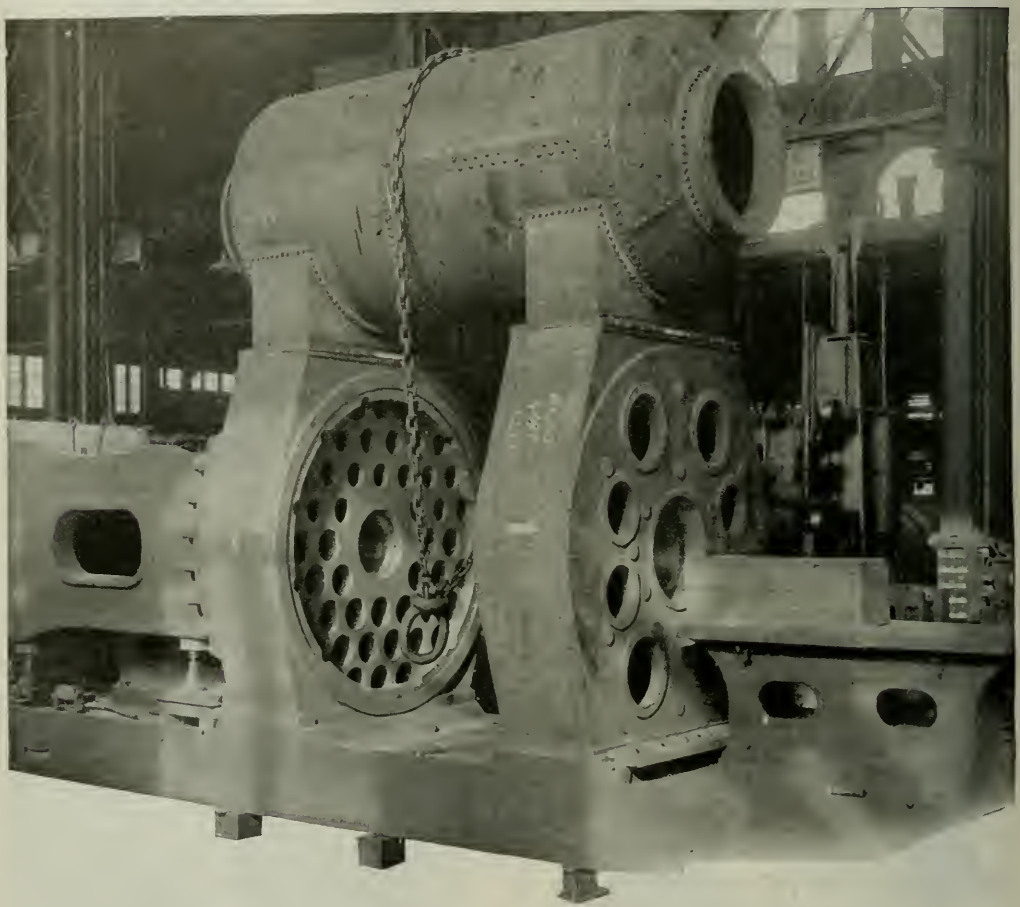
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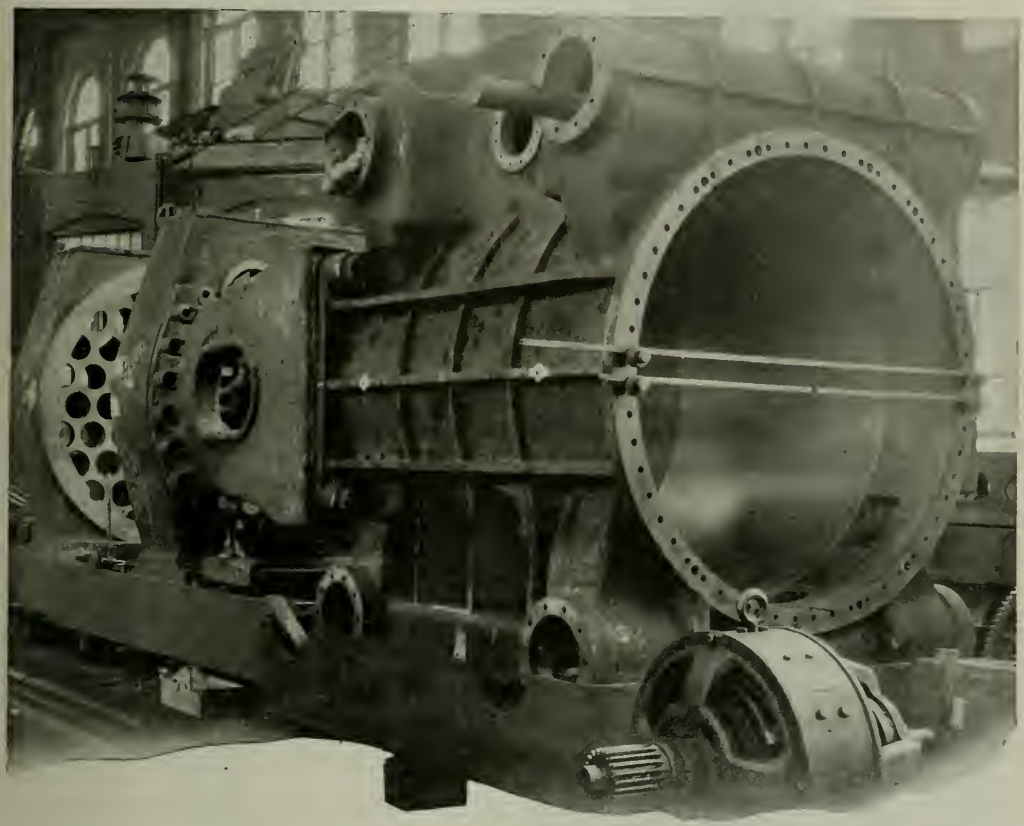
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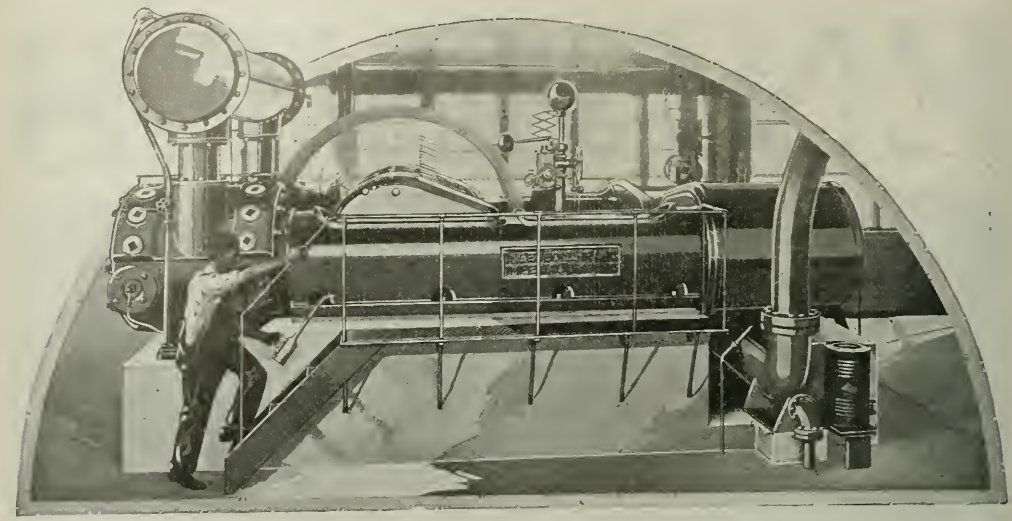
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Well sir, there's nothing wrong with that thread!



Not a thing wrong with it. This Forbes' has cut each V sharp at the bottom and just a little flat on top, which is right. Not only that, but each side of the V's are cut true.

That's something I never found in using other power machines. You see, boys, in most machines they make the dies drag the heavy pipe, while threading it. So of course a deeper slant is cut on one side of each thread. This isn't a very large piece of pipe, but you take 10 feet of this, or a larger size and you've got considerable weight. After all, it's the dies that do the work, and if they are allowed to cut thread only, and don't have a lot of heavy dragging to do besides, the thread is bound to be perfect.

That's what the Chief told me about this Forbes' Pipe Threading and Cutting Machine: "The die head revolves, and the pipe remains stationary."

Yes, sir, I sure am going to like this Forbes'!

We can send you a Forbes' Pipe Threading and Cutting Machine which will probably handle all the pipe sizes you use. And you, too, will like it, because it is the all-round practical machine for plant or plumbing establishment. Write us for further details.

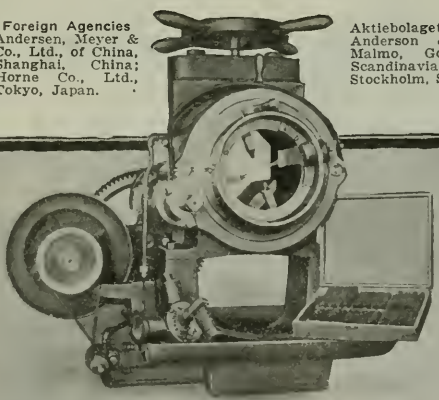
CURTIS & CURTIS CO.

324 Garden Street, Bridgeport, Conn., U. S. A.

Foreign Agencies
Andersen, Meyer & Co., Ltd., of China, Shanghai, China; Horne Co., Ltd., Tokyo, Japan.

Aktiebolaget Sigfr. Anderson & Co., Malmo, Goteborg, Scandinavia and Stockholm, Sweden.

2031-K

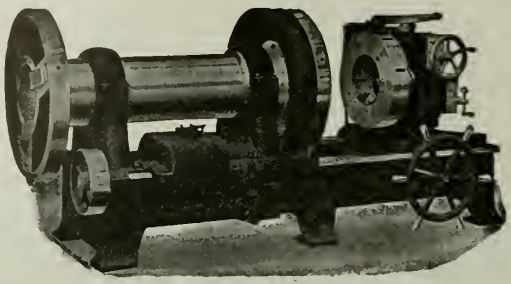


FORBES'



IT THREADS PIPE ACCURATELY

PEERLESS B&K DUPLEX P.D.Q.C



ALWAYS ON THE JOB

READY for threading pipe any moment from Monday morning to Saturday night—overtime too, if needed. Continuous satisfactory service in a machine starts in the designing. There is where every little detail is studied with a view of producing a finished machine that will stand the hard knocks. Every part will sooner or later be called upon to stand right up to hard work. The dies, the die adjusting device, the cut-off, the chucks, the oiling system, should all be dependable. B & K machines have that look of strength and bigness that you like to see in a pipe machine. *Send for a catalog.*

FORGE AHEAD WITH A BETTER THREAD

BIGNALL & KEELER MACHINE WORKS
EDWARDSVILLE, ILL.

PEERLESS B&K DUPLEX P.D.Q.C

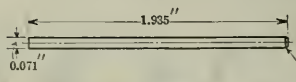
This DAYTON
SWAGING MACHINE



Helps in the Economical Production of Modern Office Equipment

Efficiency, the watchword of the Elliott-Fisher Co. office devices is also their manufacturing standard. This photograph shows the Dayton Swaging Machine chamfering a wire end for entrance into the reducing die at 1000 pieces per hour. An operation that seems to indicate that the equipment of this Harrisburg Plant is as efficient as the machines they make.

May we tell you more of the varied uses for Dayton Swaging Machines?



The Torrington Co., Excelsior Plant
Successors to Excelsior Needle Co.
57 Field Street Torrington, Conn.

Coventry Swaging Co., Ltd., White Friars Lane, Coventry, England, Agents for Great Britain. Fenwick Freres & Co., 8 Rue de Rocroy, Paris, France, Agents for France, Italy, Belgium, Spain, Portugal and Switzerland.

You'll Find Etna Swaging Worth While



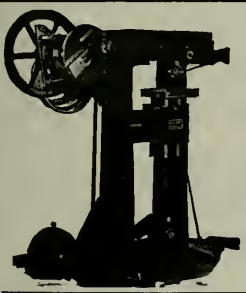
No. 5

For pointing, tapering, or otherwise reducing metal rods and tubes, for forming a wide variety of metal parts, from button-hooks to automobile steering rods, you'll find Etna Swaging far superior to turning or grinding.

Thousands of hammerlike blows from rapidly-revolving dies impart to the metal the quality of a forging, and simplicity in operating assures rapid, economical output.

The capacity of Etna Machines varies, this No. 5 Machine being adapted to handle work up to 4″ diameter and tapers to 18″ long. All, however, have the extra outer bearing and other distinctive features that insure a long term of profitable service. Details on request.

THE ETNA MACHINE CO.
Maplewood Avenue and Castle Blvd.
TOLEDO OHIO, U. S. A.



Brand your trade-mark into your product—and your advertising will go 'round the world. Dwight-Slate Marking Machines cut permanent trade-marks. Our up-to-the-minute steel engraving department will supply the dies for the work. Write for booklet of samples and list of users.

NOBLE & WESTBROOK MFG. COMPANY
19 ASYLUM STREET HARTFORD, CONN.

Burr Portable Shaft Keyseater



Saves trouble—cuts costs of installing new machines. Cuts keyways to 5″ in diameter and 12″ long without resetting and without dismantling the shafting.

Circular?

JOHN T. BURR & SON
429 KENT AVE.
BROOKLYN, N.Y.

Wood Screw Making Machinery

Send for Catalogue Series B-3



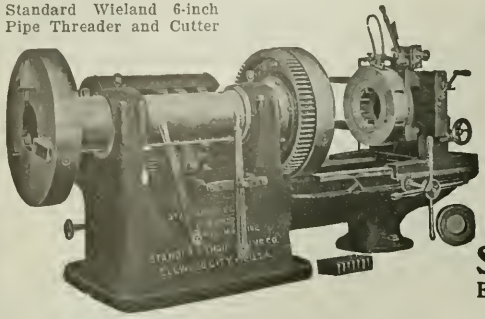
For sixty years we have constantly manufactured machinery for making screws, always studying to improve and refine our product.

Write or Wire us

Cable Address: "Cook," Hartford, U.S.A.
Codes: Liebers, Western Union

Asa S. Cook Co.
Hartford, Conn.

Standard Wieland 6-inch Pipe Threader and Cutter



Thread Pipe Do You? How?

The modern, efficient way is the Standard Wieland way, with a heavy, sturdy, durable machine, simple and positive in operation, fast and accurate in production.

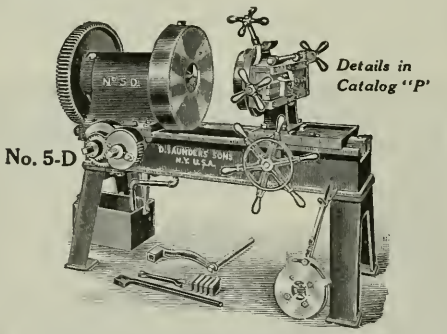
A few features: One-piece bed; single-speed pulleys; gear speed changes through semi-steel cut gears; deep chasers, cutting long taper threads in one cut perfectly, steel as well as iron pipe.

Send for the Circular.

Standard Engineering Company
ELLWOOD CITY PENNSYLVANIA
San Francisco Office: 1801 Claus Spreckles Bldg.

Saunders Machines Thread and Cut Pipe up to 18" Diameter

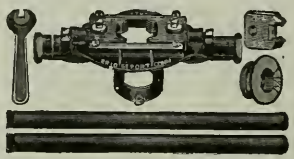
Powerful, well-built machines with speed, accuracy and operating convenience developed to the maximum. This No. 5-D Model, for example, threads pipe up to six inches in diameter, and is arranged for operation by both belt and hand power, equipped with Adjustable Expanding Die Heads with Interchangeable Chasers, and is arranged with eight speeds, giving uniform speed for each size of pipe threaded by machine.



No. 5-D

Details in Catalog "P"

D. SAUNDERS' SONS
Yonkers New York



Genuine Armstrong Stocks and Dies

Some of the advantages of the ARMSTRONG Stocks and Dies:
Can be adjusted to the variations in the size of fittings.
Results are accomplished with less work and time.
Can be sharpened without drawing the temper.
The dies are interchangeable in the stocks.

Have you a Set in Your Kit?

Our catalog tells the rest of this interesting story, send for it today.

THE ARMSTRONG MFG. CO.
297 Knowlton Street Bridgeport, Conn.

MERRELL Pipe Threading and Cutting Machinery

Hand or Power Operated

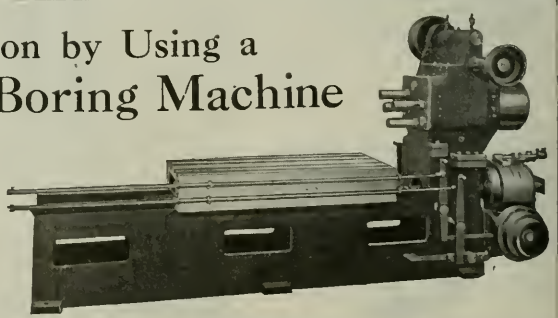
THE MERRELL MFG. COMPANY
15 Curtis Street TOLEDO, OHIO

CHAMBERSBURG HAMMERS

STEAM DROP—BOARD DROP—SINGLE AND DOUBLE FRAME TYPES
All Sizes for Every Class of Forging Work
HYDRAULIC MACHINERY
CHAMBERSBURG ENGINEERING CO., Chambersburg, Pa.
Send for Catalog

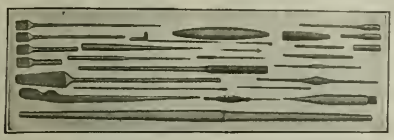
Increase Production by Using a Multiple Spindle Boring Machine

Built by
MOLINE MACHINERY COMPANY
MOLINE ILLINOIS



ROTARY SWAGING

The MODERN METHOD of Accurately Forming Metal with ECONOMY





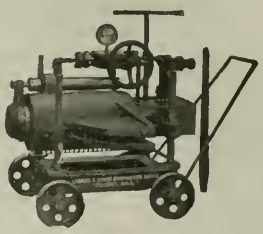
The function of these machines is the reduction sizing or tapering of metals of round, square, hexagonal or other section to a circular section either solid or tubular and hot or cold by power actuated dies striking up to as many as 3000 blows per minute.

Our policy is to equip the machines in every detail with work holders and feeding devices as will enable them to give the most efficient service at low upkeep expense when operated by unskilled labor.

Machines built up to date, have capacities ranging from a pin point up to 2½" diameter on solid stock and up to 5½" on tubing.

LANGELIER MFG. COMPANY
Arlington, Cranston, R. I., U. S. A.

ELMES
Chicago—Hydraulics



We wish to thank the machinery users of America and foreign countries for assisting us in making this press the greatest seller in the world.

Charles F. Elmes Engineering Works
Established 1861 Incorporated 1895
222 N. MORGAN STREET CHICAGO, U. S. A.

Drop Presses

for all purposes our specialty

The
Peck Drop Lifter
can be readily applied to foot or hand drops, making them automatic

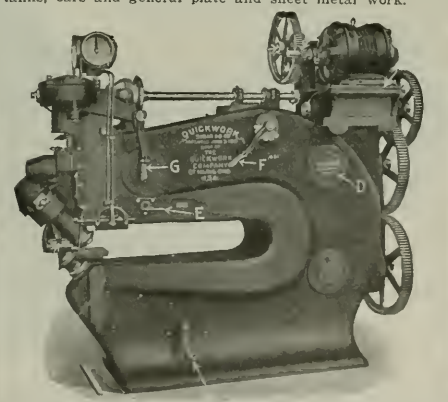
MINER & PECK MFG. CO.
Proprietors of the PECK DROP PRESS WORKS
NEW HAVEN CONN., U. S. A.

PRESSES—Foot and Power.
WIRE FORMING MACHINES—Standard or special.
TUMBLERS—All kinds.
BALL BURNISHING EQUIPMENT.

BAIRD MACHINE CO.
BRIDGEPORT, CONN.

QUICKWORK
Registered in U.S.A. and Foreign Countries
ROTARY SHEARS
MADE IN SEVEN SIZES

Cut all gauges of sheet and plate metal up to 1 inch thick in straight or irregular shapes and openings without cutting in from side of sheet. Leaves square true edge that requires no finishing. Used in building ships, boilers, tanks, cars and general plate and sheet metal work.



Patented June 3rd, 1913. Write for Catalogue No. 60
SAVES 50% to 90%
Eliminates Oxyacetylene Cutting and Plate Planing
THE QUICKWORK CO., St. Marys, Ohio, U. S. A.
New York Exhibit: Grand Central Palace
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Cable Address, "QUICKWORK" Codes: W. U. and General

PRESSES AND SHEARS
SHEET METAL WORKING MACHINERY
THE D. H. STOLL COMPANY, Inc.
Military Road and Grote Street, BUFFALO, NEW YORK

WATSON-STILLMAN
HYDRAULIC STRAIGHTENING PRESS

For Straightening Crank Shafts, Cam Shafts, Automobile Front Axles, Etc., or with Table Removed Can Be Used as a Mandrel Press, Broaching Press or Assembling Press

A rapid working, self-contained unit with all working parts under removable dust-proof guards.



This is a quick acting press that is under absolute control of the operator, both as to speed and pressure, by means of a hand or foot operated valve, which is so arranged that the movement of the ram through the low pressure portion of its stroke is very rapid, and the change to high pressure is effected automatically for the actual bending operation.

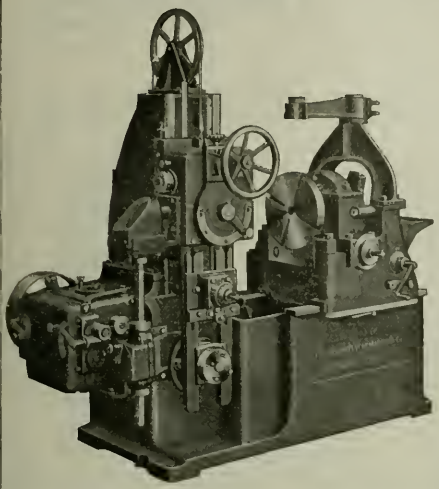
The table can be easily removed, and in this shape the press becomes a universal purpose forcing press capable of a wide range of shop operations.

Detailed information will be furnished upon request.
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THE WATSON-STILLMAN CO.

192 Fulton St., New York **McCormick Building, Chicago** 434
Philadelphia, Widener Bldg.

Cams! Cams! Cams!



DO YOU MAKE THEM OR BUY THEM?

Either way we can solve your problems. If you cut them in your own plant we recommend the Rowbottom Cam Milling Machine. If you buy them we'll cut them for you on the same machine.

In either case they'll be good cams accurately cut on a thoroughly practical machine built by experienced cam cutters.

Let us tell you more about Rowbottom Cams and Cam Milling Machines.

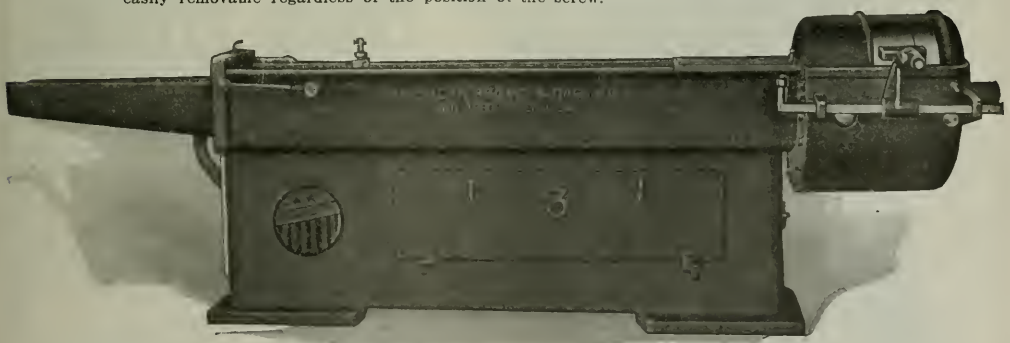
THE ROWBOTTOM MACHINE CO.
Factory, Waterville, Conn.
WATERBURY CONNECTICUT

Rowbottom for Cams

American Broaching Machines

Practical Profitable Durable

The cut shows our No. 3 machine—the most recent development in our line. Especially fast; with high speed return stroke, ample lubrication and convenient operating controls. Single belt drive, roller thrust-bearing and nut run in oil in a special compartment, and the nut is easily removable regardless of the position of the screw.



Send for the circular of this efficient Broaching machine.

American Broach & Machine Company, ANN ARBOR MICHIGAN

F. J. LAPOINTE, President and Authority on Broaching

REPRESENTATIVES: Detroit Office, 305 Scherer Bldg., Phone, Cadillac 5381; Cleveland, O., M. Jaeger, 342 Engineers Bldg.; Toledo, O., National Supply Co.; St. Paul, Minn., Savage & Winter Co.; Belgium, Henri Benedictus, Brussels; France, Louis Besse, 39 Rue De Lappe, Paris; Finland, Norway and Sweden, Ryiander & Aspiund, Stockholm, Sweden.



Send for Bulletin 112-IJ which gives detail specifications

Eastern Representative:
57 Transportation Building, Philadelphia, Pa.

THOMAS

Open Back Inclinable

POWER PRESSES

Some of the Reasons for Their Satisfactory Service

Thomas Power Presses are built with more than ordinary care—with unusual accuracy—and each press is operated under belt for several hours to insure the correct adjustment of every working part.

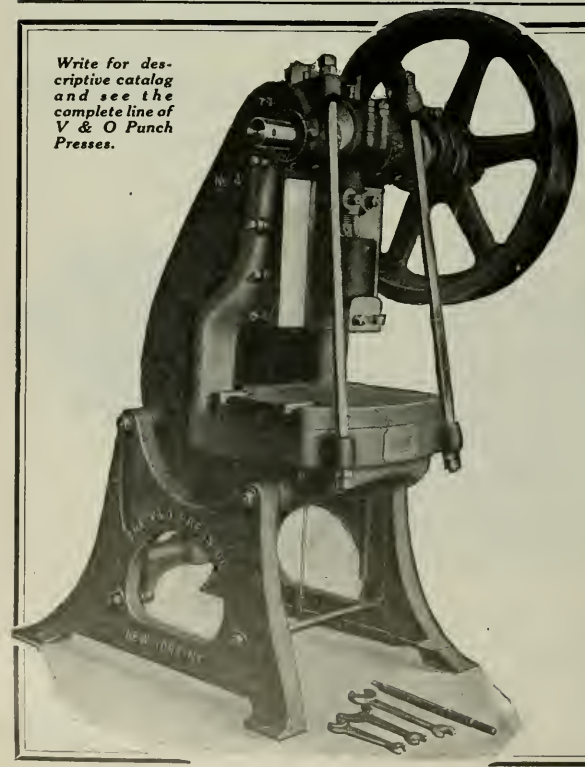
Crank shafts are open hearth steel forgings, heat-treated before finish-grinding.

The Automatic Safety Type of Clutch is furnished on all presses. The patented non-repeat feature makes it safe and convenient for the operator.

A "safety lock" set screw on the clutch block allows him to turn the press over by hand for setting and adjusting dies without danger of the machine being operated accidentally.

THOMAS SPACING MACHINE CO.
Fulton Building PITTSBURGH, PA.

Write for descriptive catalog and see the complete line of V & O Punch Presses.



V & O
INCLINABLE
Punch Presses

For Rugged Strength and Absolute Accuracy

V & O Inclinable Punch Presses are safe, are adapted to a wide variety of work and can be used for practically any sheet material with plain, gang and combination dies of almost every description.

Stock can be fed from right to left, front to back, or vice versa.

V & O "LONG SLIDE" Construction Cuts die repairs in half.

The V & O Press Co.

100 Dry Harbor Road
GLENDALE BROOKLYN, N. Y.

Presses, Dies, Sheet Metal Working Machinery

Niagara Power Presses



Inclinable Power Press

LET OUR ENGINEERING DEPARTMENT ASSIST YOU WITH YOUR PROBLEMS

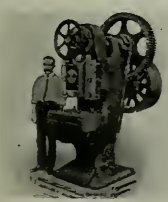
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Geared Punching Press

NIAGARA MACHINE & TOOL WORKS

BUFFALO, NEW YORK





FERRACUTE PRESSES

For Cutting, Forming and Drawing Metal

A Size and Style for Every Job

Photographs and full information on request.

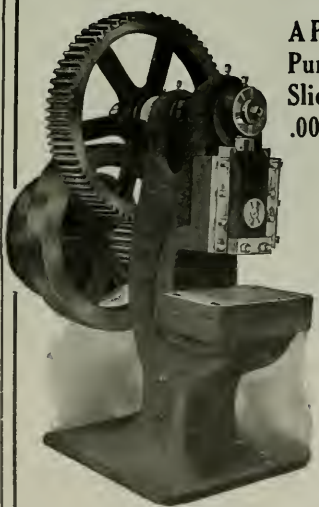
Ferracute Machine Co.

BRIDGETON, NEW JERSEY





SWAINE



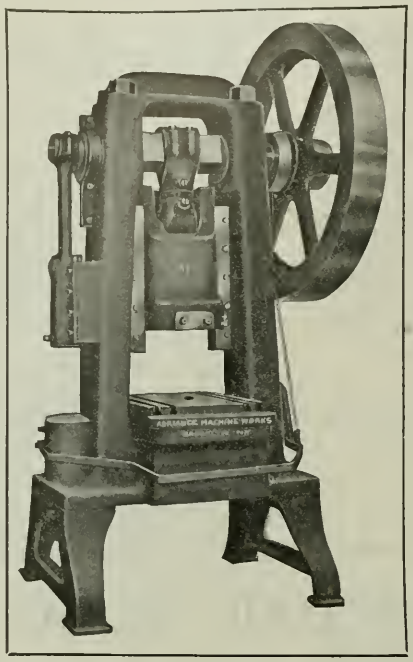
A Practical Geared Punch Press with Slide Adjustable to .001"

Box cap grip holds punch shanks in this as in all other Swaine Presses, and gearing is cut from the solid. Shafts and clutch parts are of vanadium steel. Gear guards, self-oiling devices, box type frame, slide adjustment to .001", and other features insure safety and a powerful, accurate stroke. Full details of this and other Swaine Presses in catalog.

Fred J. Swaine Mfg. Co.

7th and O'Fallon Sts. St. Louis, Mo.

Largest Press Builders in the West

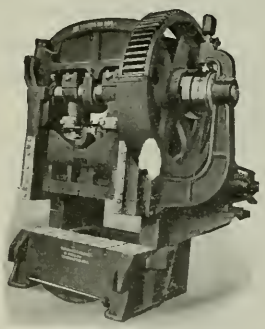


ADRIANCE
No. 67 Power Press
Carefully thought out in Every detail of Construction

The Adriance No. 67 Straight-side Power Press has many important details of design not ordinarily met with. Rigidity is assured by four large steel tie bolts running vertically through the press body, bed and crown, bolting all securely together. Wide slides are supported to gibs for almost their entire length when slide is at bottom of stroke. Right- and left-hand screw connections for adjustment of slides are extra heavy. Crankshafts are of forged steel. Write.

ADRIANCE MACHINE WORKS, Inc.
BROOKLYN NEW YORK

THE "TOLEDO"
High Speed Forging Presses



The "Toledo" Forging Press No. 210A. for high speed heavy forging, forming, stamping and embossing.

Have capacity for a recommended speed of not less than 30 strokes per minute so that as many as five or more operations may be performed in succession with but one heating.

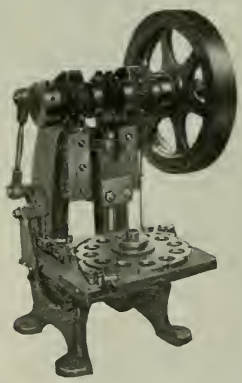
These presses are constructed to withstand the most severe treatment and to stand up under unusually heavy loads.

The Toledo Machine & Tool Co., Toledo, Ohio

OVER-SEAS REPRESENTATIVE
ALMACOA ALLIED MACHINERY COMPANY OF AMERICA ALMACOA
51 CHAMBERS ST. NEW YORK, U.S.A.

PARIS TURIN ZURICH BARCELONA

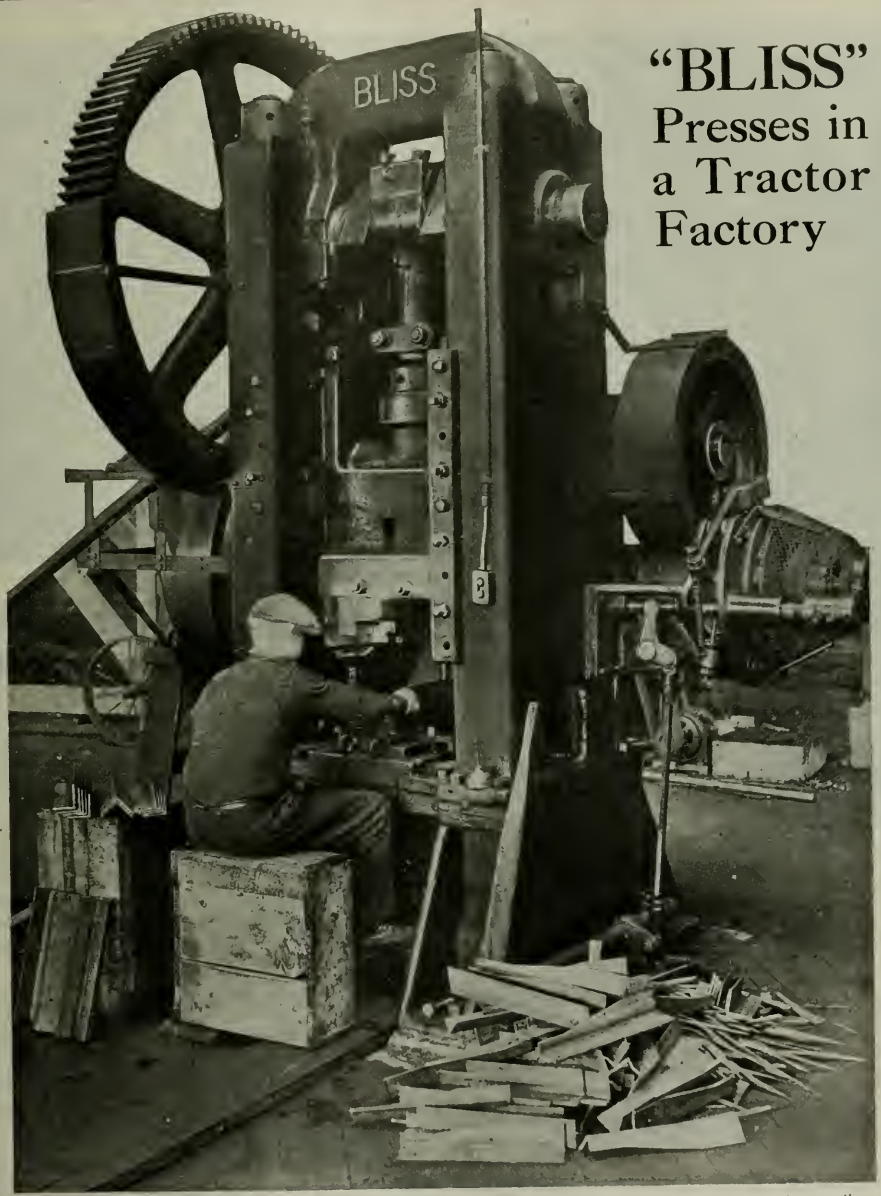
Acme Dial Feeds



Furnished to Fit All Sizes and Makes of Presses

We Also Build Acme Roll Feeds Complete With Scrap Cutters and Straightening Rolls

F. J. Littell Machine Co.
SUCCESSORS TO
ACME MACHINE WORKS
4125 Ravenswood Ave. Chicago, Ill.



"BLISS" Presses in a Tractor Factory

"BLISS" No. 78½ Straight Side Press trimming angle bars for wheel cleats for the Samson Tractor. An unusual trimming operation.

BLISS
1857

E. W. Bliss Company

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American Factories: BROOKLYN, N. Y. *and* HASTINGS, MICH.

SALES OFFICES

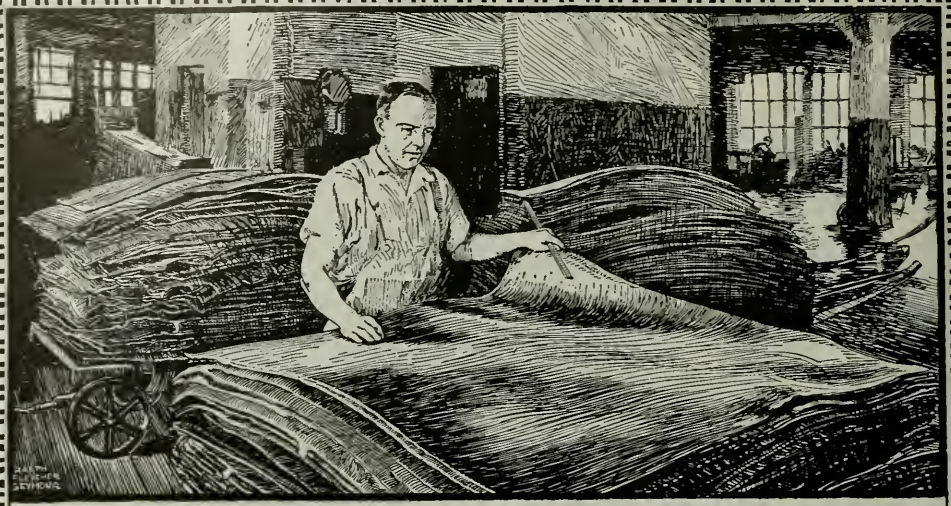
CHICAGO, People's Gas Bldg.
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DETROIT, Dime Bank Bldg.
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PITTSBURGH, Keenan Bldg.
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BLISS
1920

107



Leather Sense" Plus-Honesty

BY INVITATION MEMBER OF

NEW YORK, U.S.A.

"LEATHER SENSE" is that rare quality possessed by some few men in the leather business, that includes judgment, training, and experience, and goes beyond them. No amount of training or experience can give you "leather sense". You either acquire it or you don't, and few have it.

The man has it who is shown inspecting the leather before the center stock is cut out for our Reliance and Sea Lion belting. He not only has "leather sense" but he had eleven years training as a belt maker before he was entrusted with this important work. And when we add to judgment, training, experience, and "leather sense", the inherent honesty of character which is a fundamental requirement of all of our workmen, we know that one more responsibility has been well placed.

Leather belting is peculiarly a product in which the capability and honesty of the men who make and market the belts are all important factors in the finished result. These qualities are basic possessions of the entire personnel of both our manufacturing and sales departments. They are the main reason why Chicago Belting is now regarded as the standard of quality in the field of power transmission by belting

Write for our new 96 page Belting Reference Book and Catalog.

Chicago Belting Company

Manufacturers of Leather Belting

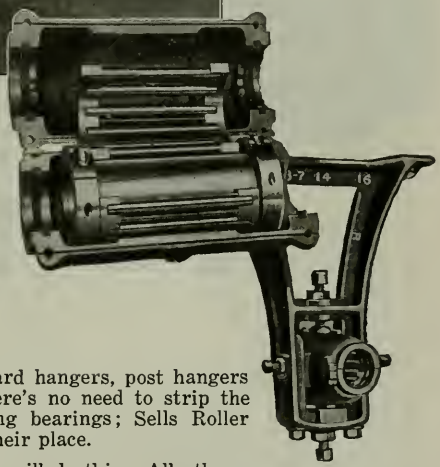
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127 NORTH GREEN STREET
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Chicago Belting





OVERNIGHT

You can substitute Sells Roller Bearings for your power wasting bearings—using your present hanger frames.

Sells Roller Bearings, size for size fit all standard hangers, post hangers and pillow blocks. When you install them there's no need to strip the shafting. Just pull out the old power wasting bearings; Sells Roller Bearings are split throughout and fit right in their place.

The Sells is the only bearing, roller or ball, that will do this. All others require new hangers or blocks, or stripping the shafts.

Also your shaft is protected from wear by the high carbon split sleeve of the Sells Roller Bearing. It fits over the soft shaft. The rollers bear against it, also against a similar high carbon steel surface inside the box. Sells Roller Bearings are full floating; there can be no end thrust. Neither can there be roller-against-roller friction, for the rollers are retained snugly in a cage and kept apart. Both rollers and cage revolve with the shaft.

Let us tell you all about Sells Roller Bearings. Then you'll appreciate why such concerns as Dodge Bros., The United Shoe Machinery Company, Aunt Jemima Mills Company, The American Car and Foundry Company, The Gillette Safety Razor Company and other nationally known concerns have adopted them.

A post card brings our book on anti-friction bearings.

John D. Sells
MANAGER

ROYERSFORD FOUNDRY & MACHINE COMPANY

54 North Fifth Street **PHILADELPHIA, PENNA.**

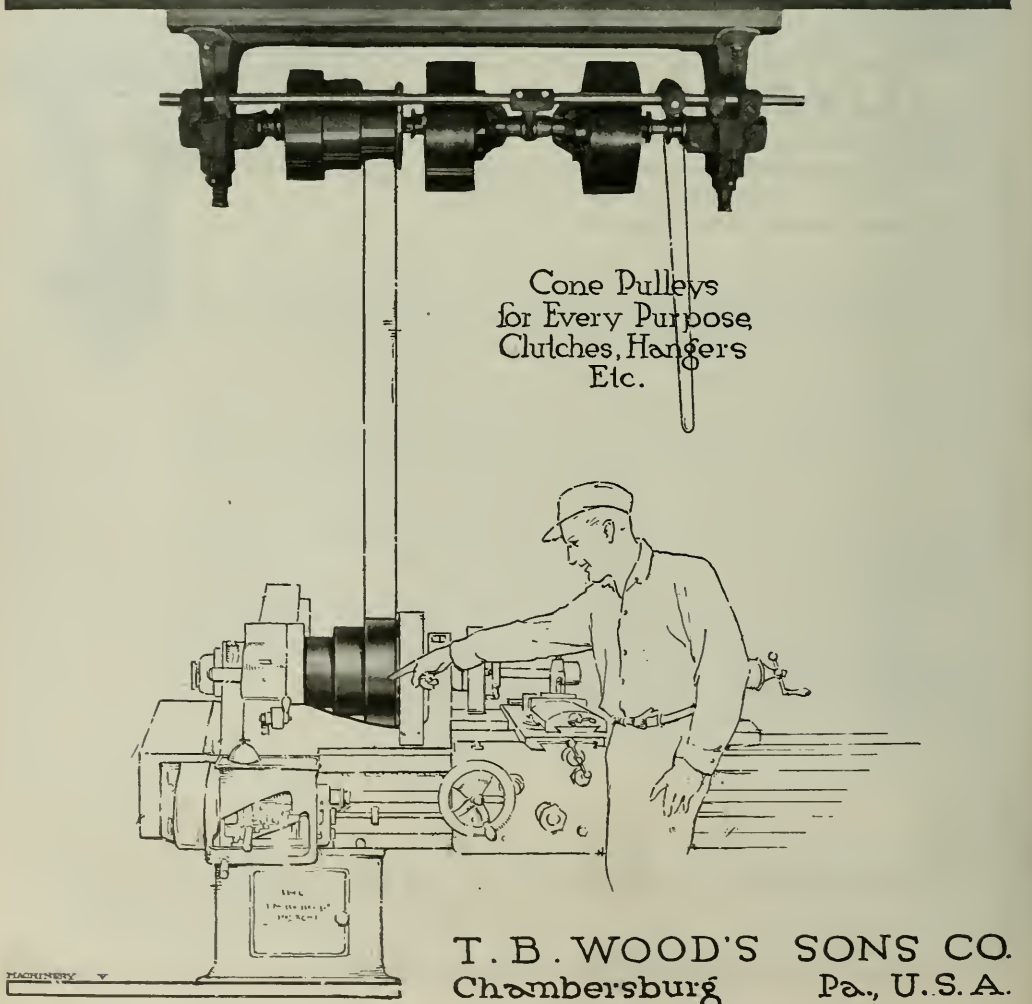
624

Power Transmission Appliances

We've been specialists in this line for 63 years—experimenting, expanding and improving. Though we have limited ourselves exclusively to the one class of service, our line includes every item even remotely connected with transmitting power from generator to tool-spindle, even cone-pulleys for lathes, milling machines, etc.

Machine tool builders who use them agree that these parts are as much improved by "specialization" as bearings, spindles, clutches and other parts of their machines which they no longer attempt to make for themselves.

They find, also, that a complete T. B. Woods unit—countershaft, clutch and cone pulley complete—is a profitable "feature" to incorporate in high grade belt driven mechanisms. Send for our latest Catalog, it illustrates the most complete line of POWER TRANSMISSION APPLIANCES.



T. B. WOOD'S SONS CO.
Chambersburg Pa., U.S.A.



Smoothly, Steadily, Efficiently—

A Shepard Traveling Crane rolls along its tracks—day in, day out there is no variation. After years of service it will be found as dependable as the day it was installed.

All running parts of a "Shepard," except the winding mechanism and truck wheels, are enclosed within the main frame of the trolley. This frame forms a compact, and rigid foundation for the working parts and provides an effective enclosure. Gears operate in baths of oil, insuring thorough lubrication.

Shepard Electric Traveling Cranes are made in capacities of 1 to 50 tons; Electric Hoists, ½ to 30 tons.

Engineers of wide experience will gladly assist you in planning the right type of equipment for any plant. Their services are extended without obligation on your part.

Shepard Electric Crane & Hoist Co.
354 Schuyler Ave., Montour Falls, N. Y.

New York, Boston, Detroit, Philadelphia, San Francisco, Melbourne, Chicago, Cleveland, Montreal, Pittsburgh, Baltimore, London

Member Electric Hoist Manufacturers' Assn.
Member Material Handling Machinery Manufacturers' Assn.

2120-S

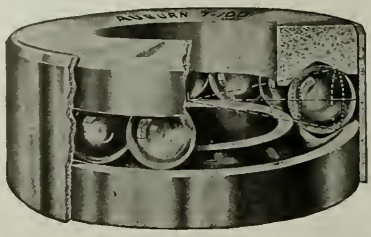
REG. U.S. PAT. OFF.

SHEPARD
ELECTRIC CRANES & HOISTS

AUBURN THRUSTS STAND THE STEADY DRIVE OF THE BUSY SHOP



Steel, Brass and Bronze Balls





Put your problem up to us and get the Auburn Answer

AUBURN BALL BEARING CO., 33 Elizabeth Street, Rochester, N. Y.

It's a Gem



Pleased! He sure is. His shop has standardized on **Gem Oilers.** No more leaky cans with spasdomic feeds, no more makeshifts. Gems are made of the real stuff—four gauges thicker than the ordinary—seams are brazed, bottoms are tempered steel, bushings machine cut solid brass. Highly polished and lacquered. Gem Oilers are made in all styles and sizes.

Send for latest catalogue

GEM MANUFACTURING CO.
1229-41 Goebel Street, near Fulton St., Pittsburgh, N.S., Pa.



MICHAUD Safety Lathe Dogs

Lathe dogs carry a heavy responsibility and can't be chosen too carefully. Michaud Lathe Dogs are rigid, well balanced, 100 percent safe—let us show you. Write today.

Bridgeport Safety Lathe Dog and Machine Co., 353 Warren Street Bridgeport, Conn.

N.B.

NELSON Universal Angle Fixtures and 90° Angle Plates have a Second Face and T-Slot

Let us tell you about them

Nelson Tool & Machine Co., 82-88 LEWELLYN AVENUE, BLOOMFIELD, N. J.



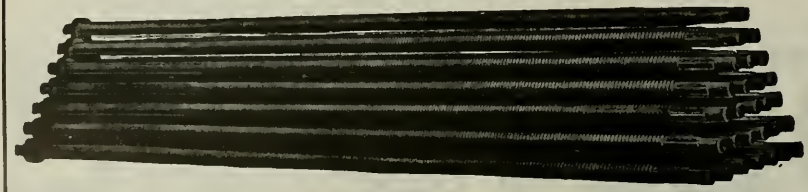
FINISHED BRONZE BUSHINGS

Made to your formula. Machined to your specification. Brass and bronze castings. Rod work in brass. Send us your blue prints

STERLING SPECIALTY CO.
Newcomerstown Ohio

Hindley Screws

We cover the field for power, lead, feed screws of greater strength and durability and can furnish interesting estimates. Write us your requirements—any pitch, thread or size.



HINDLEY GEAR COMPANY
1105 Frankford Ave.
PHILADELPHIA, PA.

The User Speaks Again—

Recently a manufacturer who had stopped buying Arguto Oilless Bearings because he could buy a cheaper oilless bearing, came back to Arguto with this comment:—

"Our chief engineer says he has had all sorts of bearings submitted, but could not find any other oilless bearing as good as Arguto.

"We have tried every other oilless bearing on the market in careful tests, and our chief engineer is so positive in his report that we are again going to put our bearing problems in your hands."

Back of Arguto Oilless Bearings is a jealously guarded principle of sound materials properly treated, true and accurate workmanship. That is why we are continuously bearing from the users of Arguto Oilless Bearings.

It is the say of the user that counts.

Outwears the best bronze.

Smoother than grease.

ARGUTO OILLESS BEARING COMPANY

145 W. Berkley St., Wayne Junction, Philadelphia



JACKSON BELT LACER



Write for "The Jackson Book"

WHAT IT DOES

It will completely lace a 6-inch belt in 3 minutes. It will produce a wire laced joint of uniform strength across the full width of the belt.

One man can do in ten minutes time what it takes two men a half hour to do under the old method—a saving of 600 per cent. in labor.

Birdsboro Steel Foundry and Machine Company

Birdsboro, Pennsylvania



MICHIGAN SIGHT FEED OILERS

Insure Efficient Lubrication

Used by machine tool builders everywhere. Write for catalog showing our complete line, including multiple oilers, plain brass oilers, etc.

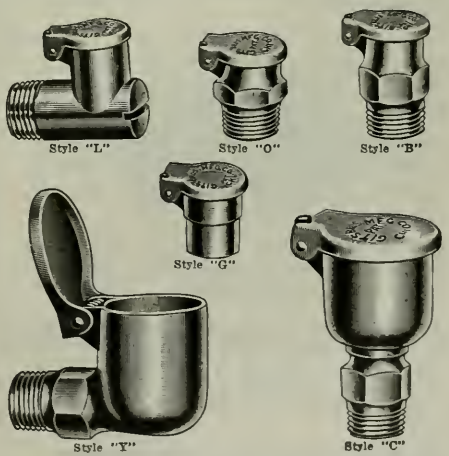
MICHIGAN LUBRICATOR CO.
DETROIT, MICHIGAN

"FRASSTEELS"

A GOOD GRADE FOR EVERY PURPOSE

Manufacturers
Frasse Steel Works
Incorporated
Hartford Conn.

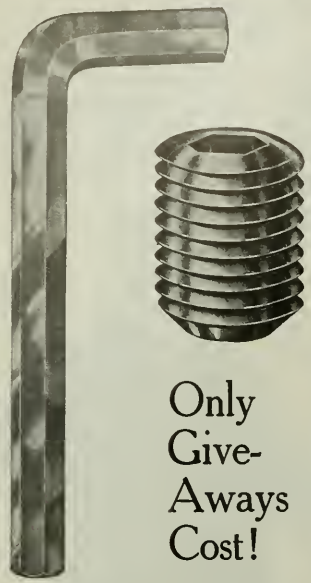
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Peter A. Frasse & Co., Inc.
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GITS OIL CUPS

Give perfect satisfaction where others fail. State style and size in which you are interested, and we will send free samples and catalog.

Gits Bros. Manufacturing Company
1901 S. KILBOURNE AVE. CHICAGO, ILLINOIS



Only Give-Aways Cost!

THE only time a Safety Set Screw is expensive, is when it's so cheap that it reams or mushrooms in the hole.

Then you pay the price of a thousand *good* set screws for the time of the workman who digs out the poor one—and for time lost in idle equipment.

Undeniably, the price of a *broached* hollow screw should be lower than the cold-drawn ALLEN. But the broached screw is never so low-costing in *use*.

The ALLEN is made by a patented process of cold-drawing, which increases the density of the steel around the socket-hole, and *adds to the strength of the screw 30 %*.

Even the smaller sizes, pronounced impractical by other makers, will stand all the strain that the best-made wrench can apply.

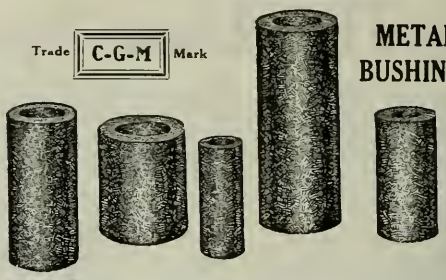
The sockets are clean and perfectly-formed down to the bottom—and this extra depth, with the 30% extra strength of the sockets, is ample prevention against reaming, bursting or mushrooming.

The process is more expensive than broaching—*for us*. It is less expensive for you. The new Allen booklet shows *why;* may we send you copy?

THE ALLEN MFG. CO.
125 Sheldon St., Hartford, Conn.

Pacific Coast Branch Office: The Charles A. Dana Sales Co., 320 Market St., San Francisco, Calif.

Trade C-G-M Mark



METAL BUSHINGS

Self-Lubricating Bushings!

MANUFACTURERS!

Why buy grease cups or oil cups? Why drill oil holes, cut oil grooves or pay for expensive tubing for oil ducts? Also why pay for installing all these obsolete methods of oiling a bearing when you can purchase a SELF-LUBRICATING bushing from us completely finished ready to press into place.



Trade P-L Mark

WOOD BUSHING

We Make Oilless Bushings for:

Conveyors
Vacuum Cleaners
Washing Machines
Textile Machinery
Weighing, Packing and Baling Machinery
Baking Machinery
Candy Machines
Scales
Automobile
Spring Eyes
Brakes
Steering Gears
Soot Blowers and Automatic Stokers

Catalogue on Request

Send blue prints with loads, speeds and general details for our recommendations.

MASSACHUSETTS OILLESS BEARINGS COMPANY
Worcester **Mass.**

Of What Does This Remind You?

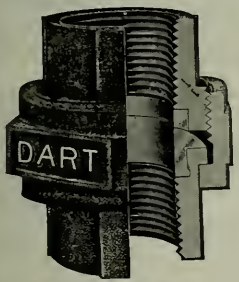


SUPPOSE that you had on hand when your first tap was broken a commercial device built especially to remove the broken pieces of tap, a commercial device not a home-made article, would you not have saved a great deal of time?

Write Us for Information

The Walton Company

310 PEARL STREET HARTFORD, CONN.



No Leaky Rusty Joints

if you use

DART UNIONS

Seats are bronze to bronze, cannot rust or corrode. Accurately fitted, strong, durable. Price list and sample union on request. Write now.

Unions, Ells, Tees, Flanges.

E. M. DART MFG. CO., Providence, R. I.

The Fairbanks Co., Sales Agents. Canadian Factory: Dart Union Co., Ltd., Toronto



WELDING

WILLSON GOGGLES



CHIPPING

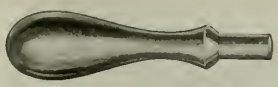
WILLSON GOGGLES Inc., Reading, Pa. *Ask for catalog*



Flexible Steel Tubing

for cutting-tool lubricant. "Wheelock" tubing is most flexible, oil tight, durable. Try it on your machines. Low priced. ⅛-, ¼-, ⅜- and ½-in. sizes. Send for samples.

WHEELOCK MFG. CO., Wheelock, Vt.



Machine tool handles that fit the hand

The workman who operates a machine tool eight hours a day appreciates a good machine tool handle. It makes his work easier—it aids production.

Back of "Cincinnati" Machine Tool Handles are 33 years of handle making experience for the leading machine tool builders.

These handles are made from the finest screw stock, neatly turned, and then finely buffed and polished.

Moreover, we can supply you with "Cincinnati" Machine Tool Handles for less than you can make them yourself.

Our large reserve stocks of all sizes and styles insure you immediate shipment.

Write.

The Cincinnati Ball Crank Co.

DETROIT CINCINNATI



The "Cincinnati" Compression Coupling

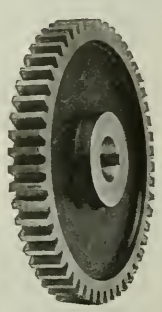
The "Cincinnati" Compression Coupling has just five parts—two rings and three longitudinal sections.

The three longitudinal sections grip the two ends of the shaftings, while the rings hold them on tightly.

Installation of this coupling takes about ten minutes—and you have a connection that will last for years.

The principle of the "Cincinnati" Compression Coupling is an old one newly applied. It has proved its worth through years of service.

Spurs
Bevels
Mitres
Spirals
Helicals
Worms
Worm Gears



Member; American Gear Manufacturers Association

An Investment in

CROFOOT GEARS

returns big dividends in
service, economy and satisfaction

Consult Crofoot Engineers on your gear problems. They will be glad to suggest solutions.

Trade-Mark

CROFOOT GEAR WORKS

INCORPORATED

33 Ames St., Cambridge 39, Boston, Mass.

Nuttall Gears

EVERY GEAR REGISTERED

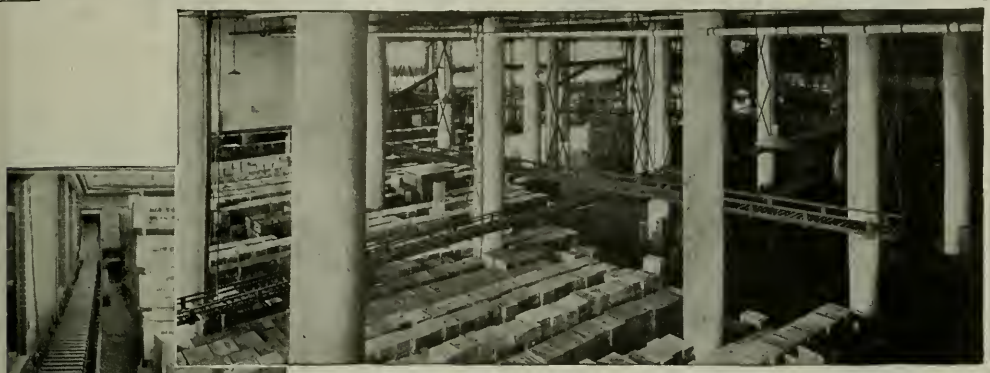
A PAYING INVESTMENT



If you were told that a new make of automobile truck had been placed on the market at an acceptable price and which was guaranteed by responsible parties to last a specified length of time longer than the ordinary type, wouldn't it look like a pretty good investment?

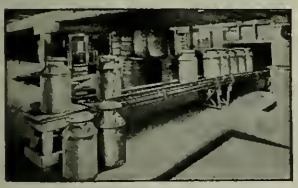
Today, cranes and presses are driven with the greatest satisfaction, not by the ordinary type of gear made of cast steel, but by Nuttall B. P. treated gears ***which are guaranteed to last four times as long as standard cast-steel gears in identical service.***

R. D. NUTTALL COMPANY
PITTSBURGH, PA.



With a Mathews Conveyer system the California Associated Raisin Company can fill or empty this warehouse in one-fourth the time and with one-fourth the labor it would require to do it by wheeling, trucking or carrying. And note the floor space saved! Mathews Conveyers are just as practical in your line of business—indoors or out.









One Big Labor Problem Solved

YOU can't cut down productive labor without cutting down production. But you can cut down handling labor and thereby actually *increase* production. Here's how:

Convey by Gravity—to and from cars, floor to floor, operation to operation, warehouse to shipping platform, etc. Gravity conveying speeds up production by keeping the lines of supply and output open; hands busy; machines "fed".

Gravity costs nothing—draws no pay; consumes no fuel. Gravity reports every morning; no hands short. Gravity stays on the job; lives forever and never goes on strike. Gravity works most anywhere and carries most anything—boxes or bales, barrels or buckets, bundles or bags, cases or crates, cartons or cans, lumber or bricks, castings or pig, etc.

Gravity conveying saves in a way that can be plainly seen—in smaller payrolls, lower costs, greater production. Look into it. A letter or postcard brings further information and, if desired, a nearby Mathews branch sales engineer qualified and glad to discuss your particular problems. No obligation.

Mathews systems are the most thorough exponents of gravity conveying on the market. They are engineered systems. Each is specially adapted to the requirements of the business, plant, layout, handling routes of the concern it is to serve. Portable single units for light work, short hauls, etc.

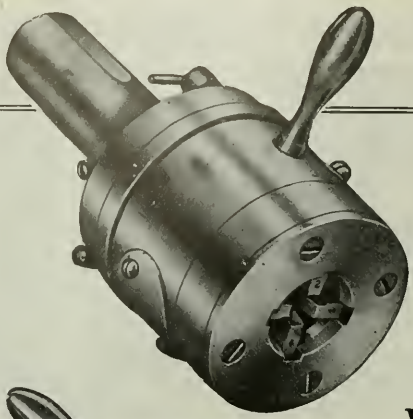
Patented drawn-steel, ball-bearing rollers balanced true and shaped to hold objects to their course. Special rollers for brick and tile, bundled shingles, etc.

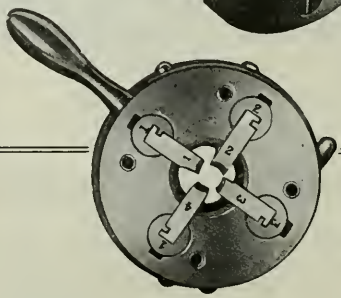
MATHEWS GRAVITY CARRIER CO.
144 Tenth Street, Ellwood City, Pa.

Branch Factories:
Port Hope, Ontario London, England

Member of Material Handling Machinery Manufacturers Association

MATHEWS
SPEED ECONOMY
GRAVITY ROLLER CONVEYER





SEE IT?

Foremost in the ranks of modern thread cutting equipment stands the Victor Self-opening and Adjustable Die Head. Troubles met with in tools of its type have been done away with, and maximum efficiency assured with a minimum of attention.

Has individual plungers set at an angle of 14.5° which support the chasers at a corresponding angle. Slots in the latter fit into a tongue milled in the former. Plungers are securely held in a collar insuring simultaneous action in opening or closing head. Bearing is given chasers along their entire length—THEY CANNOT TILT AND CUT TAPERED THREADS.

VICTOR DIE HEAD

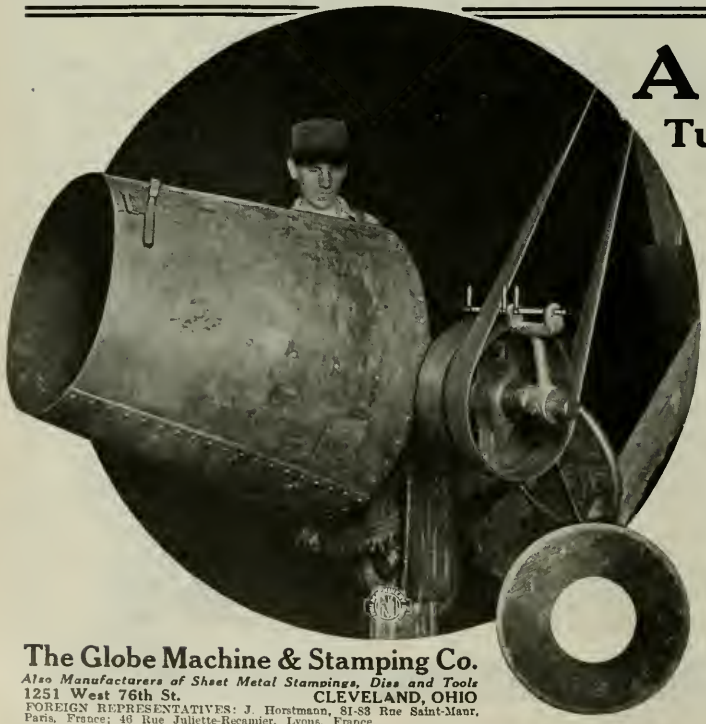
SELF - OPENING — ADJUSTABLE

SEND FOR EXPLANATORY BOOKLET TODAY

VICTOR TOOL COMPANY

WAYNESBORO PENNA.

REPRESENTATIVES: New England, O. H. Lorange, Boston. Michigan, Firmhill Machine Supply Company, Detroit. Illinois and Wisconsin, Eugene Goller & Co., Chicago. Indiana, Thomson Tool and Supply Co., Indianapolis, Philadelphia, Swind Machinery Co. Cleveland, A. H. Howard Sales Engr. Co. Cincinnati, Gang Machinery Co.



A GLOBE
Tumbling Barrel

Cleaning and Burring Washers for the Nash Motor Co.

For one year this GLOBE Tumbling Barrel has been in service at the Nash Motor plant, Kenosha, Wis., where it is used for the cleaning and "burring" of washers. The foreman of the Press Department (where this machine is installed) says that the GLOBE Tumbling Barrel has given them excellent results. To finish a barrel of work takes from fifteen minutes to an hour, depending upon the condition of the work—by this is meant, how much "flash" and "burrs" must be removed.

Let us show you what a GLOBE Tumbling Barrel will do for you.

The Globe Machine & Stamping Co.

Also Manufacturers of Sheet Metal Stampings, Dies and Tools

1251 West 76th St. CLEVELAND, OHIO

FOREIGN REPRESENTATIVES: J. Horstmann, 81-83 Rue Saint-Maur, Paris, France; 40 Rue Juliette-Recamier, Lyons, France.

ADJUSTABLE TAPER CALIPER

QUALITY K. T. W. TOOLS



Easily adjusted, always accurate, insures duplication of tapered parts

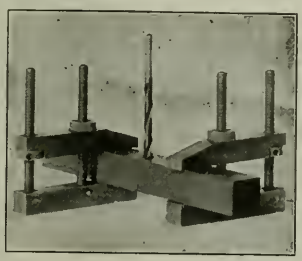


Tapered Part Being Gaged

High Speed Parallel Clamps

Stand firmly and hold work truly parallel. Durable and convenient.

Circulars?



KNAUEL TOOL WORKS

Rock Island Illinois

Rieker Levels Talk

In the same language as the micrometer. The vial is graduated in thousandths, and each graduation indicates 1/1000 out of level per foot of length of machine being leveled. Rugged yet precise. Made in several styles. Send for circular.



RIEKER INSTRUMENT CO.

Manufacturers of Scientific Instruments

1919-1921 Fairmont Ave., Philadelphia, Pa.



Polishing Economy

The "Abbott" Burnishing Barrel is the last word in "polishing economy"—it is a machine that eliminates skilled labor from the polishing department. One man or a boy can operate four or five machines. We will burnish a sample of your work free and give you an estimate of time and cost. Write us today.

THE ABBOTT BALL COMPANY

ELMWOOD, HARTFORD, CONN., U. S. A.

Speed Up "Turnover" on Machine Investments

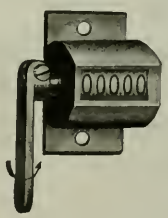
This is a time to turn over quickly the money invested in machines; get out the goods and get in the money; cut down the time of production.

The man at the machine should know what is rightfully to be expected of him in speed and amount of output.

Any machine worth investing in at all is worth equipping with a

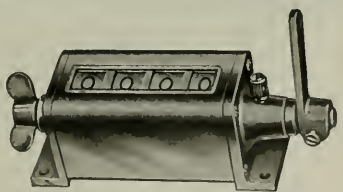
Veeder COUNTER

—to record its production, speed up its operator and make it a quicker *dividend-payer.*



This small **Rotary Ratchet Counter** (No. 6) counts reciprocating movements of the lever, as required in recording the product of punch presses. When the lever is moved through an angle of 40 to 60 degrees, the counter registers one. A complete revolution of the lever registers ten. This counter is adaptable to no end of small machines, simply by regulating the throw of the lever. Price, $2.00. *Cut nearly full size.*

The **Revolution Set-back Counter** below is designed for the larger machines where a shaft-revolution indicates an operation.



Registers one for each revolution of shaft, and sets back to zero from any figure by turning knob once round. Supplied with from four to ten figure-wheels, as required. Price with four figures, as illustrated, $10.00 (List). (*Cut ½ size*)

Write for new booklet showing counters for every possible application.

The Veeder Mfg. Co.

39 Sargeant Street, Hartford, Conn.

Middle West Distributor:
Carey G. Wirick & Co.,
564 W. Randolph St.,
Chicago, Ill.

Pacific Coast Distributor:
F. Somers Peterson Co.,
57 California St.,
San Francisco, Cal.

SaBeN-KERAU

The Super High Speed Steel

SaBeN-KERAU is in demand where the finest grade of High Speed Steel is appreciated—

Because for one and one-half centuries its makers have been reputation building;

Because quality has never been sacrificed to tonnage, and

Because the same conscientious care with all the modern resources of test, analysis and research is devoted to every bar of steel.

MANUFACTURED BY

SANDERSON BROS. & NEWBOULD, Ltd.

ESTABLISHED 1776 SHEFFIELD, ENG.

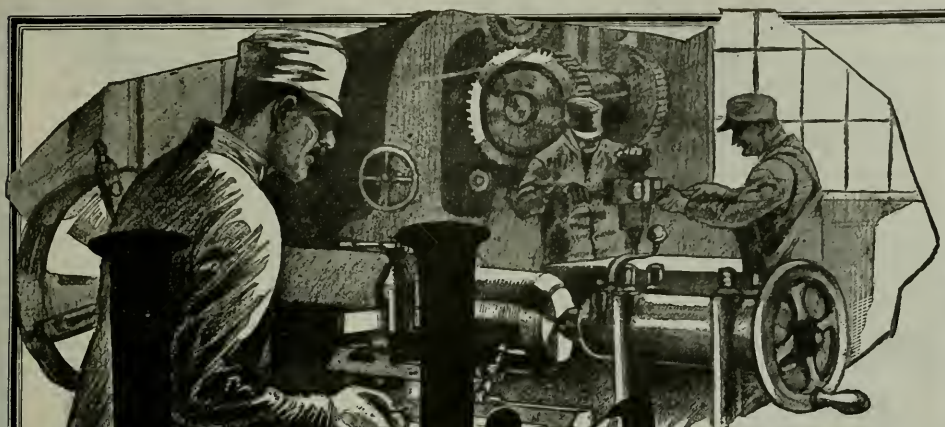
"Made as well as Steel can be made"

ROBERT K. GREAVES AND COMPANY

549 West Washington Boulevard

DETROIT CHICAGO NEW YORK

SOLE AGENTS FOR THE U. S. A.



Higher speed at any depth of cut

Here's a Shaving—

The measurements of this small shaving are: 13 inches long, three-fourths of an inch wide, $\frac{1}{8}$ to $\frac{1}{4}$ inches thick at butt. The shaving was made from an axle forging of 25 per cent. carbon steel, and is *the last of a twenty-hour run with the same Stellite tool.*



BECAUSE tools of Stellite will specifically and actually do more work, and do it cheaper than tools of any other metal or alloy, they are of interest to every manufacturer who seeks *increased production* and a *decreased cost* per unit.

Stellite tools are made for high speed. Stellite is harder than the hardest steel, and this hardness is inherent.

Stellite is not a tempered metal. Tools of Stellite are immune to heat up to 1800 F. Up to this point *the hotter they get the better they cut.* It follows that higher speed at any depth of cut is assured with a corresponding decrease in manufacturing costs, in other words *greater production at less cost.*

HAYNES STELLITE CO., KOKOMO, INDIANA
CARBIDE & CARBON BLDG., 30 EAST 42ND STREET, N. Y. C.

STELLITE

Not Steel—But Its Master

UNION DRAWN SERVICE

Bright Finished Steel

Quality, Variety, and Delivery Unexcelled



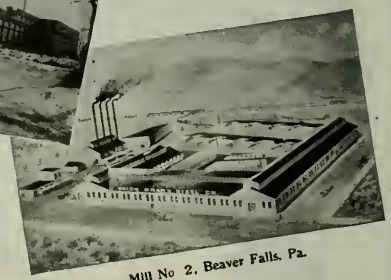
Main Mill, Beaver Falls, Pa.



Mill, Gary, Indiana

WE specialize in Cold Drawn, Turned and Polished Shafting and Elevator Guides, Free Cutting Screw Stock, Squares, Flats, Hexagons and Special Cold Drawn Shapes—Best Bright Bessemer, O. H. Alloy and Electric Steels.

Write for Quotations



Mill No 2, Beaver Falls, Pa.

Union Drawn Steel Co. Main Office: **Beaver Falls, Pa.**

WORKS: Beaver Falls, Pa. and Gary, Ind,

Other Offices and Warehouses—New York, 460-466 Washington St. Philadelphia Ninth and Willow Sts. Cincinnati, Spring Grove Ave. Chicago 570 West Adams St. Detroit, 69 Jos. Campau Ave.
Sales Offices—Boston, 95 Milk St.; Buffalo, White Building, Cleveland Rockefeller Building.



"Ketos" Exclusively Here

This photo was taken in one of America's leading airplane factories, where exhaustive experiments have proved "Ketos" the best steel for expanding taps, thread and ring gages and other special tools that must hold their shape through heat-treatment.

It hardens uniformly, without shrinkage or distortion, and is an excellent substitute for high speed steel at an appreciable saving in cost—as many manufacturers have proved by experience, die-makers being particularly enthusiastic about it. Try it in your toolroom.

Hawkridge Brothers Company

303 CONGRESS ST. BOSTON, MASS.



A Big Thing in Ball Bearings

UNIFORM carbonizing and case-hardening are paramount to the success of any ball-bearing. Because of their non-oxidizing properties Cast Nichrome Retorts and other heat-treating containers permit the heat to penetrate readily and uniformly. Heats are shorter and fuel consumption is less for the same reason. Cast Nichrome Containers last for thousands of hours at 1800° F. without warping, cracking or scaling. Economy is doubly assured by the Nichrome guarantee: Cast Nichrome Heat-treating Containers for every purpose—

Manufactured under HENDERSON Patents by

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BRITISH WORKS
DRIVER, DRENNAN & COOPER
MANCHESTER, ENGLAND

Rotary Retorts of

Cast Nichrome

ENDURE IN HIGH TEMPERATURE

Besly Taps Are Well Appreciated in Making Agricultural Tools



For five years Besly Taps have been used exclusively in the William E. Pratt Mfg. Co.'s factory at Joliet, Ill., for tapping malleable iron clevis castings for plows, wagons and other agricultural tools. A specially designed four-spindle machine is used and three clevises are run on the tap shank, which is removed and replaced without stopping the machine.

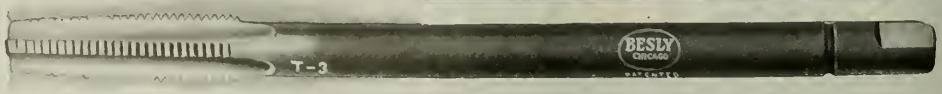
These castings are particularly mean to tap, as there is apt to be sand in them; but the superintendent says that Besly Taps "stand up better than any others."



Big Output Per Day and Between Grinds

When photographed the machine was tapping $1\frac{19}{32}$"—12 holes, with all four taps working at once, and turning out 750 per spindle per day—3000 from the whole machine. One tap threads 1500 clevises—2 days' work—between grinds.

Charles H. Besly & Company
120-B No. Clinton St. Chicago, Ill.





Better Than The Average Drills

OBVIOUSLY, the drill that stands the test is the drill which is made with the greatest measure of care and precision.

Celfor Drills are made with a view to standing tests. Their makers forsee the stress, the punishment to which they will be subjected.

They recognize the probability of human error. They are aware of the fact that in using the small motor-driven drill, a man cannot continue to bore exactly on a vertical plane. Fatigue compels him to occasionally drive on the bias.

This especially on the deeper holes, is what tells on a drill.

The grain of Celfor Drills is uninterrupted by milling. They are forged. Their flutes are twisted into the high speed steel while at white heat; they are cooled properly and well, so that only tough, wear-resisting, fibrous steel remains, which is deprived of its brittleness by a soft core.

A book called "Putting Mettle in Metal" tells you more about the qualities of Celfor Drills. It will be sent to you on request.

CLARK EQUIPMENT COMPANY
Buchanan, Michigan

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Montreal, Rudel-Belnap Machinery Co.; Toronto, Rudel-Belnap Machinery Co.; Amsterdam, U. S. Trading Corp.; Buenos Aires, Marden, Orth & Hastings Co.; Calcutta, Tapper & Selikowitz; Christiania, John M. Larsen; Copenhagen, John M. Larsen; Gothenberg, John M. Larsen; Stockholm, John M. Larsen; London, Coates Machinery Tool Co.; Milan, Weiss & Stabilini; Tokio, Andrews & George; Paris, Moerch & Roumet.

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or
Set Screw Sermons
No. 4



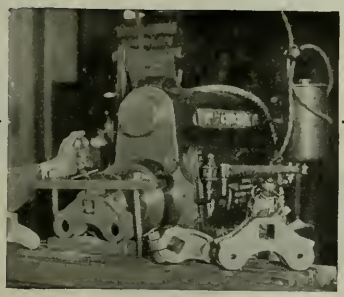
mac-it



BRANCHES
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Just as a tack can puncture a tire, a set-screw which goes wrong can tie up an expensive machine or a whole department. There are few worse places for careless buying than on set-screws.

THE STRONG, CARLISLE & HAMMOND COMPANY
CLEVELAND
(MAKE MAC-IT ENDURANCE YOUR BEST INSURANCE)

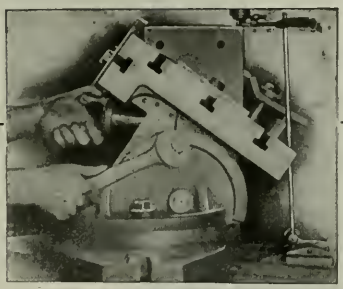


Can You Use SQUARE HOLES?

Many industries are now using square holes in their manufacturing processes, but many more have been unable to do so because there has not been on the market a device for quickly, cheaply and accurately producing them. With the

Radbore Head

it is possible to *drill* square holes and produce a finished job in a single operation. Holes may be drilled in sizes ranging from ⅛" up to 2" in diameter, to any depth or blind with absolutely flat bottoms, and with a twist drill. There is no vibration, and while in operation the drill always maintains alignment by a 4-point bearing, thus giving positive action. The holes can be drilled in any substance, out of whole material, in a single operation, and without previous preparation or subsequent finishing.



Nelson Angle Fixture

The Nelson Fixture and Angle Plate is the only fixture which provides a second face and T-slot. Here are some of the exclusive features:

Complete absence of overhang in any position.

Low and compact.

Vertical adjustment up to 90 degrees by means of a handle operating a worm-wheel sector, the design of which has been worked out in such a way that dirt or chips cannot become lodged in the machine.

Location of T-slots allow for powerful clamping without disturbing the most accurate setting.

Swivel base graduated up to 360 degrees; swivel for tilting tables graduated up to 90 degrees.

Absolute rigidity and stability.

Zero adjustment on horizontal plane.

THESE two devices, sold exclusively by the Fairbanks Company, are fast becoming essentials in every up-to-date machine shop. They are designed scientifically and therefore do their work more quickly and produce more accurate work at a lower cost.

Besides these and other special devices, the Fairbanks Company also sells a complete line of machine tools and machinist's and machine shop equipment. The pooled stock of 24 branch houses is at your disposal, the consequently enormous purchasing power assures a fair price, and the FAIRBANKS O. K. is your guarantee over all. *Send for descriptive literature.*

The FAIRBANKS *Company*

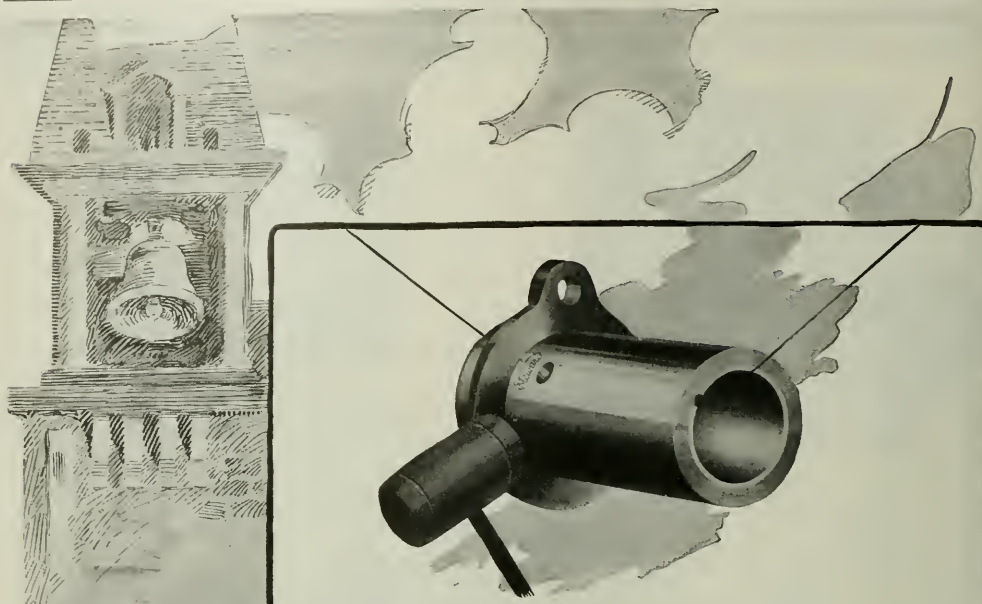
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The Bell-Like Ring of One Solid Metal

Bronze-Back Bearings

Suspend a Stewart Bearing by a cord and tap it with a hammer. The surprisingly clear bell-like ring proves the unity of the bronze backing with the babbitt lining. These two parts are so inseparably united that disintegration is practically impossible.

Stewart Bearings are designed for use in automotive equipment, transmission machinery, electric motors and generators, as well as special machinery involving unusual problems of load or lubrication.

Let Stewart engineers work with your own engineering department in designing a special bronze-back bearing that will be best for your product.

Stewart Manufacturing Corporation
4500 Fullerton Avenue, Chicago

Stewart

FIRTH-STERLINGISM

is the doctrine of the human element in steel making and tool making, a just tribute to the man at the fire and the man at the machine. Efficiency and capacity in tools are in proportion to the character put into the work.

Steel and tools have character just as men have character. All character, human and metallic, is developed by natural processes. There must be enough friction, but not too much. There must be enough work, but not too much. Claims for tool steel or advertisements which eliminate the man and the human element of coöperation have a depressing effect on personal ambition and this effect means failure. The mechanic has pride in his job just as the president has pride in his job. Both have responsibility and both need encouragement.

Nothing is more helpless than a bar of steel. Alone it can do nothing. It leans against the wall of a blacksmith shop awaiting man's skill and the heat of the forge to call it to work and action. The human element of determination makes steel tools cut metals; the human element of determination makes steel ships cut the seas.

No first-rate tool was ever made in a hurry except by accident. Time is required for honest work. A thoughtful tool dresser will measure aright the value of time in heating steel. The design of a tool is more important than the temper, but every good tool must have both. Proper designing and proper forging are important, tempering to suit the work is important, the grinding is important, but all these may be right and the tool fail by improper use. Firth-Sterlingism recognizes that credit to all is the spirit of the age; including the man that designs, the man that forges, the man that tempers, the man that grinds and the man that uses the tool, all coöperating for success and profit to the man that pays the bills. There is a capacity in a well-made tool that defies analysis because it is part of the man himself. The mission of a bar of steel has only begun when it is delivered to the buyer. At that point the seller's responsibility ceases and the buyer's responsibility begins. The outcome is beyond the control and responsibility of the maker of the steel. Superiority in steel is a fact. All steel is not alike. There is more in steel than chemists can find. Good steel came before laboratories. Good bread came before cook-books. Good blacksmiths and good mechanics came before printing presses.

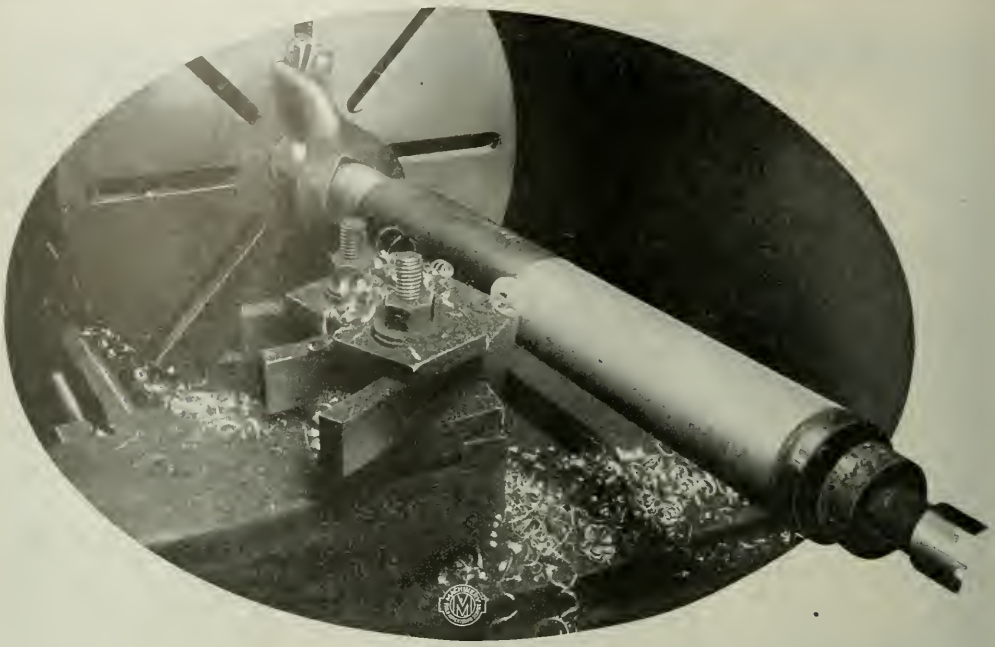
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High Grade Tool Steel For Every Purpose

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NEW YORK BOSTON PHILADELPHIA CLEVELAND
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A Unique Set Up Made Possible by the Cutting Qualities of

Electrite Uranium Tools

Though there are three Electrite Uranium Tools shown in this photograph only two are used in each operation.

This manufacturer cuts the non-productive time in manufacturing rear axle tubings by arranging his tools to cut on both the forward and reverse movement of the carriage. The first and center tools take the cut on the forward movement—a new tube is inserted and the third and center tools come into operation on the return. This time-saving method of handling this job is aided by the cutting qualities of the tools—all of Electrite Uranium.

Try Electrite Uranium Cutting Tools. They pay.

LESCO

Use Lesco Steels for every purpose. Tell us which one you need.

LATROBE ELECTRIC STEEL CO.

Latrobe **Pa., U. S. A.**

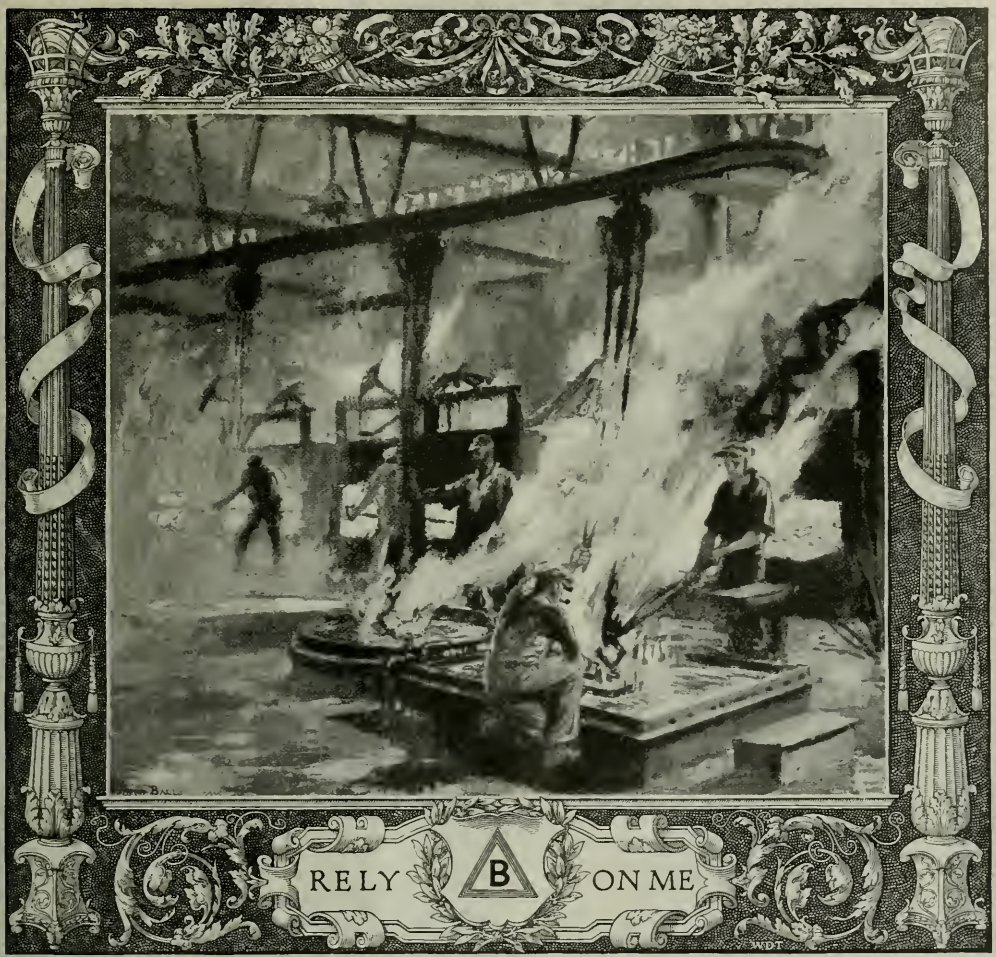
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THE man who tempers a BILLINGS & SPENCER die performs a task of infinite delicacy. He builds high character into steel. His craft goes beyond mere knowledge—it is work no machine can perform, no instrument gauge. The rightness of the Triangle B die passes inevitably to the Triangle B forging. In steel, as in men, character begets character.



Produced in the United States

Have you ever stopped to consider that Molybdenum is the *only* "commercial steel alloying element" produced in the United States in sufficient quantities to take care of our growing domestic industries?

In fact, the world's chief source of supply lies right in the town of Climax, Colorado.

Thus is the American steel industry assured of a continuous supply under *any conditions.*

The superior commercial properties of the Molybdenum Steels are completely set forth in our book, "Molybdenum Commercial Steels," which will be sent upon application to

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Molybdenum Steels

Easier to Heat Treat
Easier to Machine

Dynamically Tougher
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has been one of our most popular publications because it not only tells what steel to use, but the proper methods of handling, treating, and the results that can be obtained. A unique and successful feature is the inclusion of a set of curves showing the critical temperatures and physical properties of all the steels listed. Do you have a copy? If not, our nearest district office will be pleased to supply you with one.

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To Increase Output and Lower Cutting Costs

It cuts faster and longer between grinds than any corresponding steel on the market. That is why we claim that Novo Superior will increase your output and lower your cutting costs.

We know it is the best high speed steel on the market—the only one that high power machines can safely drive at top speed.

Prove it?

That's just what we're hoping for an opportunity to do. We're ready to fill your trial order without delay and we leave it to you to decide whether or not our claims are fully justified.

All standard styles and sizes in stock in our nearest warehouse.

We carry also a complete stock of High Speed Novo Twist Drills.

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CORED AND SOLID BRONZE BARS

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DIXON'S ELDORADO

"the master drawing pencil"

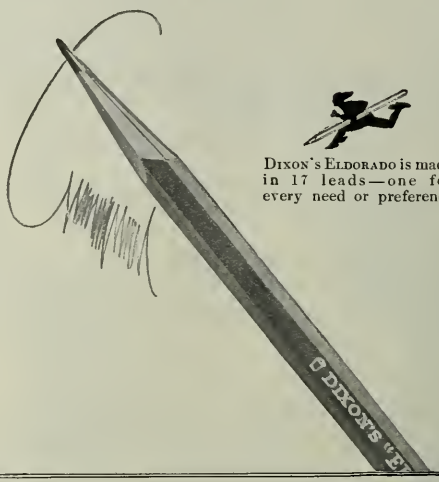
Use a 2H, 3H or HB Dixon's Eldorado for making simple detailed drawings. The final result is eloquent proof of the quality of this master drawing pencil.

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Write to us on your letterhead, tell us the kind of work you do, and we will mail you full-length free samples of the pencils best suited to your particular needs. Also write for interesting free booklet—"Finding Your Pencil."

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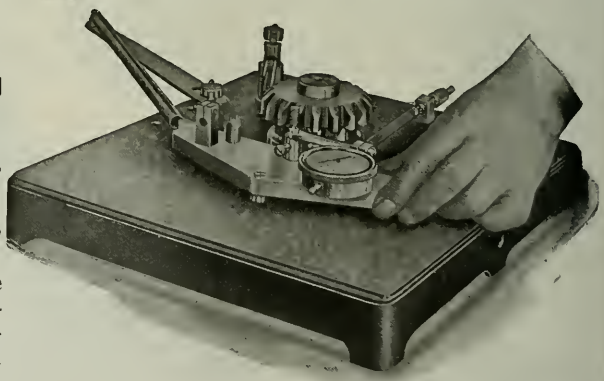
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Dixon's Eldorado is made in 17 leads—one for every need or preference

KAVLE

Correct Involute Contour Indicator



You are interested in Quiet, Long Lived Gears.

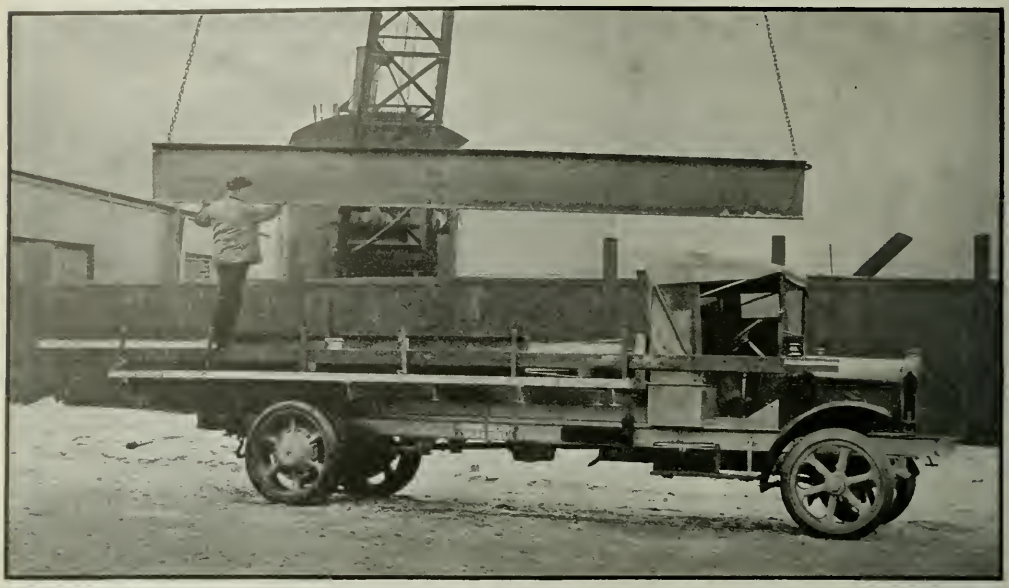
Therefore, you will welcome "KAVLE CORRECT INVOLUTE CONTOUR INDICATOR"—a newcomer in the shop.

This indicator will indicate the accuracy of contour and indexing to within .0002" by direct reading on the indicator dial.

One of the largest transmission manufacturers in America made this statement: "Before indicating our gears with the 'Kavle Correct Involute Contour Indicator' it was necessary to assemble, test, dissemble and reassemble 60 per cent of our transmissions in order to obtain quietness. By assembling gears which passed inspection by the use of this gauge, this dissembling and reassembling was reduced to 2 per cent. The noise from this 2 per cent was found to arise from other sources than the gears."

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SYRACUSE **NEW YORK, U. S. A.**


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QUICKLY
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One of a fleet of 8 Whites owned by The Bourne-Fuller Co., of Cleveland

The MOST WORK *for the* LEAST MONEY

THE Bourne-Fuller Co., of Cleveland, has had seven years' experience with White Trucks. Cost records have shown this owner that Whites last longer, do more work, and cost less to operate and maintain.

Evidence of this fact is shown in the comparative records of a 5-ton White and a 5-ton truck of another high-grade make doing similar work, kept during a period of a year. Summarized, these records show that:

The cost per mile traveled was 22 per cent less for the White than for the other truck.

The cost per ton hauled was 13 per cent less for the White.

The White gave 30 per cent greater mileage per gallon of gasoline.

The repair cost on the White was 17 per cent less than on the other truck; the White ran 8450 miles, the other truck only 6820 miles.

It is through such records as this that the White's reputation for economy has been so unquestionably established. The most experienced truck users increase their White equipment steadily because White Trucks steadily do the most work for the least money.

THE WHITE COMPANY
CLEVELAND

White Trucks



Distinguished For Excellence of Design

"New Britain" Tote Box Racks are real space and time savers. Especially valuable for stock and assembling room use, but may be employed in many different capacities in various parts of your plant.

Simple in design, light in weight; they are strong and rigid enough to withstand any weight with which they may be loaded. Racks are made to accommodate 16″ x 10″ x 5″ or 20″ x 12″ x 6″ boxes, and can be furnished in height and length to suit individual requirements.

"NEW BRITAIN" Tote Boxes and Tote Box Racks

"New Britain" Tote Boxes represent a radical departure from previous tote box design. The shaped-for-comfort handle; the unique nesting and stacking features; the greater capacity for withstanding abuse without loss of shape—due to formed hem and firmly welded joints; a construction affording maximum strength with minimum weight—all combine to produce boxes of unusual merit, a quite general recognition of which has resulted in their widespread adoption as the standard equipment in hundreds of factories.



We are confident a trial would make you a steady user. Prompt shipment can be made! How many?

The New Britain Machine Company

New Britain, Conn. U.S.A.



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From Shop to Cost Department



Periodograph time tickets carry their message of truth regarding time spent on jobs.

From workman to cost clerk the process of registering time, planning work and computing costs is simplified.

Let a Gisholt salesman trace the course of a Periodograph time ticket through your plant and show you how it will help your production.



Gisholt Methods Insure Accuracy and Economy

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An organization of lubrication specialists



The Sun Company—one of the world's largest producers, refiners and shippers of oil products—has specialized on lubrication for a quarter century. Its output of lubricating oils alone exceeds a million and a quarter gallons per week.

From its very beginning, the Sun Company has aimed to furnish accurate and efficient lubrication rather than just "oil." It has become an organization of lubrication experts.

The choice of oil for any particular service demands expert advice. Manufacturers and big users of lubricants can no more afford to buy oil except on a basis of its lubricating efficiency than they can afford to buy coal other than on a basis of its thermal units.

Engineers and experts of the Sun Company are always available to make a thorough analysis of your lubrication requirement and submit recommendations. This service is free, and will be promptly and cheerfully performed on application to any branch office of the company.

Manufacturers using cutting oils should not fail to read our announcements to follow regarding the Sun Cutting Lubricants. They include Sun Emulso, Sun Automatic Cutting Oil and Sun Pipe Threading Oil.

These lubricants are not just so many more "oils." Tests under every condition of service have shown extraordinary results in lubrication and refrigeration. They have set new standards.

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The money you get from the junk man will pay for enough Texaco Crater Compound to keep him away for a *long, long time*

Texaco Crater Compound saves the gears.

It is a rich heavy lubricant and coats each tooth with a film of lubricant that stays put. So that when tooth meets tooth on "Crater" lubricated gears there is no clash, no wear, no noise, for this great lubricant takes up the impact which the metal would otherwise receive.

Then, too—Crater lasts a long time, for besides being highly adhesive, Crater is waterproof. Water or even chemicals will not wash off Crater. You can use it on chain belts, wire ropes, etc.

For all gears enclosed in oil tight cases use "Crater's" little brother, Texaco Thuban Compound.

Get a supply—Start saving gears

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THE TEXAS COMPANY

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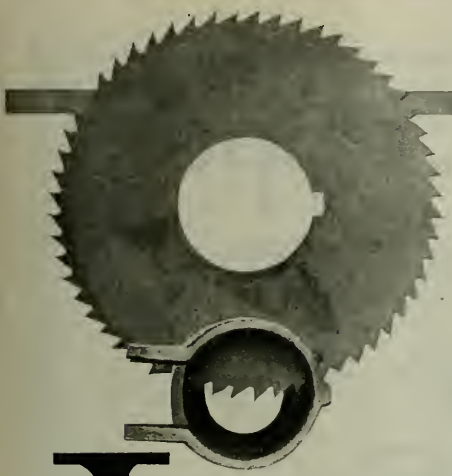
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LINCOLN

HIGH SPEED SCREW SLOTTING CUTTERS

Now
Read What They Have to Say



" . . . we had difficulty procuring saws that would stand up to the work of sawing malleable iron castings until we received a shipment from the Lincoln Twist Drill Company. From the first, these H. S. Screw Slotting Cutters have been used steadily; there is very little variation in them; they combine toughness with the right degree of hardness, and their lasting qualities are better than in any other saws that we have been able to purchase for this work."

Quoted from a letter written May 18, 1920, by one of the largest manufacturers of electrical equipment in the metropolitan district (name on request).

Will you give us your opinion of these saws? Try them.

LINCOLN TWIST DRILL CO.

Taunton **Mass., U.S.A.**

Goggles for Chippers





STOCO

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"CELOGLAS"

SHATTER-PROOF LENS

Stoco Safety Goggles because of their broad smooth surfaces bearing on the face and their remarkably light weight—when their strength and durability are considered—may be worn for hours at a stretch without discomfort.

This feature coupled with the fact that they protect between the eyes makes Stoco Safety Goggles—when equipped with Celoglas Shatter-Proof Lenses—the ideal protection glass for wear by operators on chipping and similar work where the eye hazard is high and continuous.

We are always glad to send a sample Stoco Safety Goggle without charge to interested responsible people on receipt of request on letterhead.

Stoco SAFETY GOGGLES

Price Per Hundred (F. O. B. Geneva, N. Y.)

With Celoglas Shatter-Proof Lenses . . .	$115.00
With Optical Glass Lenses	90.00

Adjustable black elastic headbands or easy cable temples at the same price. Discounts for quantity orders.

STANDARD OPTICAL CO.

GENEVA, N.Y. U.S.A.


Sheffield
By means of our up-to-the-minute equipment and highly skilled workmen we are enabled to build into our tools the highest quality and longest service. We know your wants and can fill them.
Send us your inquiries regarding our
Thread Gauges, Deming Indicators and Thread Lead Checking Instruments
The SHEFFIELD MACHINE & TOOL CO., Dayton, Ohio

better holes fewer dollars

CRITCHLEY SUPER EXPANSION IMPROVED SIX REAMER

"They've pulled me out of some bad holes."

They'll do the same for you. A complete set of Critchley Improved SUPER-SIX Expansion Reamers will ream any hole from $15/32''$ to $4\frac{1}{16}''$ as accurately as you can gage it with a "mike"

The unusually large range of expansion of SUPER-SIX Reamers makes them mighty handy for the repair shop. The $15/32''$ SUPER-SIX, for instance, expands to $17/32''$, while the $15/16''$ reamer has an expansion of $1/8$ of an inch. You can ream any hole from $15/16''$ to $1\frac{1}{16}''$ with just that one reamer.

Besides, SUPER-SIXES will expand — without forcing — from .010 to .015 of an inch over their rated maximum size, allowing them to be reground again and again before new blades are needed.

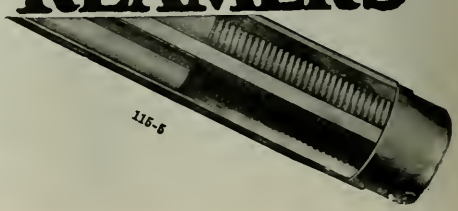
This feature, together with the low first cost of the reamers, makes it worth your while in dollars and cents to look for the SUPER-SIX trade mark.



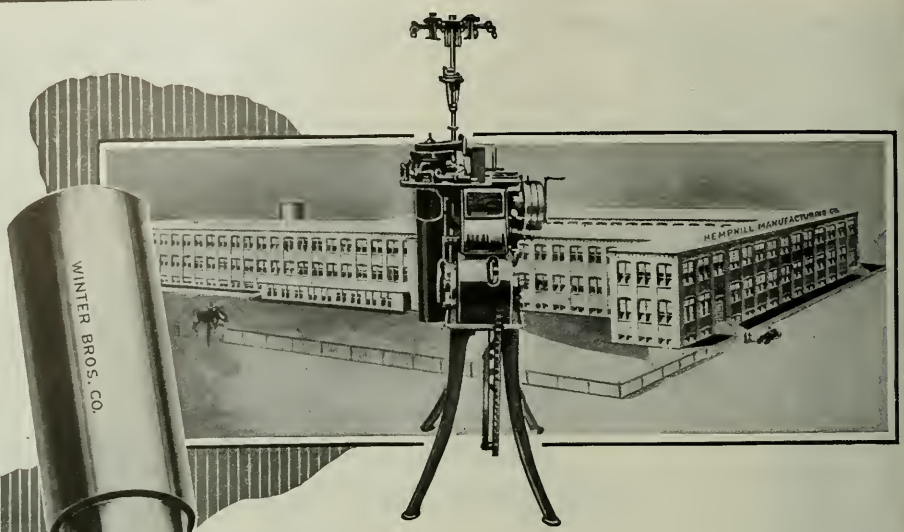
Cutter & Wood Supply Co.
73 PEARL STREET
BOSTON 9, MASS.

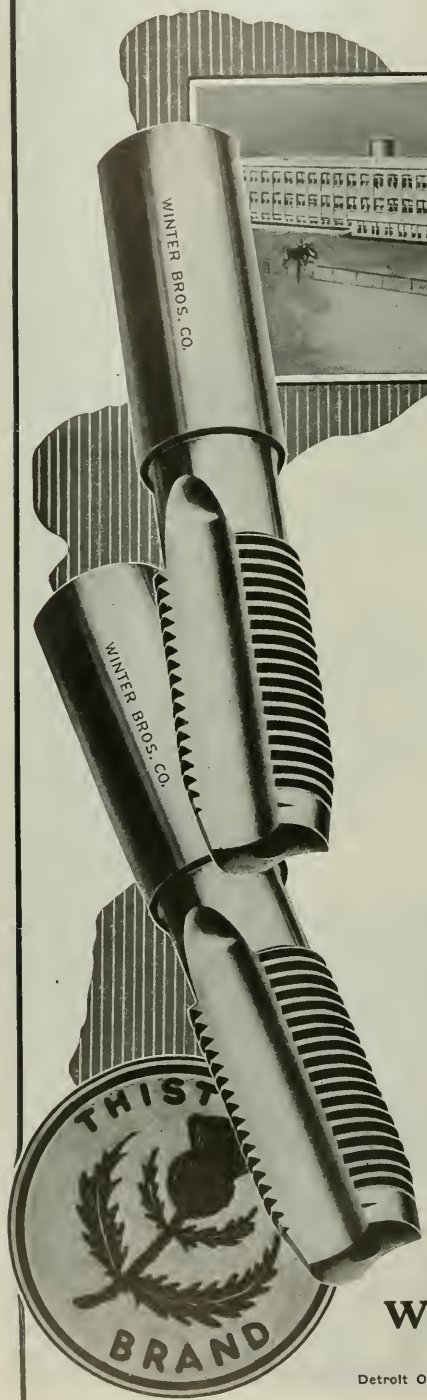
USE SUPER-SIX EXPANSION REAMERS

Proper grinding is absolutely necessary to insure the accuracy and cutting efficiency of a reamer. We shall be glad to send free upon request complete instructions and diagram for regrinding reamers. Just write and say, "Send me regrinding instructions and descriptive price list of Critchley Improved SUPER-SIX Expansion Reamers."




TRANSPORTATION and NATIONAL PROGRESS are Allied Terms
The welfare of all depends largely upon adequate and efficient TRANSPORTATION. In building new equipment and repairing the old few tools play as important a part as do HIGH SPEED DRILLS AND REAMERS.
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High Speed Drills & Reamers
Are long-lived Tools, built not only for accuracy and speed, but to withstand shock and strain. Latrobe DRILLS AND REAMERS are the American Standard of Perfection and Efficiency wherever QUALITY in Tools is recognized.
Look for this mark HIGH LATROBE SPEED on the shank.
LATROBE TOOL COMPANY
MANUFACTURERS
Latrobe = = Penna.
WRITE FOR CATALOGUE
HORSE SHOE CURVE ON THE PENNSYLVANIA LINES NOT FAR FROM LATROBE, PA
Latrobe
The hot rolling of this special high speed steel section compresses the steel in the center, therefore when the drill is twisted the toughest portion is in the exact center.
FOUR FLUTE SPIRAL REAMER





Banner Automatic Knitting Machines Are Built Down in Pawtucket—*and with*

THISTLE BRAND TAPS

"We are pleased to advise you we have been using Winter Brothers' Taps for several years. We cannot recommend them too highly as they are giving us entire satisfaction in every respect"—John Lawson, Pres. & Mgr. Hemphill Company, Pawtucket, R. I.

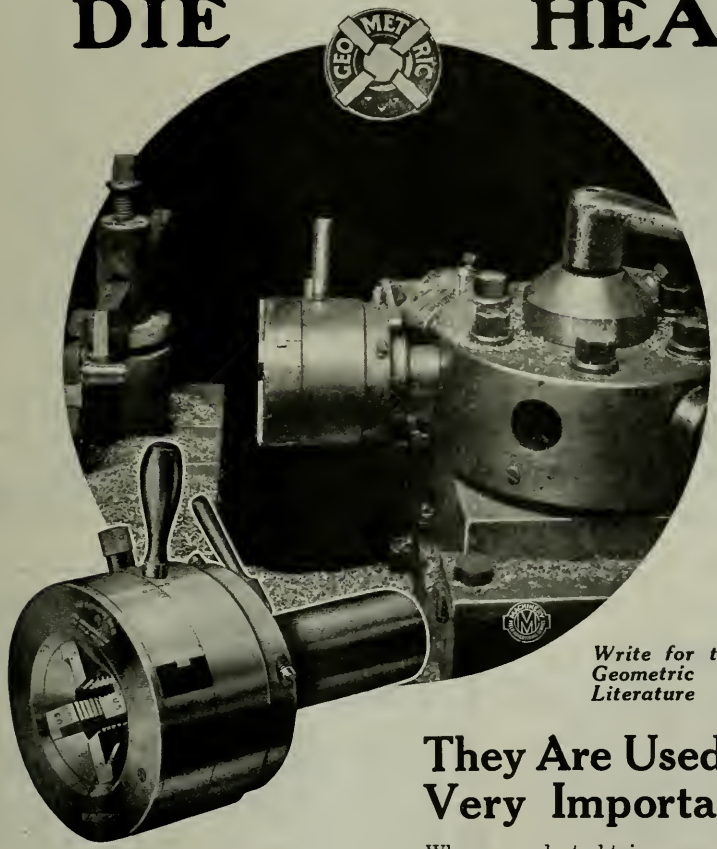
Nothing qualified about this expression of opinion. Yet it's typical of the testimony of all users of Thistle Brand Taps.

Purchasing agents are requested to observe that No. 13 is the only valid edition of our catalog. Yours correct?

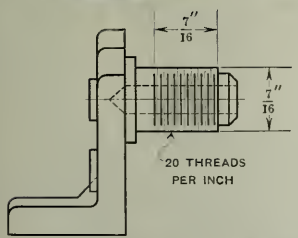
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DIE HEADS



Write for the Geometric Literature



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When a product obtains a world-wide reputation, is adopted everywhere in the best known plants, it is sure to be worth a tryout at least.

Six years ago the National Gage & Equipment Company, LaCrosse, Wis., seeking better, quicker, more accurate threading methods, tried out Geometric Die Heads, now a full installation is kept continually busy—they met every need.

The photograph shows a Geometric Die Head used for threading brass automobile air gage sockets.

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Performance Talks Loudest

When you buy a cutting oil, buy it for what it has done in the past—not for what it promises to do in the future. Performance is the thing that counts.

Because of its remarkable efficiency—extending over a long period of years—you have the positive assurance, before you use a single drop, that you will get uniformly satisfactory service from

LARCUL CUTTING OILS

Many of the largest and most important machine shops in the country are using Larcul, and we are told that the results are even better than with lard oil.

LARCUL AMBER CUTTING OIL

On account of its transparent quality, Amber Larcul has a distinct advantage in work that must be kept constantly under the operator's eyes.

We recommend Larcul Amber on all types of automatic machines, turret machines, gear cutters, hobbing machines, etc., for high carbon, vanadium, chrome nickel and tungsten steel.

LARCUL EBONY CUTTING OIL

Identical with Larcul Amber in cutting characteristics. Particularly efficient for pipe threading, bolt threading, nut tapping, on turret machines running on high and low carbon and alloy steels, and on automatic machines for forming, turning, boring, threading, etc.

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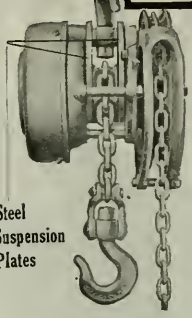
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LIFTING an unusually heavy forging and placing it in a lathe for machining will severely tax the strength of a chain block.

Ordinary cast suspension members might break under the strain. But the steel suspension plates of the Yale Spur-geared Block *safely* carry the load.

The economy of the speedy and powerful Yale Chain Block or Electric Hoist, makes it the first choice of the careful buyer.

Yale Chain Blocks are carried in stock by all representative supply houses. Our new Hoist Catalog explains the details. Write for it.

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Simple, Quick, Efficient

Stops handling and re-handling of materials—eliminates piling and re-piling—reduces non-productive labor to a minimum.

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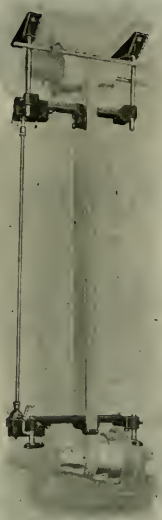
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Our engineers are ever ready to help on drive problems. Our experience is yours for the asking. *Save by securing data and estimates of "Morse Drives."*

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Avoid Accident and Loss of Time
Install the

Safshift Belt Controller



for shifting the heavy belts on those large cone-driven machines. Our No. 4 SAFSHIFT will shift a 6-inch belt up or down on both cones by simply turning a crank.

Easy to operate. Easy to apply. Made to last.

Let us send you diagrams.

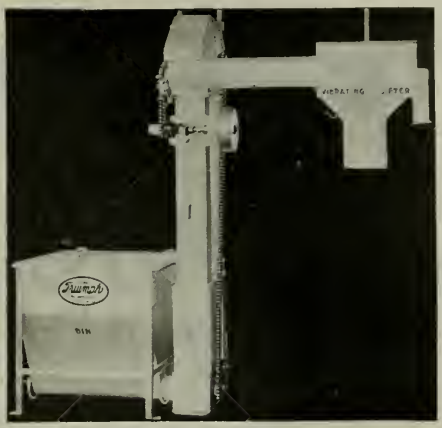
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THEY DO- AND MORE.

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The Durable Drive for Bakery Machinery

This combination all-steel bin, elevator and vibrating sifter—made by the Triumph Mfg. Co. of Cincinnati—is used extensively in modern bakeries.

It depends on two Diamond Roller Chain Drives for the efficient operation of its elevating and sifting mechanism.

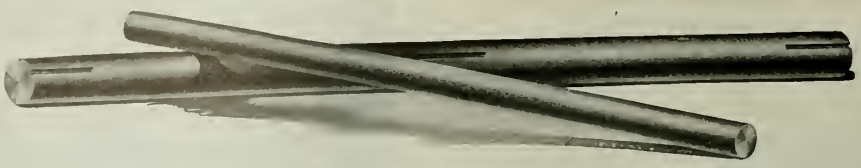
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best meets the special requirements of this machine, just as it is serving thousands of other power machines, ranging from movie machines to giant drill presses.

It delivers power with high efficiency—possesses great strength and flexibility to absorb sudden shocks and prevent breakdown of drive—reduces friction and wear by its smooth, rolling action—gives long service at low upkeep cost.

Builders and users of power machines are invited to send us their transmission problems. Thirty years' experience specializing on chain drives enables us to give you unrivalled engineering service.

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Makers of High Grade Chains Since 1890
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Turned and Polished Steel Shafting

Medart is the only exclusive manufacturer of line shafting equipment producing—*in its own mills*—all of the shafting which it sells.

Medart shafting is made of special steel particularly adapted to the purpose, is perfectly straight, true to size and highly polished—in short, it conforms in every way to those same high standards of mechanical excellence which identify each product comprising the complete Medart line.

Large tonnages ranging in size from $\frac{3}{16}$-inch to 6-inch diameter always on hand. Orders for almost any quantity filled upon receipt.

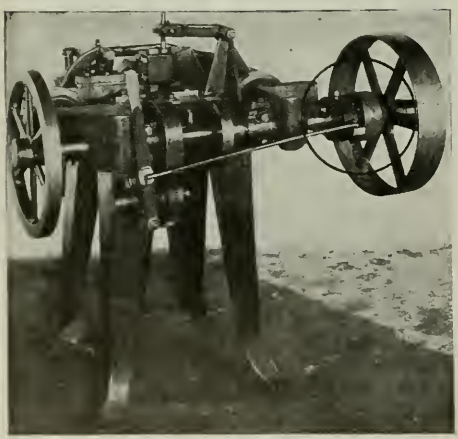
Send for booklet, "Medart Steel Shafting"; submit specifications for large tonnages.

Medart Patent Pulley Company
General Offices and Works, St. Louis, U. S. A.
Office and Warehouse: Cincinnati Offices: Chicago and Philadelphia

MEDART *means* EVERYTHING *in* LINE SHAFTING EQUIPMENT

Controlled by "MULE-PULLS"





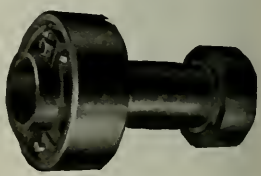
Nilson Automatic Four-slide Machine

Type E. R. (Expanding Ring) MULE-PULL clutches are incorporated in the Automatic Four-slide Machine made by the A. H. Nilson Machine Co. of Bridgeport, Conn.

A Mule-Pull Clutch on a machine tool means absolute control of power and a substantial reduction in the cost of transmitting it.

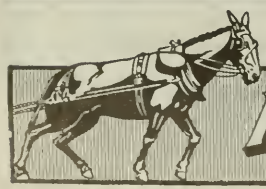
Mule-Pull design is different—many of its features are exclusive.

Complete information is ready for machine tool manufacturers

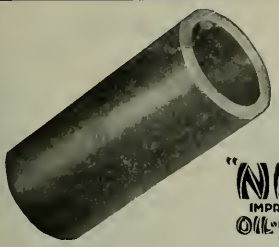


Brown Engineering Co.
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MULE-PULL CLUTCHES
REG. U. S. PAT. OFFICE



"NIGRUM"
IMPREGNATED HARDWOOD
OIL-LESS BUSHINGS

Protection Against Neglect

"Nigrum" (impregnated hardwood) Oil-less Bushings serve a definite purpose for which no other type of bushing is so advantageously suited.

At certain bearing points, difficult of access, "Nigrum" Bushings alone will function smoothly and steadily in the face of continued neglect.

We also manufacture "Bound Brook" graphite and bronze Oil-less Bushings.

All Genuine Graphited Oil-less Bushings have always been made at Bound Brook, U. S. A.

Bound Brook Oil-less Bearing Co.

Specialists in the manufacture of Oil-less Bushings for more than a third of a century

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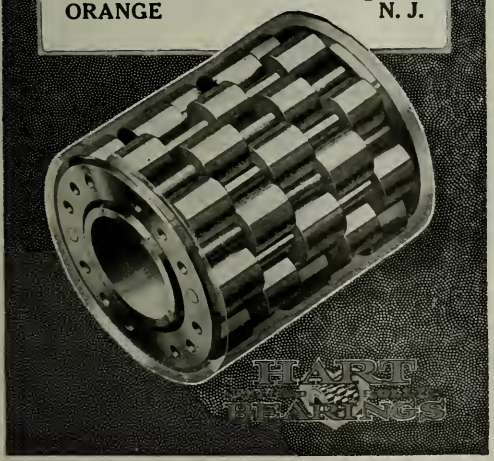
Hart Roller Bearings

FOR greater bearing efficiency and low upkeep cost, specify and use HART Roller Bearings.

Staggered rollers of unequal lengths make the HART the heaviest load carrying, best lubricated and longest wearing bearing ever designed.

The Hart Roller Bearing Co.

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RTB CO

NO MATTER what the *direction* or *character* of a machine-tool bearing load, it can be carried satisfactorily and efficiently on Timken Tapered Roller Bearings. A single Timken Bearing does the work of two ordinary bearings—carrying both radial load and thrust load.

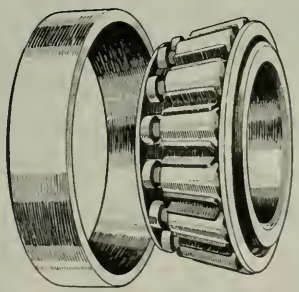
Let a Timken Engineer assist you in the selection of proper bearings for the machine tools you build.

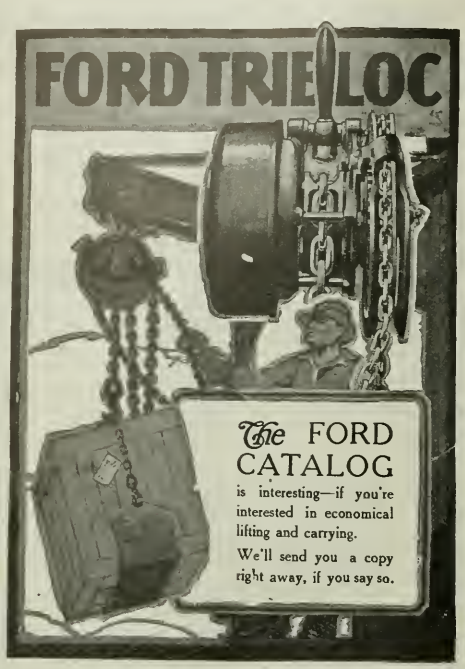
THE TIMKEN ROLLER BEARING CO.
CANTON, OHIO

Plants Manufacturing complete bearings at Canton, O. Columbus, O.; Birmingham, Eng.; Paris, France. General Offices: Steel, Rolling and Tube Mills, Canton, Ohio

Timken Tapered Roller Bearings for Machinery, Industrial Appliances, Passenger Cars, Trucks, Tractors, and Farm Implements.

TIMKEN
TAPERED ROLLER BEARINGS





RUGGED STRENGTH, "built in," is the reason for FORD TRIBLOC permanence.

It is made by men who, first of all, know by actual experience just what a Chain Hoist must do, and who, secondly, have ever striven to keep the the Ford Tribloc the best Chain Hoist made.

The Hand Chain can't jump the hand wheel flange, for a (patented) loop hand chain guide prevents this. Steel cut gears in planetary drive, set in a dust-proof housing, drop forged steel hooks and high-test steel chain, spell safety. Triblocs are built in capacities ranging from half a ton to twenty—and more.

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Reduce Handling Costs in the Shop—

Save the time of your men by equipping your plant with a machine that will lift, carry and place heavy parts, castings, etc., with the minimum amount of attendance.



CANTON

Portable Floor Cranes and Hoists

will handle loads up to 6000 lbs. with the assistance of one man. It is an indispensable part of the equipment of leading plants of the country, and is admittedly "The Handiest Tool in the Shop." Note how the Canton places its load—just in the right position. Speedy handling means greater production. Let the Canton do the heavy work. Send for Catalogue E and complete details.

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Represents a proven factor of dependability in chain equipment.

For years the name of MORTON has stood for quality chain of exceptional endurance powers.

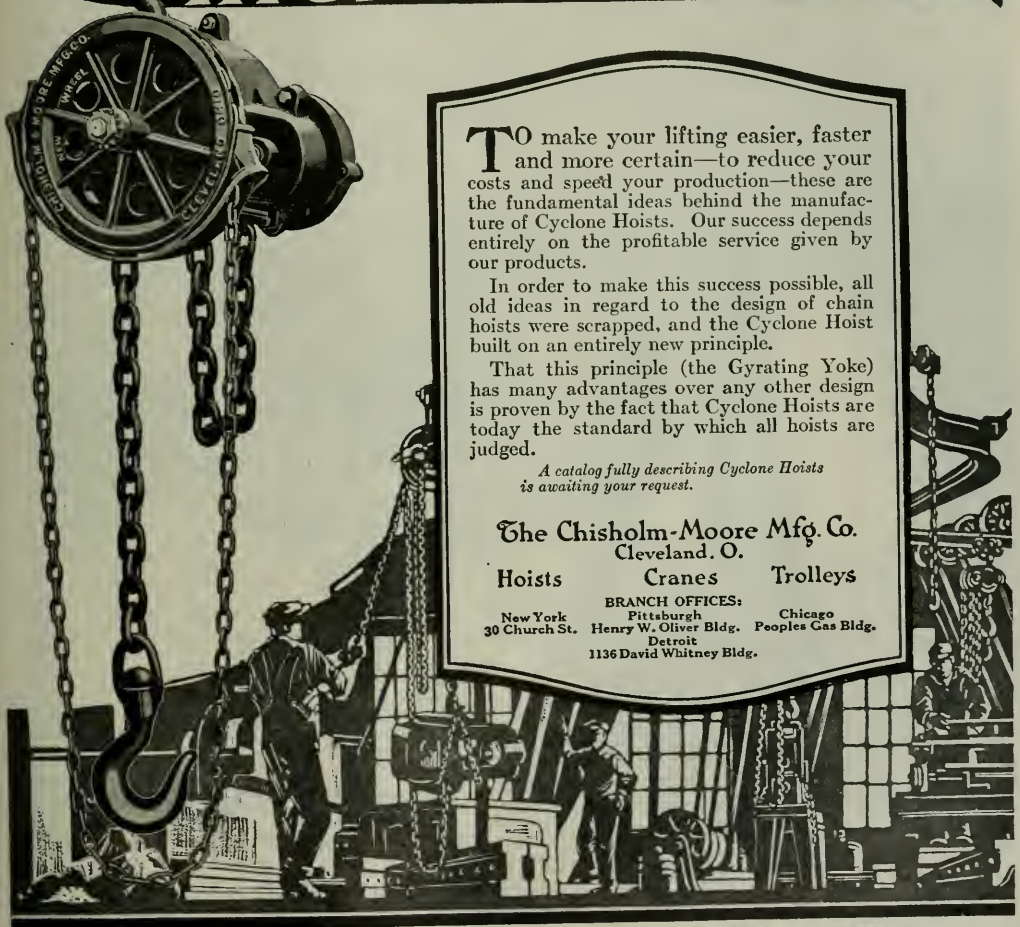
Experiments in machine equipment invariably prove costly. Choose Morton's—it's the first step toward increased production.

Write for quotations.

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TO make your lifting easier, faster and more certain—to reduce your costs and speed your production—these are the fundamental ideas behind the manufacture of Cyclone Hoists. Our success depends entirely on the profitable service given by our products.

In order to make this success possible, all old ideas in regard to the design of chain hoists were scrapped, and the Cyclone Hoist built on an entirely new principle.

That this principle (the Gyrating Yoke) has many advantages over any other design is proven by the fact that Cyclone Hoists are today the standard by which all hoists are judged.

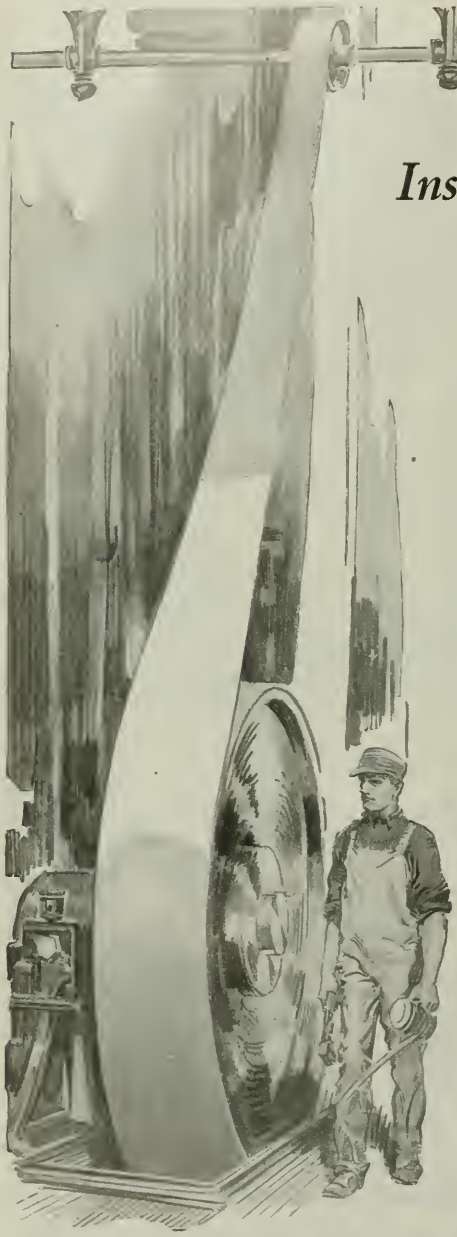
A catalog fully describing Cyclone Hoists is awaiting your request.

The Chisholm-Moore Mfg. Co.
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Hoists Cranes Trolleys

BRANCH OFFICES:
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HOISTS



Install this pulley with equal confidence in any size

THE creation of the American Steel Split Pulley would not have been so remarkable had its design been applicable to only a limited number of sizes and conditions.

Five million and more of this one type of pulley could never have been installed if the "American" Pulley idea had not been equally successful throughout the whole size range of ordinary service.

"Americans" have been made from three (3) to one hundred and forty-four (144) inches in diameter.

Whether it is the big, heavy-load-bearing main drive or the little three-inch auxiliary, each "American" is saving its proportionate share of power. Each is saving its share of shaft load; it's so light for its strength. Each is giving its share of extra belt grip, with its perfect rim. Each is running true.

With the traditions that are back of it, there is probably not a piece of plant equipment you can install with more confidence than the "American" Pulley.

For name and address of nearest Dealer, see Donnelley's Red Book. On file at all leading libraries, national banks and hotels.

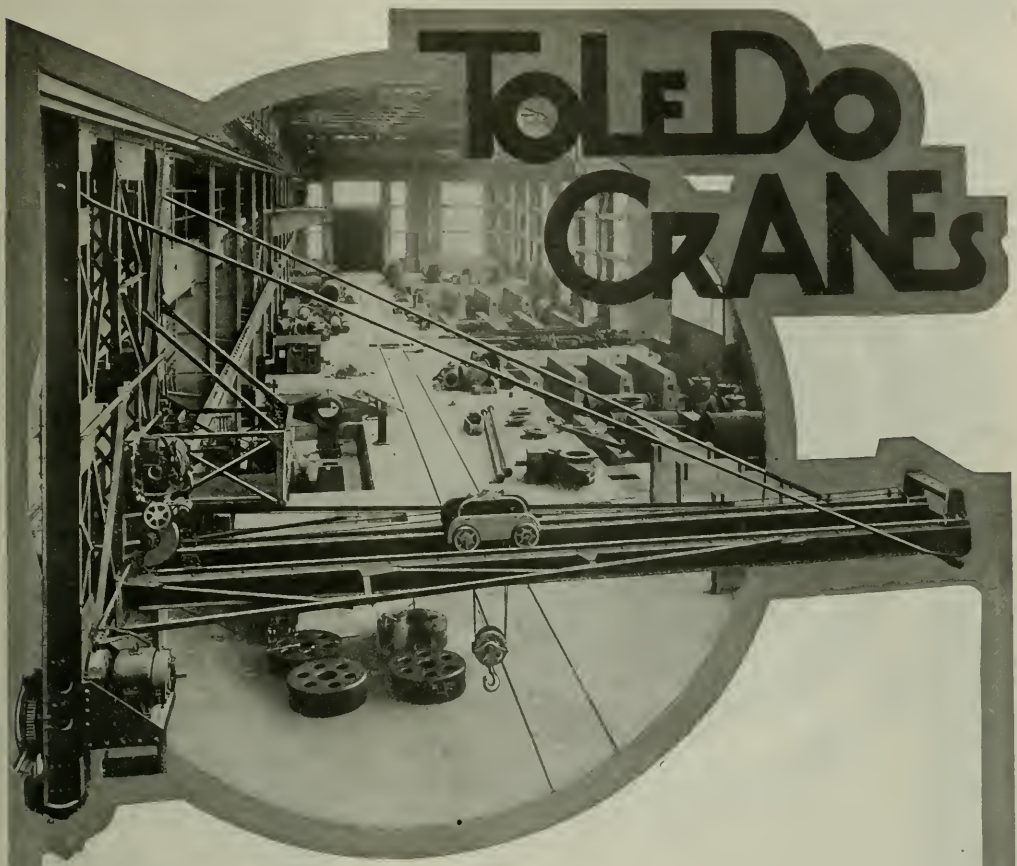
The American Pulley Co.

Philadelphia, Pa.

Write for free book
"Getting Maximum Pulley Efficiency"

The AMERICAN PULLEY

"A wheel with a broad rim transmitting power from or imparting power to machinery, or changing the direction of motion by means of a flat belt."



Payroll or Power Bill?

Local transportation is an important item in production costs. The kind of transportation is just as important. Trucking by manual power is both cumbersome and expensive, nor does either give the speed necessary to economy. A small increase in the power bill is better than a big expansion in the payroll. An investment in Toledo Crane equipment now is equal to a perpetual rebate on your wage bill in the years to come, and will save you much trouble, time and annoyance. Investigate.

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"Pioneer" STEEL HANGERS

"The 'Pioneer' Smile" is more than a trade mark. It stands for progressive manufacturing methods —permanence, economy and above all, safety.

"Pioneer" Steel Hangers are all of this—the modern standard—regularly used in equipping new factories and installed in older shops as fast as practicable. *Let us tell you about them.*

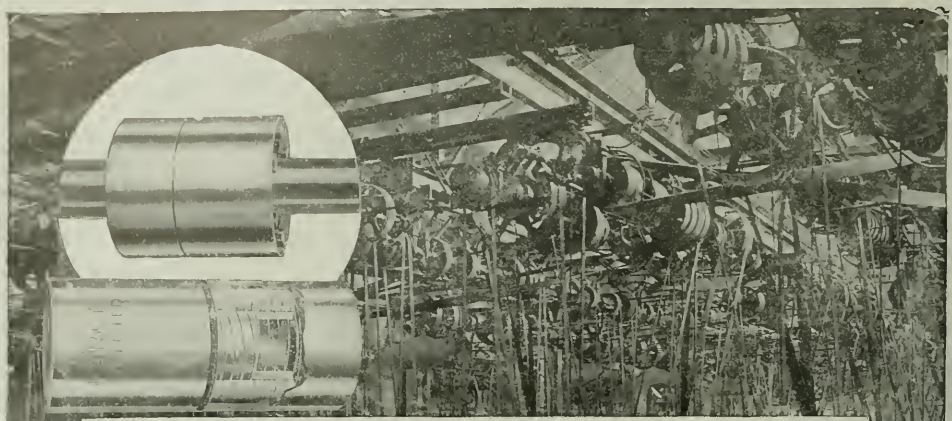
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A single test reveals the great benefits of the TIMESAVER method of fitting bearing surfaces. Mail the attached coupon with $1.50 and an ounce can, enough for 300 square inches of bearing surface, will be sent you. Your money will be refunded if you are not entirely satisfied.

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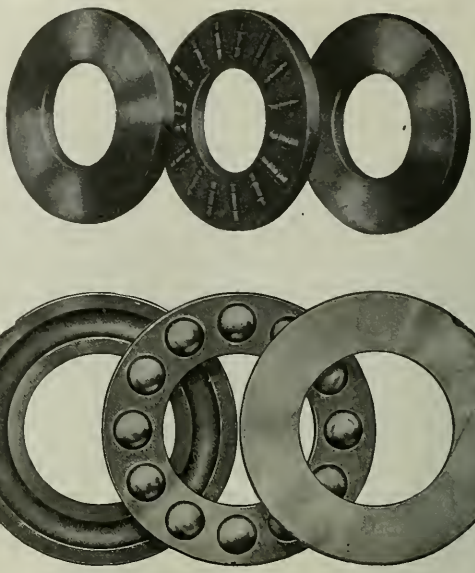
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Accuracy is a word which is inseparable from modern mechanics. Without accuracy fast transportation by road, rail, sea and air would be impossible. Lacking precision the fast moving machinery of the world would be slowed and underproduction would be the consequence.

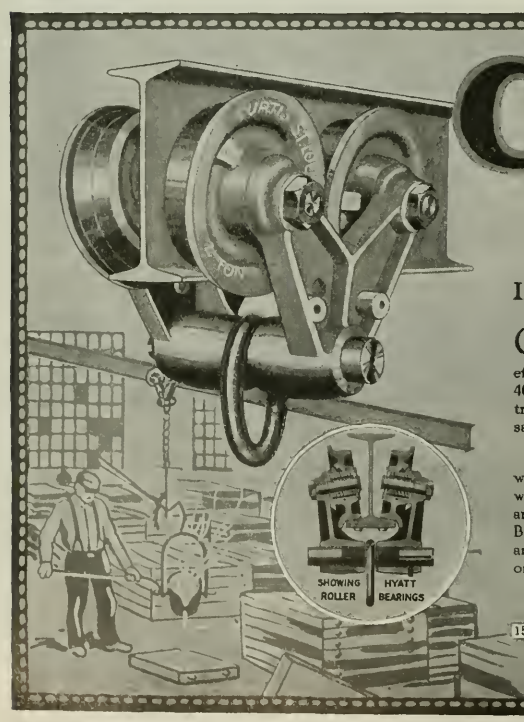
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CURTIS Single I-Beam Trolleys are being used by progressive firms demanding the highest operative efficiency. A Curtis Hyatt Roller-Bearing Trolley with a 4000-lb. load can be moved by a 50-lb. pull, while ordinary trolleys require nearly twice as much power to move the same weight.

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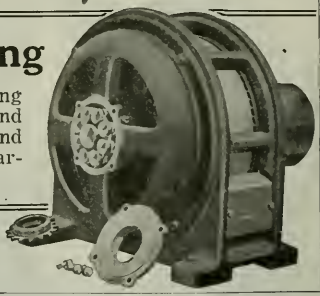
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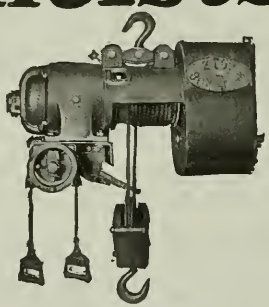
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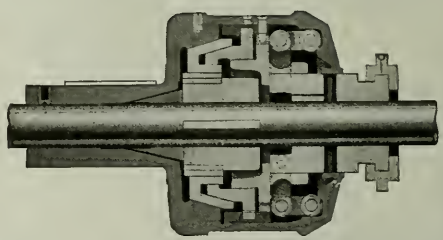
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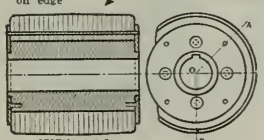


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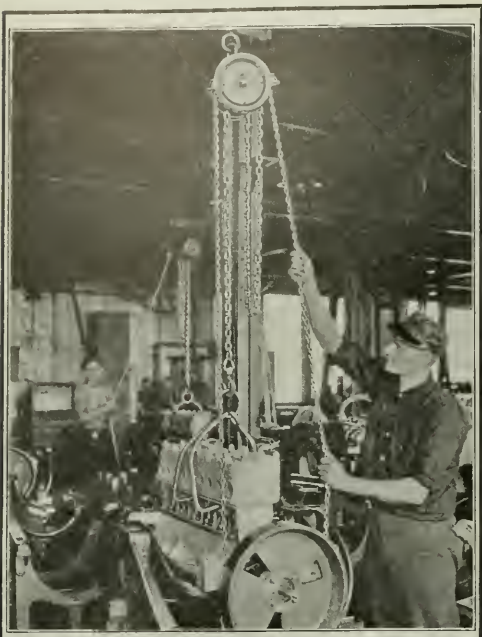
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Recommended for use on motors and in all places where there is belt slippage trouble in the transmission of power. Prompt service on special orders. Send for catalogue and full particulars.

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Cover your pulley faces with this chemically treated fibre—easily applied to any pulley material—and you'll secure a better surface that grips the belt and conveys full power with looser belts. This means less friction in the bearings and less power waste; and your belts will last longer, too. Write for Bulletin 201.

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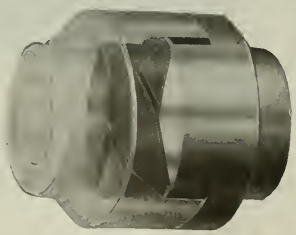
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Simple, safe, strong and durable. Thoroughly reliable in operation, and covered by a positive guarantee. Incorporate it as an integral part of your machines without fear of a breakdown. Write.



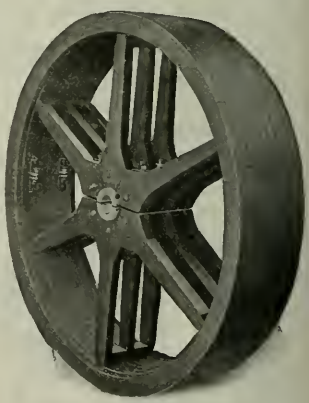
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Highly polished hard wood driving surfaces increase belt adhesion, reducing the power loss due to slippage. Lighter in weight than iron pulleys, Gilbert wood split Pulleys are better able to stand the strain of heavy drives and require less shafting to support them. Used wherever a leather belt can be used.



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The Patented "Conus" spring cover, a feature found only in "Conus" Oil Cups.

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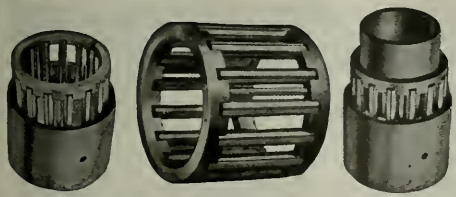
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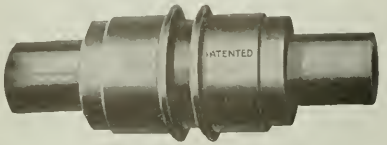
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Ball, Roller, Thrust and Combination Bearings

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Entirely cylindrical, perfectly balanced, compact, simple, powerful, reliable, fully interchangeable. Use with confidence.

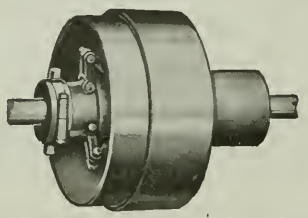
Our engineering department is at your service. Send a sketch or blueprint of the part of the machine into which you wish to work the Hanson Clutch and we will prepare drawings, submit figures, etc.

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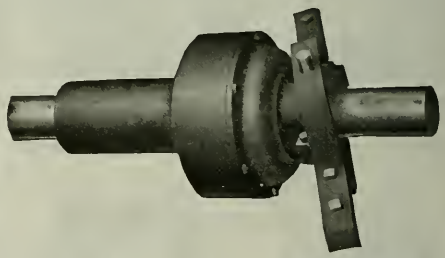
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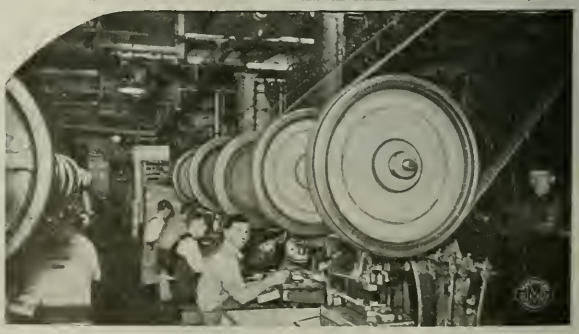
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FRICTION CLUTCHES

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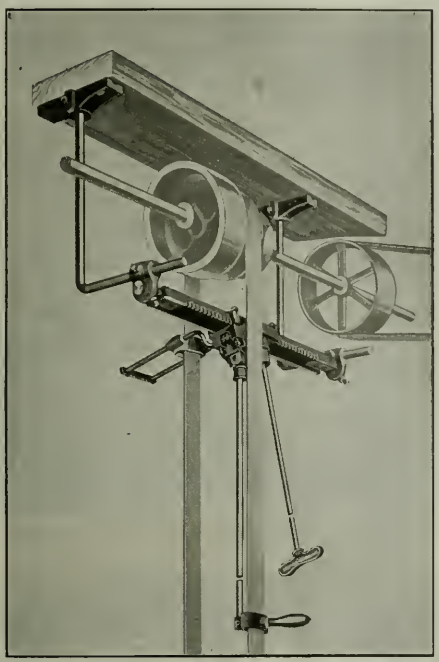
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A Safety-First Device

That Meets All Requirements

$15.00

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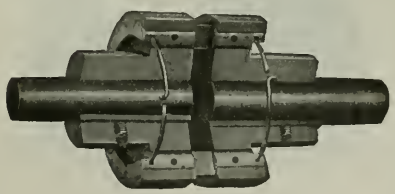
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Give your machines **Francke** protection, and you'll be free from this costly wear and tear—for each shaft will be free to run smooth and free in its own two bearings.

And you'll have the cushioning effects of laminated steel springs in the **Francke,** to protect your motors from shocks and jars of heavy load changes.

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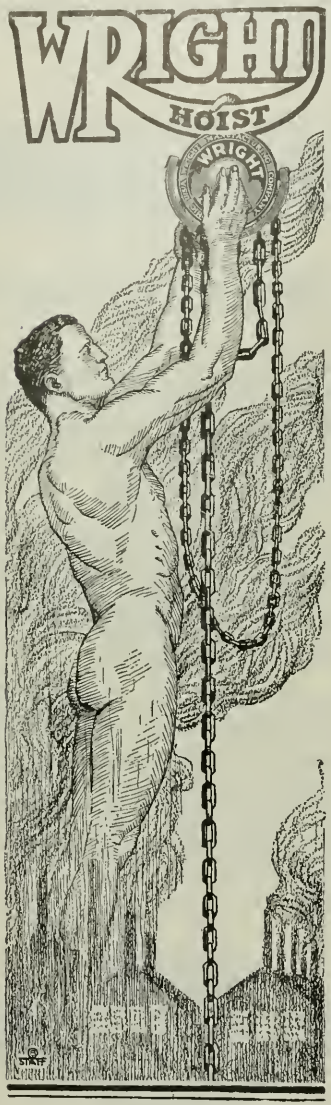


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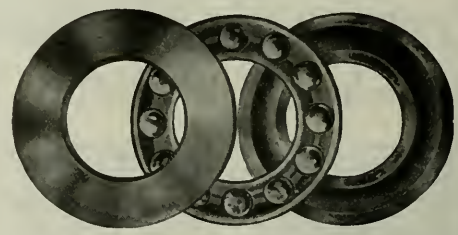
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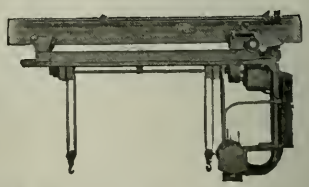
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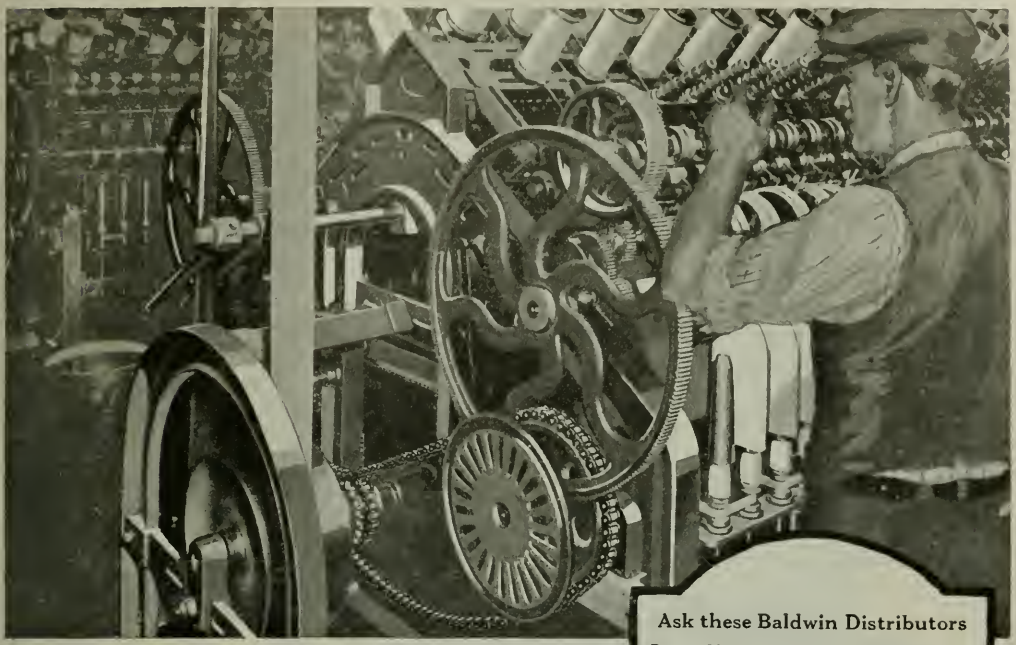
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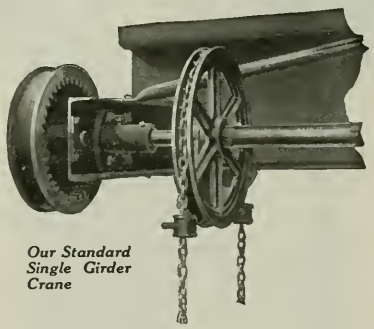
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MANNING, MAXWELL AND MOORE, INC.

PRINCIPAL OFFICE - 119 WEST 40TH. ST., NEW YORK.

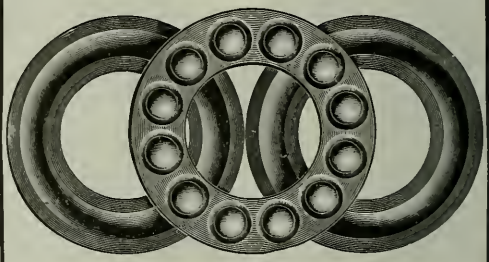
ARMINGTON
Hand and Electric
HOISTS AND CRANES



Our Standard Single Girder Crane

Traveling and Jib Cranes—Special Cranes
Hoists and I-Beam Trolleys

THE ARMINGTON ENGINEERING CO.
EUCLID OHIO



USED ON THE BEST

Drill Presses	Textile Machinery
Lathes	Rubber Machinery
Boring Mills	Rope Machinery
Milling Machines	Paper Machinery
Motors	Blowers
Cranes	Elevators

THE BANTAM BALL BEARING CO.
BANTAM, CONN.

F. M. COBBLEDICK CO.
693 Mission St.
San Francisco, Cal.

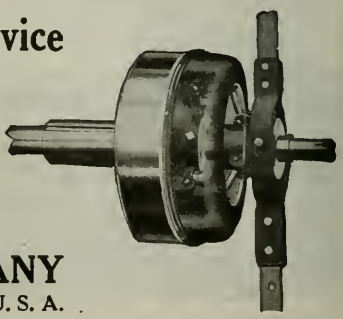
DETROIT OFFICE
905 Dime Bank Bldg.
Detroit, Mich.

"Edgemont"—the EMCO Clutch for Hard Service

Designed for heavy, rough service—to be thrown in and out constantly, to slip and pick up the load slowly or to run at high speed without picking up the load or dragging.

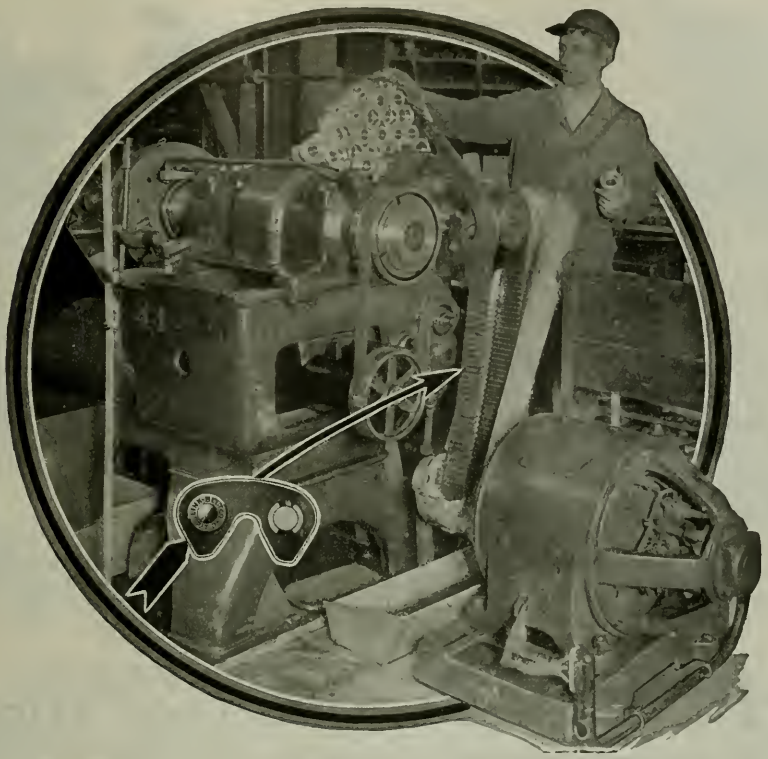
Guaranteed to transmit full rated power, to operate satisfactorily and to be well made in every particular.

This Clutch Has Made Good. Continuous repeat orders and a constantly increasing number of machine tool builders adopting it prove its worth.



Catalog describes Edgemont Clutches for all purposes

THE EDGEMONT MACHINE COMPANY
2700 National Ave. DAYTON, OHIO, U. S. A.



Silent Chain Drive Increased His Piece Rate Earnings 18%

THIS man is employed in one of America's leading manufacturing plants. He performs turret lathe operations on duplicate parts on a piece work basis.

Until recently his machine was belt driven. Now it is driven by Link-Belt Silent Chain. Since the change was made, his piece work earnings have increased 18%.

This increase was made on the same machine, same class of work, same operations, same hours, same everything as when belt drive was used.

His increased output is the direct result of the positive, non-slipping, smooth running effect of Link-Belt Silent Chain on the work in hand.

You, too, can increase the output of your plant, better your product and enable your piece work operators to enjoy greater returns by adopting Link-Belt Silent Chain Drive.

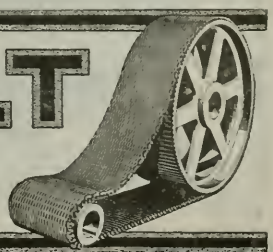
It is "flexible as a belt, positive as a gear, more efficient than either." Send for our Machine Tool Drive Book No. 312. Shows many applications and gives details.

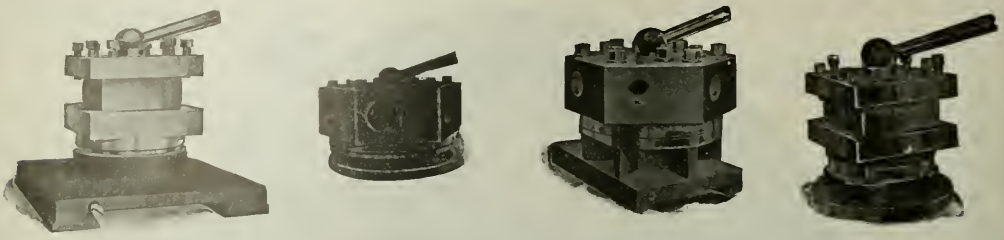
LINK-BELT COMPANY 204

PHILADELPHIA CHICAGO INDIANAPOLIS

New York - - 299 Broadway
Boston - - 49 Federal St.
Pittsburgh - 1501 Park Bldg.
St. Louis - Cent. Nat'l Bank Bldg.
Buffalo - 547 Ellicott Square
Wilkes-Barre, 2d Nat'l Bk. Bldg.
Cleveland - - 429 Kirby Bldg.
Detroit - 790 Woodward Ave.
Minneapolis - 418 S. Third St.
Kansas City, Mo., 306 Elmhurst Bldg.
Seattle - 576 First Ave. S.
Portland, Ore. - - First and Stark Sts.
San Francisco - - - 582 Market St.
Los Angeles - - 163 N. Los Angeles St.
Toronto, Can., Canadian Link-Belt Company, Ltd.
Denver, Lindrooth, Shubert & Co., Boston Bldg.
Louisville, Ky., Frederick Wehle, Starks Bldg.
New Orleans, C. O. Hinz, Hibernia Bank Bldg.
Charlotte, N. C., J. S. Cothran, Com'l Bank Bldg.

LINK-BELT
SILENT CHAIN
FOR POWER TRANSMISSION





Makes Any Engine Lathe 100% More Useful.

PHOENIX MANUFACTURING CO.
Eau Claire, Wisconsin
Cleveland Office: 913-15 Engineers Bldg.

PHOENIX Tool Post Turrets and Phoenix Carriage Turrets are recognized in up-to-date shop practice as being so necessary, that they are even being put on brand new engine lathes as regular equipment.

Those "in-between" jobs—those that can't be worked to advantage on the turret lathe, and cost too much on the engine lathe—fall naturally within the Phoenix range of work. The Phoenix Tool Post or Turret will increase the capacity and efficiency of any engine lathe 100 per cent.

A three-quarter turn of handle releases the Phoenix locking device and brings the next tool into play without readjustment and accurately adapts itself. It locks quick—it locks rigid. It won't tip—it won't shear. Write for full particulars.

PHOENIX TOOL POSTS AND CARRIAGE TURRETS



Guess Work vs. The Scleroscope

In spite of many years' experience in heat-treating steel "by eye," the Keller Mechanical Engraving Company, of Brooklyn, N. Y., had considerable trouble in keeping its dies up to standard because of the lack of uniformity in the steel—each new lot being just a little different from the last.

Whether the die broke in testing because it was too hard, or wore down quickly because it was too soft, the fact remained that costs for "experimenting" ran high until this Scleroscope was installed about five years ago. Nowadays there is no uncertainty as to results—as the superintendent says: "Since we installed the Scleroscope we know."

When writing for the "Scleroscope Book" be sure to ask about the Pyroscope and Selective Carbonizing and Hardening by the Shore Process.

The Shore Instrument & Mfg. Co.
VAN WYCK AVENUE & CARLL STREET, JAMAICA, N. Y.

FOREIGN AGENTS: Agent for Great Britain and Colonies, Coats Mch. Tool Co., Ltd., 14 Palmer St., Westminster, London, S. W.; Glasgow, Newcastle-on-Tyne. Yamatake & Co., Tokyo, Japan. Iznosskoff & Co., Petrograd, Russia. Aux Forges de Vulcain, Paris, France. R. S. Stokvis & Zonen, Ltd., Belgium and Holland.

OAKITE CLEANS



2000 Auto Parts for 78 cents

THIS Auto Factory* now uses Oakite for cleaning mineral oil from fenders, aprons, radiator shells, etc., before japanning, *at a fraction of former cost.*

The parts were formerly washed with a prepared alkali cleaner, and averaged 6 per cent. rejects after japanning.

With Oakite materials, the rejects average only one in 800!

The actual cost of Oakite materials for cleaning each lot of 2000 parts, is 77½ cents.

But in computing the *full economy* in using Oakite materials, due consideration must be given to the saving effected in practically eliminating rejects.

This Advertisement is one of a series based on actual occurrences.

* Name upon application.

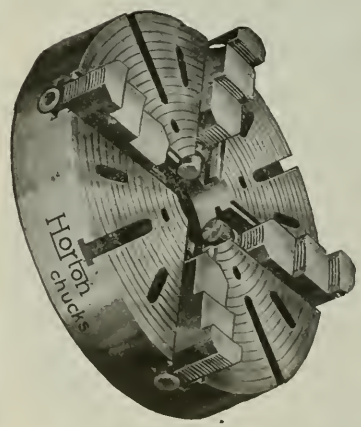
May we serve YOU too?

OAKITE MANUFACTURED BY OAKLEY CHEMICAL CO. 26 THAMES STREET · NEW YORK



All Steel Independent Chucks

(Number 3 of eight Horton Leaders)



The body of this chuck is cast of a steel practically equal to machinery steel. This, together with the very wide jaws, the heavy operating screws, the deep ribs and the generally ample proportions make this a practically unbreakable chuck.

The large center hole enables the hub of the work to be passed back into the center hole of the chuck.

This line of steel chucks is only one of eight Horton leaders. A chuck for every chucking requirement, and every chuck built for present-day usage is a Horton accomplishment.

By special invitation a member of the Rice Leaders of the World Association.

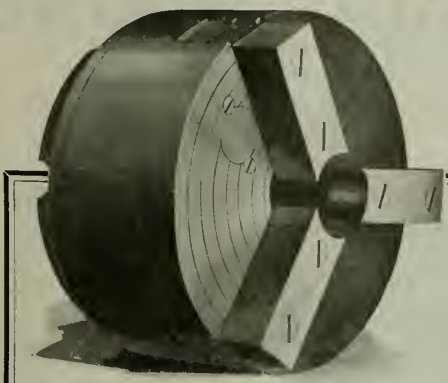
BY INVITATION MEMBER OF
RICE LEADERS OF THE WORLD ASSOCIATION
NEW YORK, U.S.A.

THE E. HORTON & SON CO.

WINDSOR LOCKS CONN., U. S. A.

Horton chucks

109-11



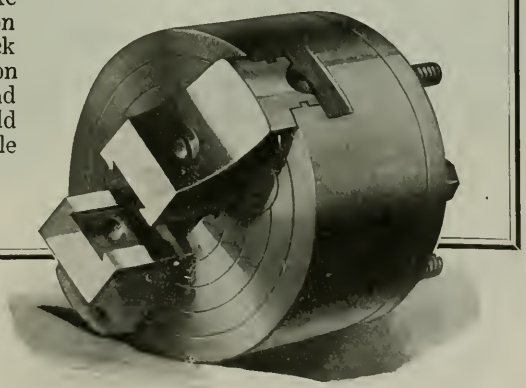
(Patented 2-28-20)

LAVOIE
AIR CHUCKS

Quicker Handling
Increased Production
Greater Economy

Lavoie Air-operated Chucks are unique in constuction, and have many important features. No air is required to release the work on completion of operation, nor is any special adaptation of cylinder to the rear end of spindle necessary. Single piping, and the fact that there is only one packing in the chuck eliminate the surplus leakage of air.

The Lavoie three-jaw chuck is adapted to take care of general production work. The two-jaw chuck is designed for production such as brass work, and light production where odd shapes require a simple method of chucking.



(Patented 2-28-20)

Write for Details

The Frontier Chuck & Tool Co., Inc.

30 Letchworth St., Buffalo, N. Y.

Strong Gripping Power

Reason No. 2



The
CASLER
Twin Screw Drill Chuck

We've turned this simple, well made device inside out so you can see for yourself the reasons for its strength and durability. Jaws and screws are of high carbon steel, tempered. Screws are the same size and unusually large—an exclusive feature with a two-fold advantage — first, they hold the drill with a uniform and powerful grip which eliminates all possibility of slipping and turning; second, the strain on the two screws is equally divided which adds appreciably to their term of service.

Other reasons—all equally good and sufficient—will be found in our circular. Send for it.

MARVIN & CASLER COMPANY

Canastota New York

McCrosky
COST CUTTING TOOLS

Service Without Limit

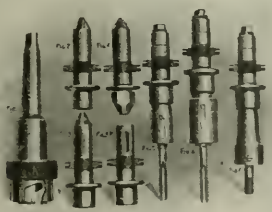
The Jackson Shaper Co. (Jackson, Mich.) makers of the Walcott Shaper, find use for

McCrosky Wizard Chucks and Collets

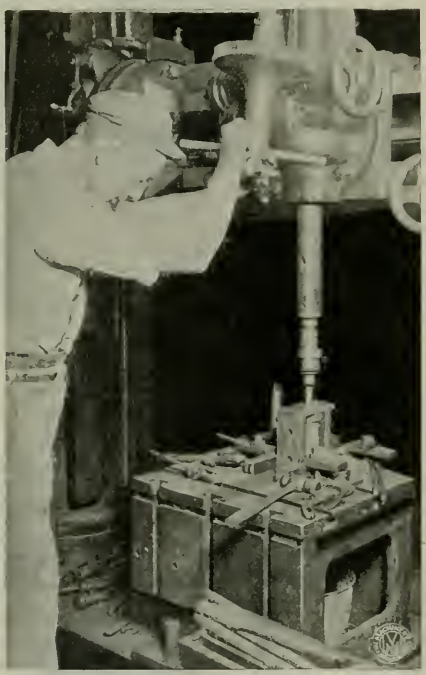
on exactly 110 different operations

The one shown is not very spectacular, but it requires a lot of power. In machining these cross-feed nuts, in which, as part of this operation, is cut a double acme thread of ½" lead, a big Radial Drilling Machine and high-speed tools are used, with a little Wizard Chuck to transmit the drive to the cutting tool and carry the biggest strain that is put on any part of the machine.

An accurate, positive chuck for the most powerful high-speed machines—a chuck which makes non-stop runs possible on several operations work—these things make Wizard Chucks and Collets first choice everywhere when once they have been used.



A Typical Wizard Outfit



Try a Wizard Chuck and Collet Outfit and test our claims. Send for the McCrosky Efficiency Book No. 7 for further details of these and the other McCrosky Efficiency Devices.

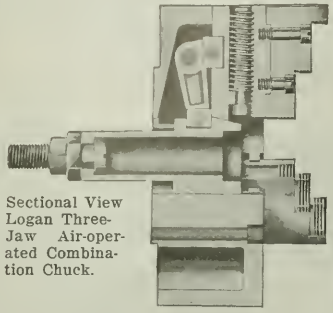
McCROSKY TOOL CORPORATION

MEADVILLE, PENNSYLVANIA

Branches and Agencies in all Principal Cities. **Export Agent: Benjamin Whittaker, Inc., New York**

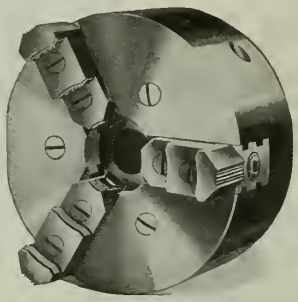
Logan Air-Operated Chucks

MANUFACTURED BY THE LOGANSPORT MACHINE COMPANY, LOGANSPORT, INDIANA



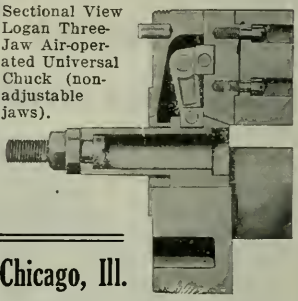
Sectional View Logan Three-Jaw Air-operated Combination Chuck.

Because of their improved jaw-operating mechanism, these practical and efficient chucks insure a positive grip on the work at all times: powerful and rigid, but without undue weight or overhang. They have compact, one-piece bodies without bolts, screws or other frequent causes of chatter and are particularly dust-proof.



Logan Air-operated Three Jaw Combination and Universal Chucks are furnished with steel or semi-steel bodies, 9½", 12", 15", 18" and 24" diameter.

Sectional View Logan Three-Jaw Air-operated Universal Chuck (non-adjustable jaws).



Logan Air-operated Chucking Devices include Two and Three Jaw Chucks, Collet Chucks, Air Cylinders, Fixtures for Automatic and Continuous Milling Machines, etc.

Details in Bulletin MR-10

GENERAL SALES AGENTS

FRANK G. PAYSON COMPANY 9 South Clinton Street, Chicago, Ill.

Woodstock Safety Tapping Chucks

Try one for 30 days at our expense



Not satisfied with successfully tapping blind holes all day without breaking a single tap, this young operator has determined to find out "why."

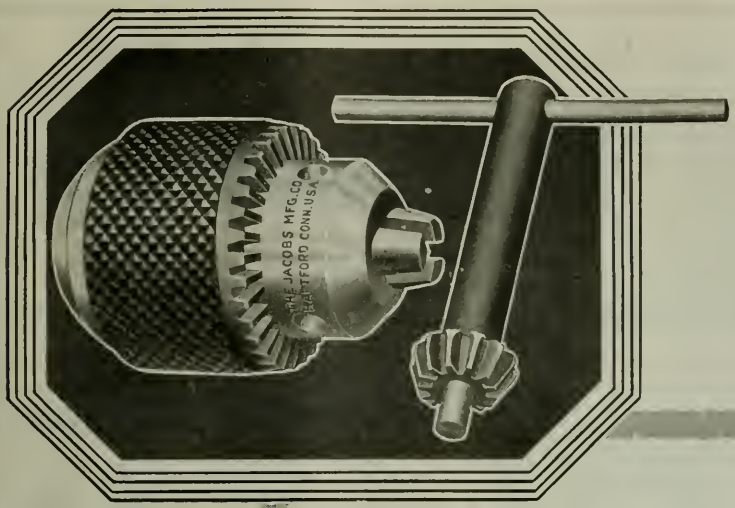
No need, however, for the foreman to worry about the safety of the Woodstock Safety Tapping Chuck in inexperienced hands. The mechanism is simple and fool-proof, consisting of an adjusting nut, a spring and two friction cones—nothing to stick or get out of order in action and only one obvious method of assembling. It's safe from every viewpoint; eliminates tap breakage and utilizes 95 percent of the strength of the taps.

When tap breakage becomes excessive, we recommend investigating Woodstock Safety Tapping Chucks.

PETER BROTHERS MFG. COMPANY

135 Railroad Avenue

ALGONQUIN ILLINOIS



An Accessory? Yes-------but

An accessory will sometimes through sheer intrinsic merit of its own assume the importance of a principal.

The exceptional performance of Jacobs Chucks resulting in greater efficiency, convenience, ease of handling, and economy in drilling operations is a case in point.

When you buy Jacobs Chucks for your plant, or drills equipped with Jacobs Chucks, you are buying better drilling. Henceforth you think of Jacobs Chucks as the principal in connection with better drilling.

THE JACOBS MFG. CO.

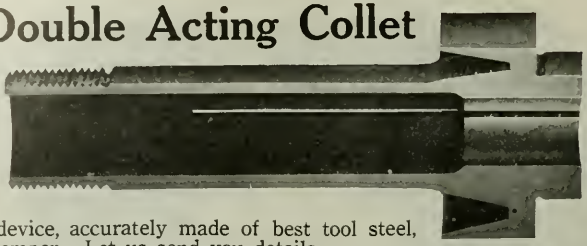
Dept. M.

HARTFORD — CONN.

Jacobs Chucks

The "Inanout" Double Acting Collet

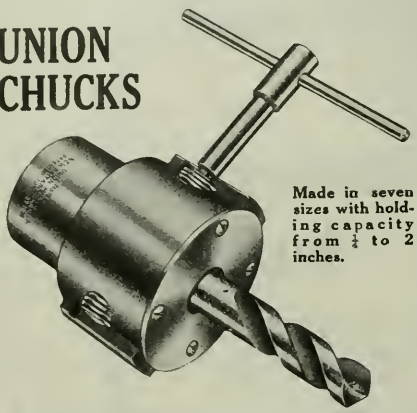
A New Departure Which Saves Chucking Time



A simple and extremely practical device, accurately made of best tool steel, heat treated and drawn to spring temper. Let us send you details.

MORRISON MACHINE PRODUCTS, Inc., Rochester, N.Y.

UNION CHUCKS



Made in seven sizes with holding capacity from ¼ to 2 inches.

The Union Drill Chuck is a positive, accurate, friction drill chuck for general use. It is durably made of the best material and has a Patent Transverse Slot which provides for inserting drills with tenons—a distinctive advantage which *you* will appreciate.

The Union line includes practical chucks for every purpose. Complete description in catalog.

Union Manufacturing Company

New York Office
26 Cortlandt Street

New Britain, Conn., U. S. A.

Makers of a Complete Line of Chucks

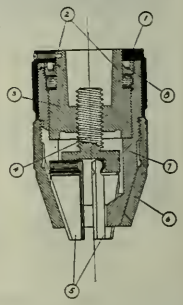
NeBaCo Eclipse Drill Chucks

Hand Operation—Instant Action

Note the Construction

A Sleeve (1) rotates on the outside of the body (7) and is fastened to the Head (3); grasp the Sleeve with one hand and turn the Body with the other, the Jaws grip the Drill positively and release easily. Can be used on Electric Drills.

Send for the circular.

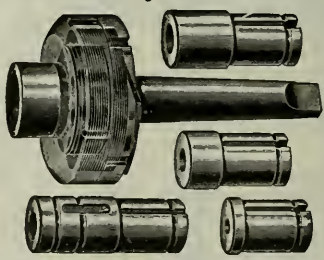


NIELSEN - BARTON CHUCK COMPANY

106 SO. JEFFERSON STREET

CHICAGO, ILL. U. S. A.

The Safety Drill and Tap Holder



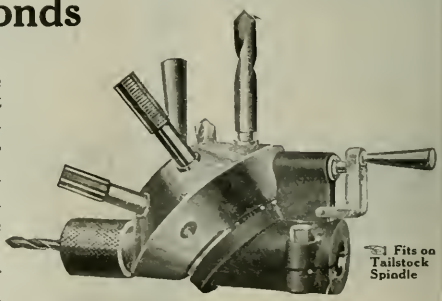
is the only attachment for the purpose that gives universal satisfaction and is unequaled in efficiency, convenience, rapidity, accuracy and simplicity. Nothing to break or get out of order. Made in 4 sizes, covering from 0 to 2½ inches diameter.

The Beaman & Smith Co., PROVIDENCE Rhode Island

A Turret Lathe in 15 Seconds

Here's the Recipe

Add one Newman Tailstock to any ordinary engine lathe. Result, a modern, efficient, quick acting turret lathe. Shops large and small are using the Newman Turret with excellent results. Centers, drills, reams, taps, etc., up to 1½″ diameter. 10 days' free trial. Newman attachments increase output as much as fifty per cent. Catalog M gives details and describes a number of other labor-saving tools and attachments. Write for it today.



Fits on Tailstock Spindle

NEWMAN MFG. COMPANY

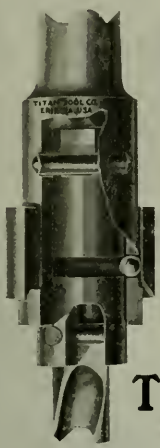
717 SYCAMORE STREET CINCINNATI, OHIO

Looking into the

TITAN CHUCK

A Chuck of Proven Merit

Makes possible the use of straight shank drills replacing the more expensive taper shank drills. Few parts and simplicity of construction is the key note.



All parts hardened and ground with liberal wearing surface.

Ideal for multiple or close range drilling.

Made in two sizes ¼ and ½ maximum capacity.

A trial order will convince you.

Titan Tool Co.

ERIE, PA., U. S. A.



The Chuck That Never Slips.

The More You Crowd It,

The Tighter It Grips.

NARRAGANSETT MACHINE CO.

PROVIDENCE, R. I., U. S. A.

If You want the best Lathe or Drill Chucks—buy Westcott's

Little Giant Auxiliary Screw Drill Chucks, Little Giant Double Grip Drill Chucks, Little Giant Improved Drill Chucks, Oneida Drill Chucks, Spur Geared Scroll Combination Lathe Chucks, Scroll Combination Lathe Chucks, Spur Geared Scroll Universal Lathe Chucks, IXL Independent Lathe Chucks, Cutting-off Chucks.



Spur Geared Scroll Combination Lathe Chuck

Strongest Grip, Greatest Capacity
Great Durability and Accuracy

WESTCOTT CHUCK CO.

ONEIDA, N. Y., U. S. A.

Ask for Catalogue

SKINNER DRILL CHUCKS



THE mechanic's judgment is reflected in the tools he uses.

Mechanics like to use Skinner Drill Chucks because they are easily and quickly handled; there are no exposed gears or screws. It is the only chuck made with all the gears beneath the surface. The strong, powerful jaws grip the drill firmly, prevent wobbling and insure better work.

Skinner Chucks hold true, do not injure the shank of the drill Known for accuracy, capacity and durability.

Skinner Drill Chucks cost more because they are built right.

May we help solve your chuck problems?

THE SKINNER CHUCK CO.

NEW BRITAIN CONNECTICUT

New York Office: 94 Reade Street
San Francisco Office: Rialto Building
London Office: 139 Queen Victoria St., E. C. 4

"DOUBLE-GRIPP" Safety Tap Chucks

Help Secure Accuracy in Safety Signal Devices

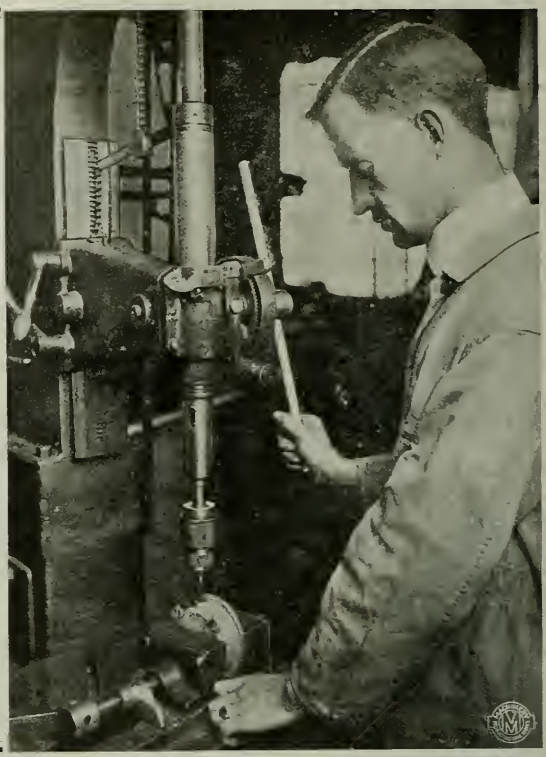
This photograph was taken in the shops of the American Gas Accumulator Co., Elizabeth, New Jersey, builders of Signal Devices, Lighthouse Flashing Mechanisms and Gas Regulators.

Work of this class demands extreme accuracy in every operation; in the one shown—tapping a straight ¼" thread in a bronze housing for an acetylene gas regulator—this is assured by the use of "Double Gripp" Tap Chucks to drive the tap true without forcing and without danger of breakage.

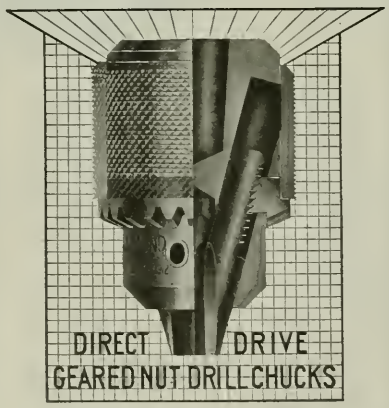
Where accuracy is important, where production time and costs are counted —use "Double Gripp" Tap Chucks.

Circular?

WILLIAM L. PROCUNIER
18 South Clinton St. Chicago, Illinois



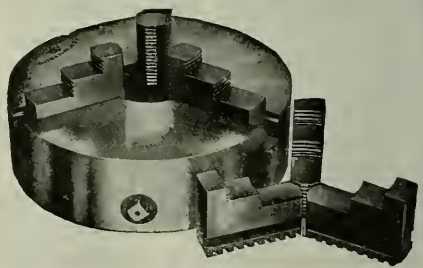
ALMOND



Teeth cut on nut giving *Direct Drive* and hardened steel Pinion Bushings which prevent wear are exclusively Almond features and insure long life.

Other ALMOND *Products:*
Lathe Chucks, Right Angle Transmissions, Micrometer Calipers, Flexible Steel Tubing.

T. R. ALMOND MFG. CO.
ASHBURNHAM MASSACHUSETTS



T-W CHUCKS

Wherever chucks are used you will find the T-W; because they have made good.

T-W policy; quality first, they cost no more than others.

If your dealer cannot supply you, we will.

Write now for catalog.

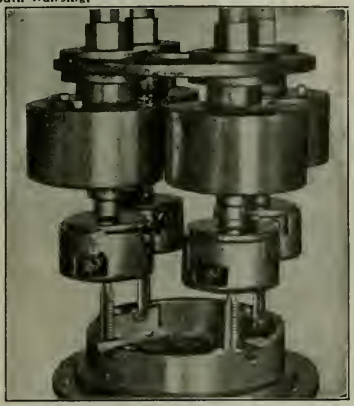
TERKELSEN & WENNBERG
326 A Street BOSTON, MASS.

ERRINGTON MECHANICAL LABORATORY

41 Cortlandt St., New York
Western Branch:
136 W. Lake St., Chicago
New England Branch:
831 Old South Building,
Boston, Mass.

Catalog Francais:
Edgar Bloxham,
Paris
12 Rue du Delta

MULTIPLE TAPPERS



ERRINGTON TAPPERS reduce tapping costs to the minimum, insure exact duplication of work, are simple, compact and long wearing. Taps up to ⅝" can be used with only 2¼" between centers, and larger sizes are proportionately compact. In the job shown in the engraving 2560 ⅜" holes were drilled and tapped in malleable iron gear cases in eight hours. Let us figure on your line of tapping.

Errington Opening Die Heads; Collapsing Taps; Opening Stud-setter; Friction Stud; Nut and Screw Setters, etc.

NO KEY—NO SLIP
LONGER LIFE

Just insert a drill by hand—it will tighten itself—Remove it the same way.

THOUSANDS AND THOUSANDS are giving satisfaction.

ARE YOU USING THEM YET?

EASTERN TUBE & TOOL CO.
Incorporated
Brooklyn, N. Y.



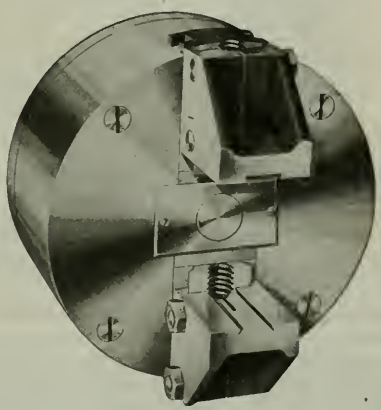
Do it today

The
ETTCO
DRILL CHUCK

Boosts Production 25 to 90 Per Cent.

Reduces Machining Cost 25 to 50 Per Cent

M. E. C.
AIR-OPERATED CHUCK



An M. E. C. insures a constant, powerful hold; permits chucking and releasing much work without stopping the machine spindle; it has speed, durability and economic features that quickly help to show profitable returns to the user.

An example: An ordinary TURRET LATHE equipped with an "M. E. C." AERO CHUCK and up-to-date TOOLS, delivers a greater volume of product at less cost than an AUTOMATIC MACHINE.

Moreover, the initial cost of an AUTOMATIC MACHINE being many times greater than that of a TURRET LATHE, plus the cost of maintenance together with expensive tools, not infrequently absorbs any gain in production.

These cold facts coupled with the limit governing brass cutting speeds on AUTOMATIC MACHINES, makes its cost practically prohibitive. Solve your problems with the M. E. C.

Upon request we will gladly furnish additional data and drawings.

Manufacturers Equipment Co.

Waller Ave. and Fillmore St., Chicago, Ill., U. S. A.

NEW YORK OFFICE: Grand Central Palace, New York City

AGENTS:

West-Fisher-Bulwitt Co., Vernor Bldg., Detroit, Mich.
William K. Stamets, Jenkins Arcade Bldg., Pittsburgh, Pa.
William K. Stamets, Hickox Bldg., Cleveland, Ohio.
R. A. Braunberger Tool & Machinery Co., Machinery Hall Bldg., Chicago, Illinois.

SWEETLAND
Lathe Chucks

"What's In a Name!"

If it's a matter of chucks and the name is Sweetland there's profit in the name. Strong, rigid, accurately constructed, Sweetland Chucks can be trusted with the toughest job in the shop. They last longer because strain comes over the dovetail and not on the screws.

There's a Sweetland Chuck for every need guaranteed to the limit.



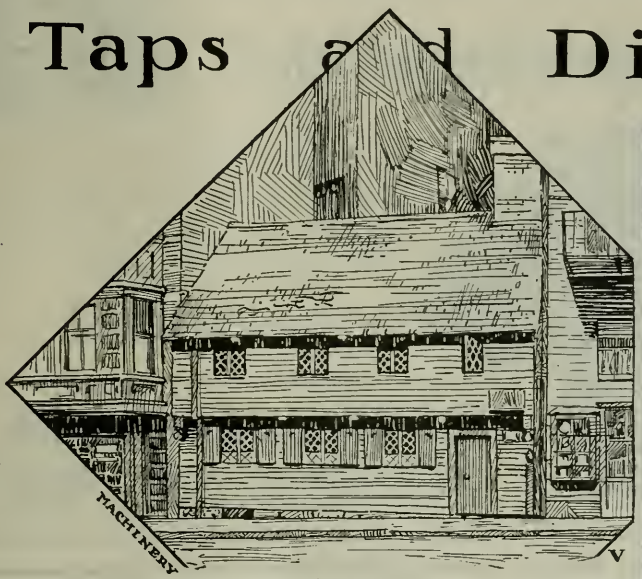
Write for Catalog 12C

HOGGSON & PETTIS MFG. CO., New Haven, Conn.
CHUCKS—DIES—STAMPS—TOOLS



BAY STATE

Taps and Dies



Paul Revere's House
Boston Mass.



The Utmost in Thread Cutting Equipment

Few landmarks in Boston are of greater interest than the house of the hero of the famous ride—Paul Revere. Standing in one of the city's most crowded quarters, it is a reminder to the people of today that those who went before, played their part in the upbuilding of America.

Could the visions of our forefathers have bridged the gap of time, what changes they would have seen; the country bigger and better—their state a leader in one of the most important of all mechanical industries—the production of tools. *"Bay State."* We chose our name with as great care as we give to the products which bear it. Bay State Taps and Dies are the utmost in thread cutting equipment. Specify *"Bay State"* with confidence.

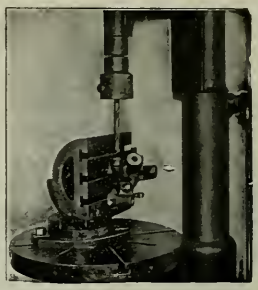
BAY STATE TAP & DIE COMPANY

MANSFIELD, MASS., U. S. A.

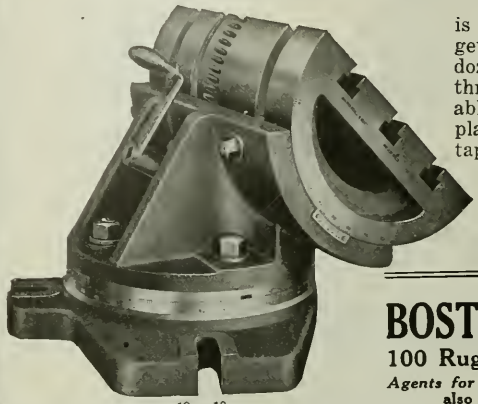
Representatives for England: Goodchild & Partners, Ltd., 56-58 Eagle St., Southampton Row, London, W. C.; Representatives for Scandinavia: Wilh. Sonesson & Co., Ltd., Malmo, Sweden.

Shop Economy and Production

No need to drive to the limit of what men and machines can stand; that will do for a "rush," but production isn't permanently increased that way. Shop economy is mostly a matter of clipping away waste motion.



The Universal Angle Plate



12 x 18

is very rigid, easily adjusted to various angles, gets the most out of time—two operations or a dozen, only one setting is required. Motion through 360° horizontally, 90° vertically, adjustable to 5 minutes or closer. Adapted for lathes, planers, millers, grinders, etc., and for grinding tapers and formed cutters.

Four sizes.
Write for particulars.

BOSTON SCALE & MACHINE CO.

100 Ruggles Street **Boston 20, Mass.**

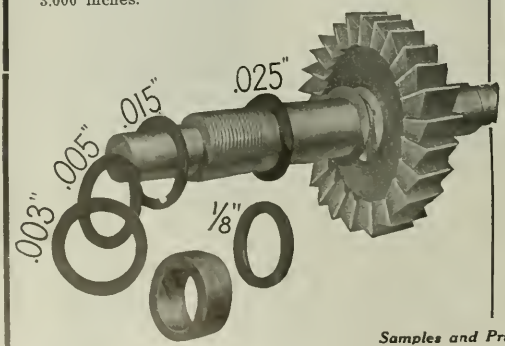
Agents for Great Britain: **Alfred Herbert, Ltd., Coventry, England also for Belguim, Italy, India, Japan, Korea and Ceylon.**

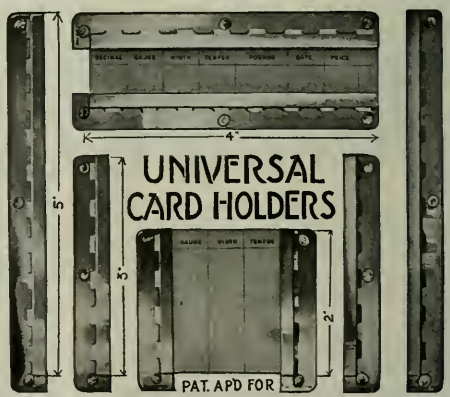
When you buy special tools and accessories from a specialist you get better tools at less cost than when you make them yourself—even such small items as

SPACING WASHERS

To Prove This, Try Ours on Your Next Order

Stock sizes—with or without standard keyways—for arbors of the following diameters: ⅜, ½, ⅝, ¾, ⅞, 1, 1⅛, 1¼, 1⅜, 1½, 1⅝, 1¾, 1⅞, 2, 2¼, 2½, 3, 3½ and 4 inches. Stock thicknesses: .003, .005, .015, and .025 inches. To order, .0015 to 3.000 inches.





Card holders for stock bins, shelves, trucks, stock boxes, etc., are another small but important commodity more economically manufactured by people in that line of business.

Universal Card Holders

are adaptable for cards of various proportions, can be used in either vertical or horizontal position and permit the use of almost the entire card which can be readily inserted and removed.

Four sizes in stock—2, 3, 4 and 5 inches. Other sizes to order. We now make these in two styles.

Samples and Price Lists on Request

DETROIT STAMPING COMPANY

951-957 West Fort Street
DETROIT, MICH., U.S.A.

DETROIT TOOLS

High Speed Reamers, End Mills, Cutters, Three- and Four-Flute Drills

No matter how large or small your needs, we're here to serve you. We carry a very large and complete stock. Standard Size Tools ready for immediate shipment; Specials to order in record time. Write or wire for quotations.

Catalog "A" lists the line.
Get it for your files.

THE DETROIT REAMER & TOOL COMPANY
DETROIT MICHIGAN



SYRACUSE GAGES

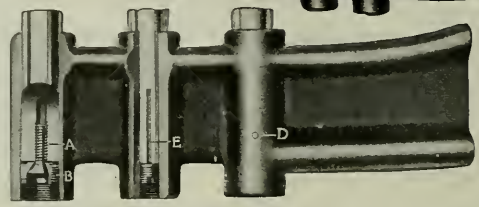
One Positive Adjusting and Sealing Point

A simple, foolproof method of setting and sealing Syracuse Gages is among the features that recommend them to busy manufacturers. To change the size the tapered head lock screw (a) within the split adjusting screw (b) is loosened and the plug set by moving the adjusting screw in and out. When the lock screw is tightened, the taper expands the split screw and locks both securely.



Details of Whole Line on Request

IMPROVED LOCKING MECHANISM



A Regular Feature of All Syracuse Gages

No exposed screws or seals and no possibility of gages being tampered with after inspection.

MEMORUM - SIMSON - GREIGER - LOWRY

SYRACUSE COMPANY, INC. NEW YORK



IDEAL PARTS

Are Built for

ACCURACY–SERVICE DURABILITY

LOOK AT THAT HEAD AND CAM. They are made from the best material obtainable, carefully selected for the duties they must perform, hardened, and ground accurately to size.

These two parts must stand the greater part of the wear and tear in the Die-head and must therefore be solidly constructed. You will see that this fact has not been overlooked.

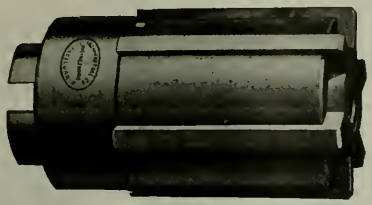
THERE IS GOOD SOLID CONSTRUCTION AND BACKING AT EVERY WORKING POINT.

Watch for next month's ad
Catalogue on request

IDEAL TOOL & MFG. CO.

BEAVER FALLS PA., U. S. A.

CASHMAN
ADJUSTABLE
SHELL REAMER



A Practical Tool That Cuts Costs

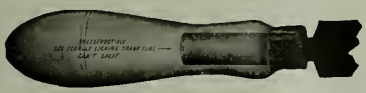
This time-saving device is simple in design and durably constructed, keen cutting, accurate and a big producer.

Blades are readily adjusted to .0001" by means of adjusting screw or lock collar. Stock sizes, 1" to 6½" diameter—larger on order.

Details in catalog "A"

CASHMAN TOOL COMPANY
WAYNESBORO, PENNSYLVANIA, U. S. A.

ONE OSGOOD OUTWEARS
Twenty Common Wood Handles



There is real economy in buying Osgood Tool Handles. A steel tube inside reinforces the wooden handle and holds the tool so it cannot pull out. Made in various sizes. Write for quantity prices, or see them at your dealers.

J. L. OSGOOD TOOL COMPANY
43-45 PEARL STREET BUFFALO, N. Y.

ROGERS
TOOLS





Reamers
Measuring Standards
Adjustable Hollow Mills

The John M. Rogers Works, Inc.
Gloucester City, N. J., U. S. A. 1865-1920

F F

TRADE MARK

FISKE'S

LUBRICANTS

Standards in QUALITY for over half a century

Do you know FISKE'S CUTTING AGENTS for IRON and STEEL have been developed to successfully displace straight Lard and Mineral Lard Oils—giving equal and even superior results while materially reducing the cost of operations?



Getting Ahead

This is just what FISKE'S CUTTING AGENTS for IRON and STEEL are doing—getting ahead. If you are not already using these proven products, the desired maximum satisfaction and results from your cutting operations have not been attained.

Our folder is interesting

Fiske Brothers Refining Co.
24 State Street New York City
PLANTS:
NEWARK, N. J. TOLEDO OHIO

F F

GRANT GEARS

IRON, FIBRE, STEEL, BRASS, RAWHIDE

Grant experience covers every phase of gear production; Grant facilities are equal to any demand; Grant deliveries are prompt, and most important just now, Grant prices are right.

A dependable source of supply, from which uniform gears may be had at any time, is an asset for any smooth-running plant. Grant Gears will keep yours going without a hitch.

Ask for latest catalogue

GRANT GEAR WORKS

151 PEARL STREET, BOSTON, MASS.

MP REG.

MEISEL

"Come Again" Gears

The rock-ribbed proof of satisfaction is the order for more.

More Meisel gears are being sold on the reorder than ever before. They are gears of uniform quality; gears *you* can rely upon for faithful performance; gears you will buy again and again. Used in tractors, machine tools, airplanes — wherever good gearing is in demand. Try them.



We do Heat-treating, Broaching, Case Hardening, Contract Work, Splining, Tooth Rounding, Internal and External Grinding and Screw Machine Work up to 5½" diameter.

Write for estimates.

MEISEL PRESS MFG. CO.
948 Dorchester Ave.
BOSTON MASS., U. S. A.

FORGED GEAR BLANKS

Speeds are so high, loads so heavy and time so precious, you can't afford to take chances any more: you must *know* that every item of equipment can stand the gaff.

Forged gear blanks are stronger and far more durable than castings, more uniformly dependable than blanks cut from bar stock.

You need them to insure safe and profitable production. *We* make them in any quantity and to any specifications.

Let us estimate on your requirements.

THE MACHINERY FORGING CO.
Hamilton Ave. and Marquette Street
CLEVELAND, OHIO

CINCINNATI GEARS



Reduce friction in the driving mechanism. Carefully designed, accurately made, scientifically heat treated—dependably uniform always.

Write for Catalog C.

The Cincinnati Gear Co.
1825-1841 Reading Road
CINCINNATI OHIO

HERRINGBONE CUT GEARS

MILL DRIVES
SPEED REDUCERS
FAWCUS
SPUR
WORM
BEVEL GEARS

FAWCUS MACHINE CO. PITTSBURGH, PA.

Hindley Worm Gearing

Complete drives with housing ready for power

ALBRO-CLEM ELEVATOR COMPANY
501 Erie Avenue, East PHILADELPHIA, PA.





Co-operation—*And* Phillie Gear Have Made Philadelphia Gears Famous

The photographer butted right into the midst of a family conference—Phillie Gear and two of his shop executives discussing a particularly intricate problem. Phillie Gear familiarizes himself with the details of every job that goes through. His lieutenants are all experienced mechanics, who know their men and machines and obtain best possible service from both.

Conferences among heads of departments and those next in command are regular "shop practice" in this plant. They insure the practical co-operation necessary to maintain the reputation of Philadelphia Gears.

Have you the Phillie Gear Catalog?

Philadelphia GEAR Works 1120-1128 Vine St. Philadelphia

JONES GEARS





Made in All Styles and Sizes for Every Need

Orders for gears of every description can always be given to Jones with the assurance of their being properly filled. Our equipment is so complete and our capacity so great that all manner of requirements can be met.

Handling every operation as we do from the casting of the metal to the finished product, we depend upon no outside source for the proper filling of your order, and our delivery dates can therefore be relied upon.

Tell us your present requirements

WORMS, SPURS, BEVELS, HELICAL AND SPIRAL CUT GEARS,
PINIONS OF CAST IRON, CAST STEEL AND FORGED STEEL;
ALSO PINIONS OF RAWHIDE AND BAKELITE MICARTA.

W. A. Jones Foundry & Machine Co.
4409 West Roosevelt Road, *Chicago.*
New York 20 Murray St.

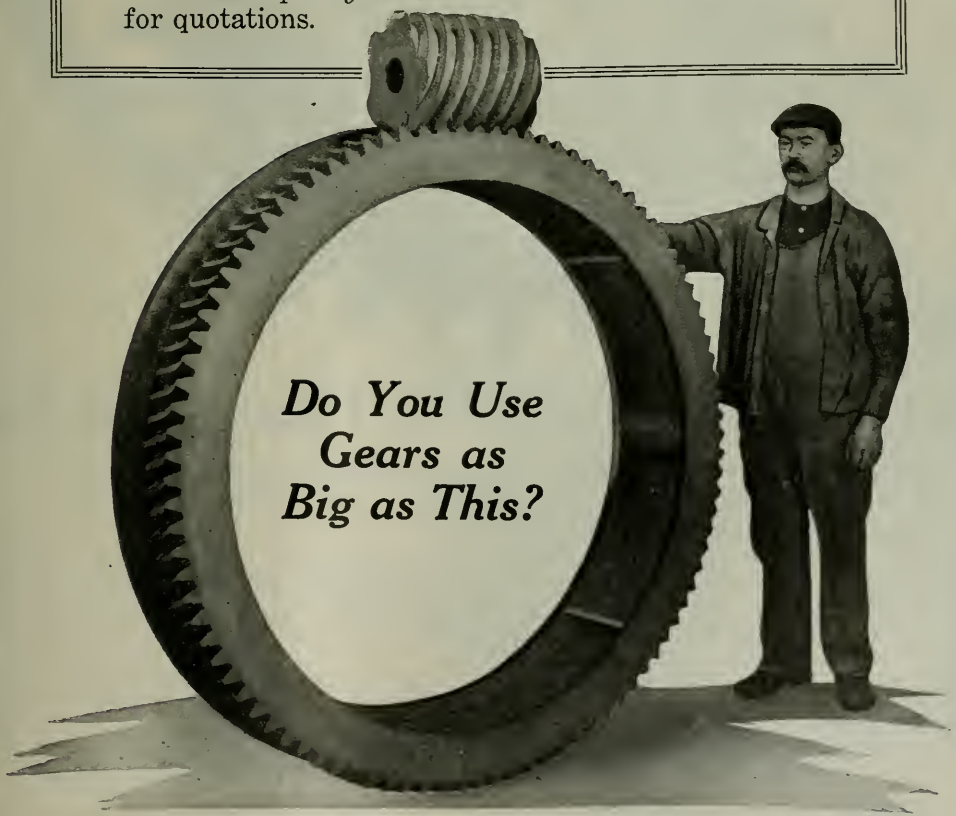
Manufacturers of cast iron pulleys, gears of all kinds, couplings, Lemley friction clutches, pillow blocks, hangers, speed reducers, and general power transmission machinery.

NEWARK

Gear Cutting Service

If your requirements call for gears of exceptional size, remember that we're fully equipped to fill your orders. We specialize in the cutting of large worms, odd size gears of all kinds and special shapes.

The men and equipment behind Newark gear cutting service give adequate assurance that materials and workmanship in *your* order will be of the best. Write for quotations.



NEWARK GEAR CUTTING MACHINE CO.

NEWARK HENRY E. EBERHARDT, President NEW JERSEY

Shock and vibration are responsible for much of the wear on machinery—lessen these and you lengthen the life of the machine.



A Pressure of Tons Gives Great Durability

The process illustrated here shows the compression and stiffening of the bat—the second step in the manufacture of a fabroil gear.

Fabroil gears are resilient enough to absorb shocks of starting, stopping and momentary overload—run equally well with cast iron, steel or bronze.

When contemplating the purchase of machinery, specify Fabroil Gears.

May we send you our gear bulletin 48703-A

General Electric Company

General Office Schenectady, N.Y.

Sales Offices in all large cities

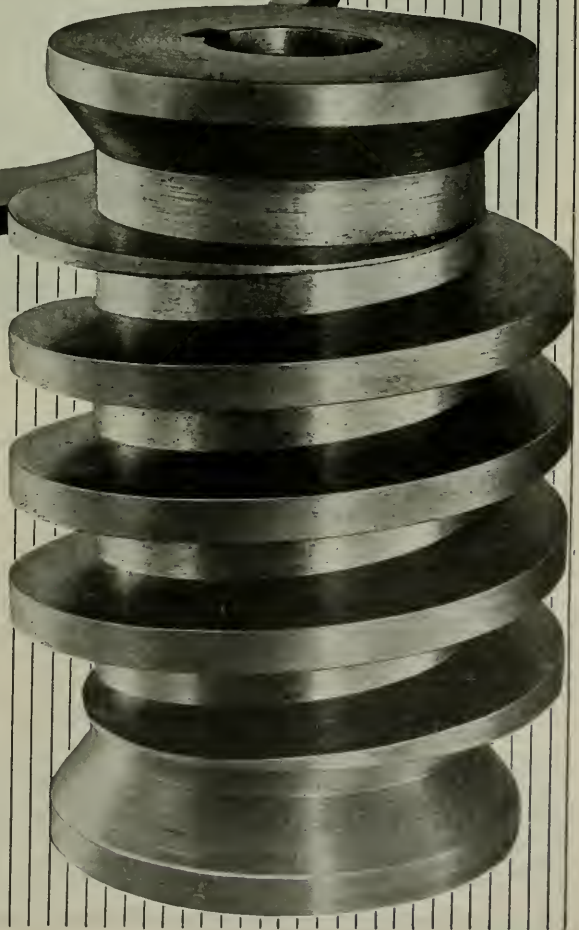
46-123

Peerless GEARS

Thirty years' experience in the manufacture of gears exclusively are back of Peerless Metal and Rawhide Gears.

Why not get the benefit of this experience by letting us make your gears? Bevel gears and spur gears from ¾" diameter to 15 ft. diameter. Worm, spiral, internal, herringbone gears and racks to your specifications.

If you buy gears, you'll want our "Blue Book on Gearing." Write for it today.

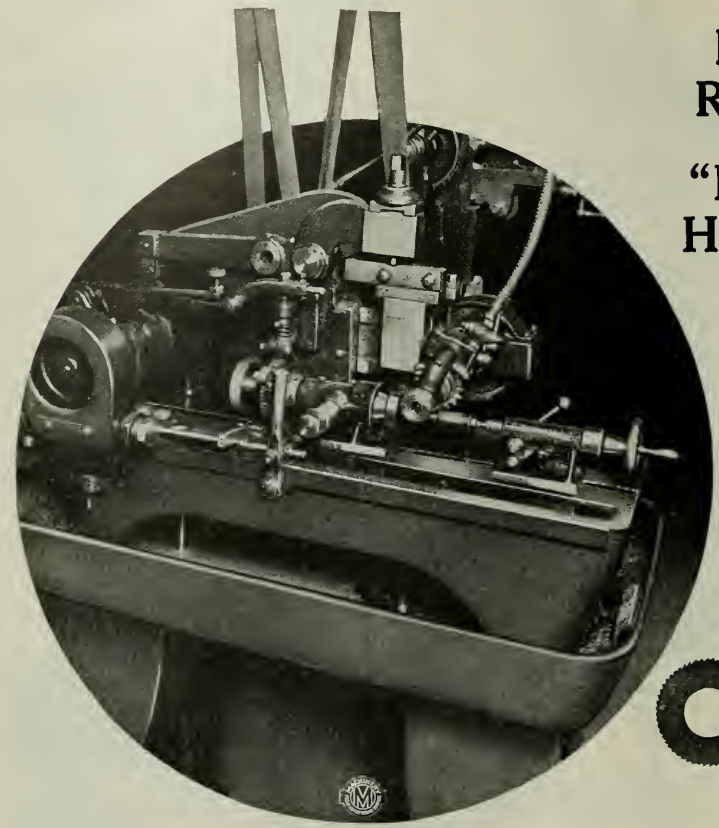


MEMBER OF AGMA

THE HORSBURGH & SCOTT COMPANY

CLEVELAND OHIO, U. S. A.

BILTON GEAR MILLERS



Milling Steel Ratchet Gears *for* "Dreadnought" Hub Odometers

Labor is high — don't waste it. Bilton Gear Millers enable operators to get top notch production at low cost.

Ask us what they can do on your work.

Catalog No. 20-G will interest you.





Measuring miles with the devices manufactured by the American Taximeter Co., is a sure-fire performance that is guaranteed for accuracy by the care with which they are designed and built.

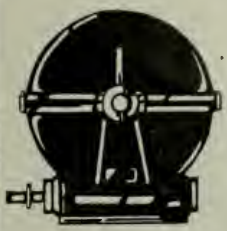
For instance—this Bilton Gear Miller, which is shown milling small Ratchet Gears for the Dreadnought Hub Odometer, insures both economy and accuracy on this operation. The ratchets are $\frac{3}{4}$" in diameter with a $\frac{1}{16}$" face, and have 56 teeth. They are loaded onto arbors 22 at a time, and finished at the rate of 132 per hour; a production rate made possible by the automatic operation of the machine, which feature also enables the operator to prepare the work and to remove the burr from the pieces already cut, while the machine is in operation.

THE BILTON MACHINE TOOL CO.

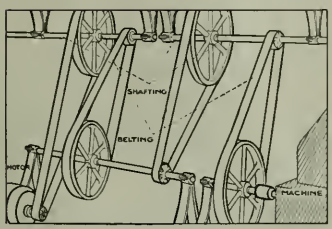
Bridgeport, Conn., U. S. A.



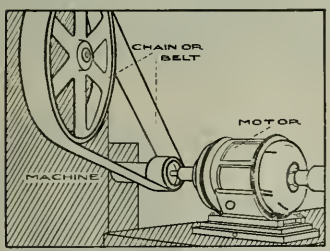




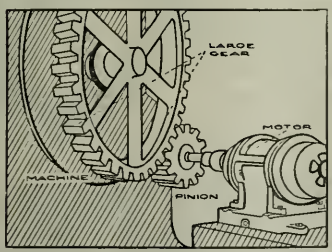
A battery of Foote Speed Transformers in use in the plant of the Republic Chemical Company, Pittsburgh, Pa.



Where belts are employed, slippage results, causing power loss, frequent replacement and repairs and when used with shafting utilize valuable space.



The use of a large and small gear to provide speed reduction causes friction, excessive wear and power loss, often resulting in production delays.



The use of open reduction equipment is dangerous to workers and costly to employers. Dust, dirt and grit cause undue wear on belts, chains, sprockets and open gears. And it is impossible to obtain as great reductions as with Foote Speed Transformers.

Foote Speed Transformers simplify motor speed reduction problems, save power, space, and replacement cost and provide positive safety for your workers.

Where a reduction greater than three to one is required, means of motor speed reduction such as the use of chains or belts driven direct from the motor or from shafting, large gears and pinion gears, are extremely wasteful.

Foote Speed Transformers are the recognized standard for reducing or increasing speeds of machinery without the use of line shafting and belts. They are made in types, sizes and speeds to meet any requirements.

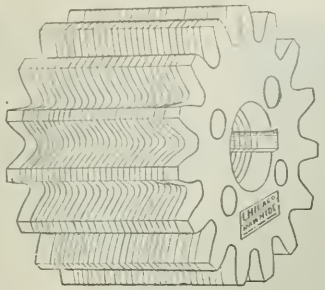
Foote Engineers have indicated better methods, safer means, greater economies of motor speed reduction for many of the largest plants in America. Foote Engineers may be able to show you how you can greatly benefit through the use of Foote Speed Transformers. Writing for advice puts you under no obligation.

Foote Bros. Gear & Machine Co.

Cut Gears of All Kind Made to Order
Send for Catalog

232-242 N. Curtis St. Chicago, U.S.A.

FOOTE SPEED TRANSFORMERS



THE ECONOMY OF RAWHIDE GEARS

In addition to making machines silent, Rawhide Gears minimize vibration, thereby prolonging life and effecting a great saving in the cost of repairs and renewals. It will pay you to investigate "Chicago" Rawhide Gears, for economy and silence.

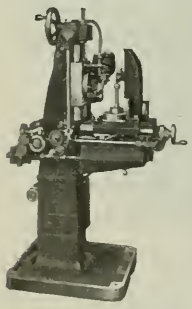
If made of leather for mechanical purposes—we make it.

We make Belting, Lace Leather and Cat Lacing, Hydraulic Packing, Rawhide Mallets and Hammers, Leather Specialties, etc., etc.

The Chicago Rawhide Mfg. Co. 1301 Elston Ave. CHICAGO, ILL.

THE GEAR HOBBER

They're All Talking About



WHEREVER it is known or used the Hercules Gear Hobber is recommended as a cost-cutter and production booster.

This machine is making good most decidedly.

It is earning repeat orders.

Let us send complete information.

Manufacturers of Tools of Precision for the Accurate Generation of Teeth.

Hercules Machine and Tool Co., Inc.

General Offices: Broome and Lafayette Streets, New York City. Works: Astoria, Long Island

STAHL GEARS

What Makes Good Gears?

Care in designing and manufacturing, high standards of accuracy, correct equipment and *experience.*

These are the qualities that combine to make Stahl Gears valuable in the construction of high grade machines.

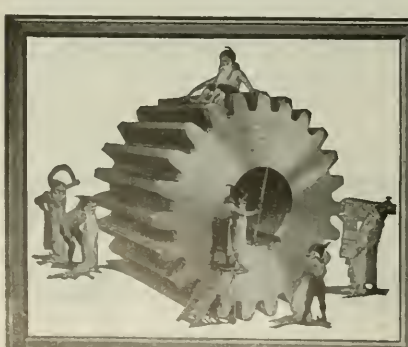
Metal Gears—spurs up to 60" dia., 2 D.P.; bevels up to 24" dia., 1¾ D.P.; spirals and herringbone gears up to 19" dia., 3 D.P.; worms up to 18" dia., 3 D.P.; racks 8' long, 4 D.P. Rawhide gears—any requirement up to 15" dia., 2 D.P.



Have you tried Stahl Gears?

THE STAHL GEAR & MACHINE CO.

1390 East 40th St.
CLEVELAND, OHIO, U.S.A.



GANSCHOW

"QUALITY"

RAWHIDE AND BAKELITE

PINIONS

WILLIAM GANSCHOW COMPANY

CHICAGO ☆ ILLINOIS



Gears

SPURS, BEVELS, MITERS, MORTISE WHEELS, WORMS AND WORM WHEELS

We have the most complete line of equipment in the U. S. A. for making machine molded cast tooth gears. With the machine molding system a single tooth block is used and all the teeth are accurately machine spaced, insuring gears that are free from the inaccuracies of pattern molded gears, at the same time eliminating a large part of the pattern expense.



Capacity 1 inch to 6 inch pitch, up to 20 feet diameter and 20 tons in weight.

CUT TOOTH GEARS

We make a complete line of ELEVATING, CONVEYING AND POWER TRANSMITTING MACHINERY.



H. W. CALDWELL & SON CO.

CHICAGO, 17th ST. and WESTERN AVE.

NEW YORK
50 Church St.

DALLAS, TEX.
709 Main St.

Buy Earle Gears for Economy

The life of a gear will depend to a large extent on the judgment displayed in selecting the material and formulating the design.

No one is better equipped to render this judgment than the expert gear maker—one whose *specialty* is the making of gears.

There is no charge for our advice on your gear problems. Write us.

THE EARLE GEAR & MACHINE CO.
4705 STENTON AVE. PHILADELPHIA

EARLE GEARS

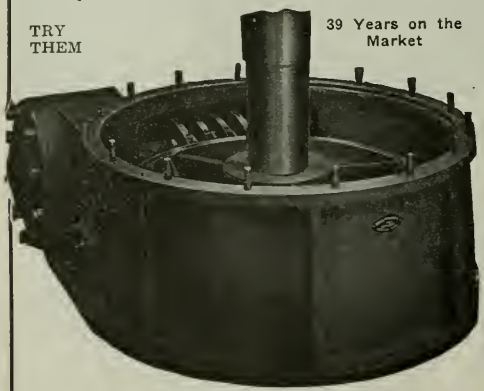
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Greater Bearing Surface—Larger Number of Teeth in Contact

Heavy pulls and high speeds require gears of the greatest possible strength and durability. The record of Hindley Gears in hard drives proves their ability to negotiate any job in the service with safety to all concerned.

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39 Years on the Market



Hindley Gear Company
1105 Frankford Avenue Philadelphia, Pa.



GENERATED

in our

Gear Cutting Department

(Cut is full size)

Let Us Quote You

MEISSELBACH-CATUCCI MFG. COMPANY
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BEVEL GEAR GENERATORS. BEVEL GEARS

CUT THEORETICALLY CORRECT.

Special facilities for cutting Worm, Spiral, Miter, Internal and Elliptical Gear Wheels.

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Gears and Gear Cutting

We guarantee satisfaction

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GEARS TO YOUR ORDER

We specialize in quality gears. Thirty years of practical experience your guarantee.

CAST IRON, STEEL, COMPOSITION

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Syracuse New York

AGMA

QUALITY FIRST



COWLES CUTTERS

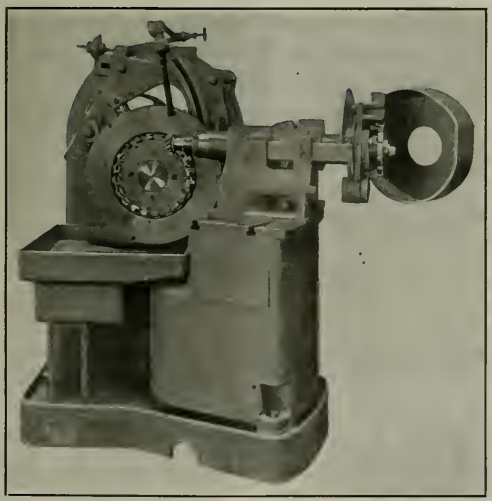
Do you believe in Specialization? We make nothing but HIGH SPEED STEEL MILLING CUTTERS. Our entire plant being concentrated on the one thing, enabling us to turn out a very high grade product. Cut shows one of the many styles we make.

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Many standard sizes carried in stock, prompt delivery on others. Write or wire for quotations

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Gleason Spiral Pinion Rougher



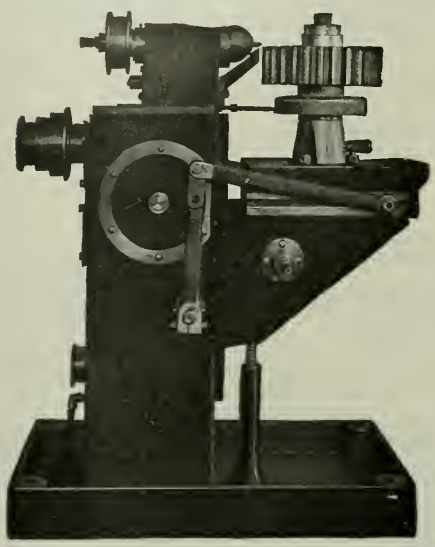
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CROSS

GEAR TOOTH ROUNDING MACHINE



The Cross Gear Tooth Rounding Machine is the original machine that allows the gear to be held rigid during the cutting operation and where the cutter spindle oscillates or rotates about an axis eccentric to its own axis of revolution. All other machines having this principle are direct infringements, and all manufacturers, sellers and purchasers of the same will be considered direct infringers and will be held liable to the full extent of the law.

Does Your Product Make Too Much Noise?

Noise absorbs energy—wastes it—for noise denotes friction. Undue noise in your product indicates neglect in its building. Whether you build machine tools, automobiles, engines, tractors, mill or other machinery—no matter what you make — grinding gears will give you away. Silence is always golden in moving machinery.

Cross Gear Tooth Rounding Machines in your plant will give these results with maximum economy. The "Cross" will, for instance, round a ⅝- or ⅝-pitch gear at the rate of 25 teeth a minute, or a ⅛-pitch at 15 teeth per minute.

Its capacity is for gears up to 36 inches diameter—2-pitch or finer.

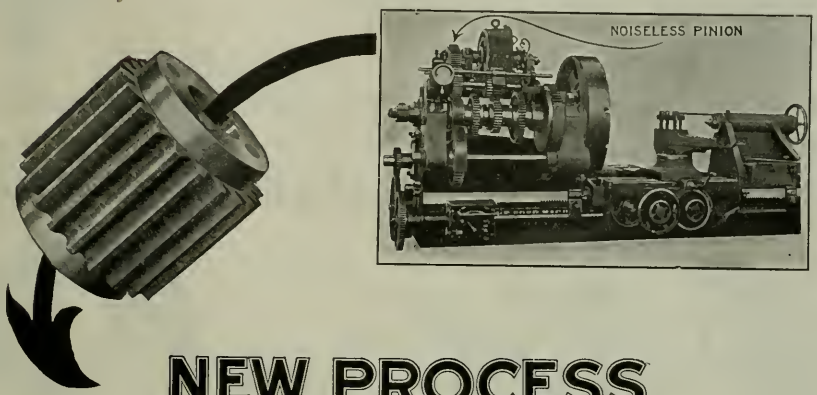
Further details will be mailed upon request. Write.

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CROSS GEAR & ENGINE CO.

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and on all types of Lathes—



NEW PROCESS RAWHIDE PINIONS

absorb the vibration that imparts a jerky motion to cutting tools and dulls their sharp edge quicker.

—their quietness reduces nerve strain

THE MEACHEM GEAR CORPORATION

Sole manufacturers of new process RAWHIDE GEARS and PINIONS.
Still made under the direction of the inventors and the men responsible for every stage in their development.

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300,000 in stock at factory.
Over 1200 sizes in our 1920 Catalog. Sent on request.



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"Zones of Quiet" GEARS



PERHAPS your product would be improved by the use of "Zones of Quiet" Gears. Their noticeable smoothness in operation and absence of harsh, grinding gear noises always attract favorable attention and mention of the finished article on which they are used. We make—

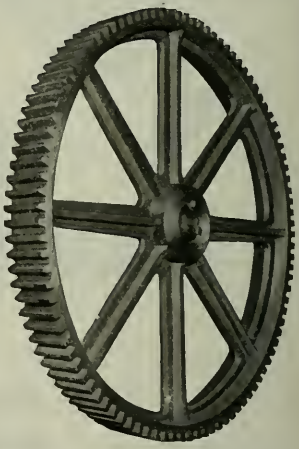
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Capacity—10,000 finished gears daily. If interested, send blue print or sample gear for estimate.

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Spur, Bevel, Mitre, Worm and Spiral Gears made in a wide range of sizes, designs and materials. Spurs to 60″ diam. 2 DP. Bevels and mitres 50″ diam. 5″ pitch. Equipped to manufacture Gears and Machine parts in quantities.



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Gear Specialists
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"TRY SIMONDS"

if you are in the market for

Cut Gears, Racks, Worms, Worm Gears, Special Machinery



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THE SIMONDS MFG. COMPANY
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BE SURE AND SPECIFY

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WILMINGTON FIBRE SPECIALTY CO., Wilmington, Del.
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The right steel, correct heat-treatment, skilled workers and modern equipment, make Dyson Forged Spindles an asset to all machines that are built to last.

Forgings of all classes from 3-inch nuts to 5-ton shafts. Have you tried them?

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If you need machinery forgings—good forgings—get in touch with us.

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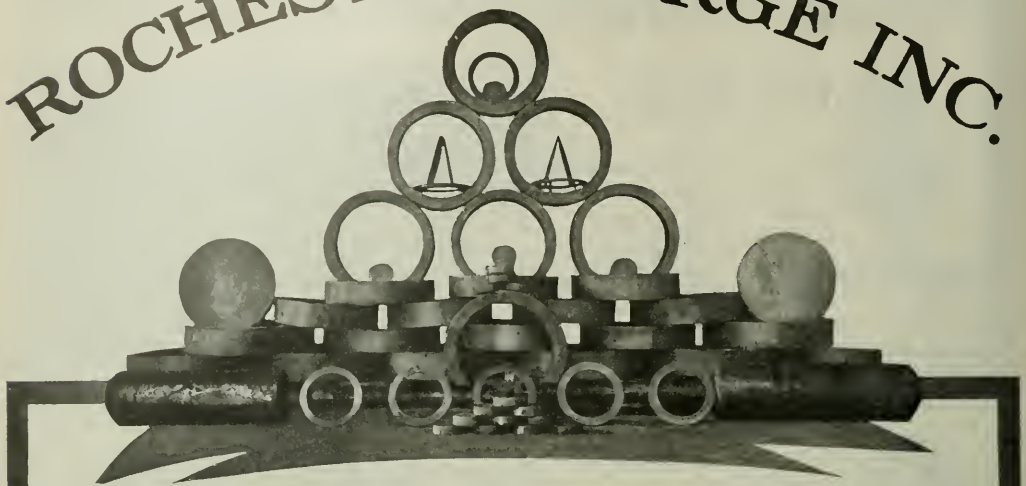
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If quality counts in your business as it does in ours, then you will be interested in our super-fine machinery forgings.

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Hollow forgings are the supreme test of forging skill. *Good* hollow forgings—i. e. concentric and close to finish dimensions—save appreciably on machining.

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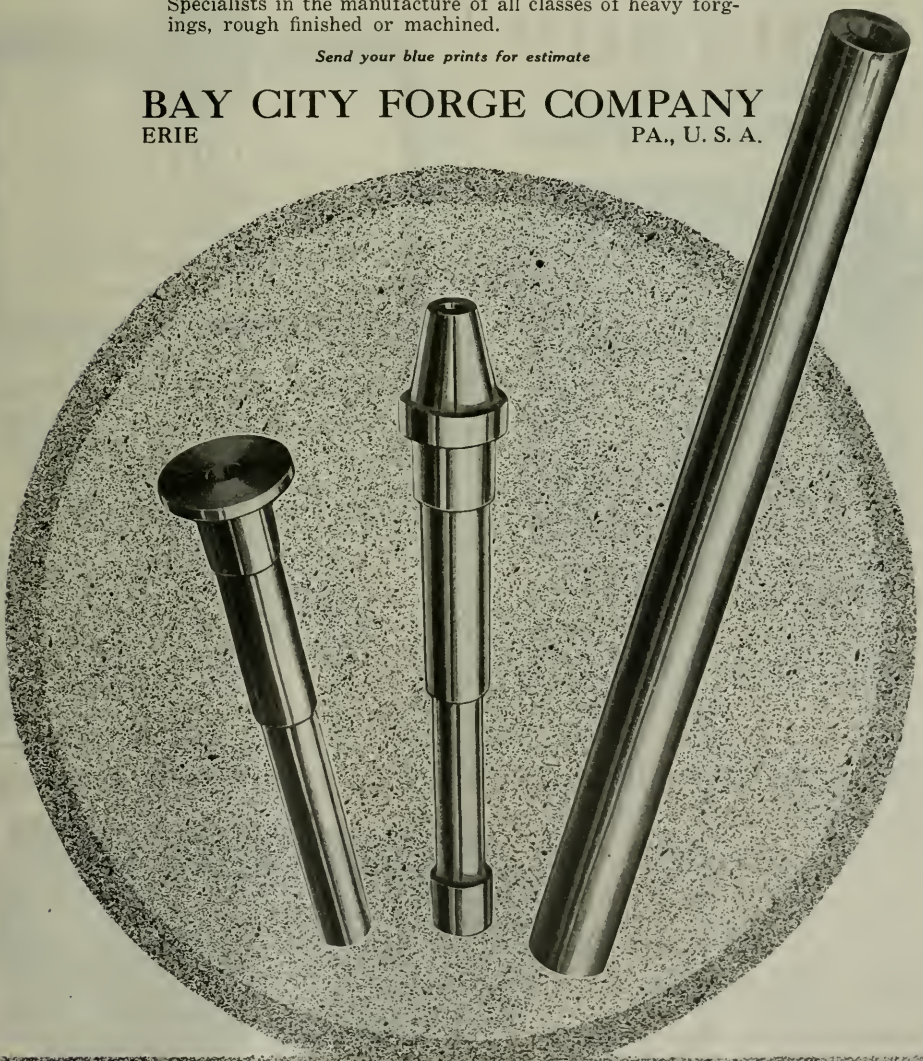
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Largest Producers in the World of URANIUM

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Foundry Pattern Plates, all shapes and sizes, Core Plates, Flattened, Ground and Polished Steel Plates and Discs—straight, accurate, finely finished. Finished Machine Keys and Machine Racks; Round and Hex. Cold Drawn Screw Steel. Cold Drawn Shafting; Flats, Squares and Special Shapes. Write for particulars and prices.

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FEDERAL INSERTED CENTERS

For Milling Machines,
Grinders,
Gear Cutters,
Lathes.



The Point only is changed

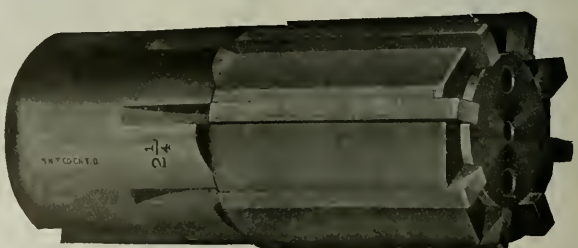
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THE ACME RIGID H.S. EXPANDING BLADE SHELL REAMERS

You can spend two hours of toolmaker's time underlying blades and grinding reamers down to size for every few hours' use if you want to. With the Acme reamers ninety per cent of the time thus wasted is saved. With the Acme reamers you can get an expansion as fine as .0005 in a few seconds and a minimum expansion of the blades of ⅛". When the blades are worn out they can be renewed.

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The Continued Prosperity of Every American Citizen is Largely Dependent on Efficient Railroad Facilities

Unless raw materials and finished products are moved quickly and efficiently to their destinations, production is seriously checked and costs mount higher and higher.

Any plan to combat the high cost of living which does not wisely provide a sound financial basis for our railroads is certain of failure.

Any business enterprise forced to buy its material at 1920 prices and sell its product at pre-war figures would inevitably collapse. This is the situation of the railroads at this moment.

A living wage for the railroad is the most vital need of the day.

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Main Office & Works
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$35.00

Converts Your Shaper into a $1000.00 Slotter

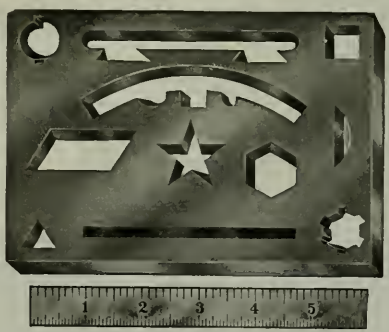


BRUNO Attachments

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Extensively used in the most exacting shops and have been found to make possible the most intricate shaping, such as that required for Dies, Jigs, Gages, Keyways, Slotting, etc.

The attachment is simple in construction and quickly applied. The cutting tools may be made from round or square stock and may be turned to cut from any angle.



Photograph of a steel plate, one inch thick, machined with our slotting attachment. Note the sharp points of the star. Why file? You can quickly and accurately machine these shapes with our attachment.

Made in the following regular sizes. No. 0—takes $\frac{3}{8}$″ to $\frac{1}{2}$″ Round Shanks, No. 1—takes $\frac{1}{2}$″ to $\frac{5}{8}$″ Round Shanks, No. 2—takes $\frac{5}{8}$″ to $\frac{3}{4}$″ Round Shanks.

Each size is furnished with two cutting tools.

Dept. M.

H. A. MOORE CO.

ROCHESTER, NEW YORK, U. S. A.

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"Neither rusts, stains nor tarnishes"

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A high-chromium alloy steel (containing approximately .30 percent carbon and 13 percent chromium), whose most useful property is an exceedingly high resistance to the corrosive effects of acids and gases.

VALVES: In addition to its rust resisting and non-corrosive qualities, Stainless resists the oxidizing effects of hot gases to such an extent that it is particularly valuable for aeroplane and automobile engine valves, where it is replacing nickel and tungsten steels. Not only does it resist scaling to a marked degree, but its low co-efficient of expansion (.00001091512) is an asset. In practice, Stainless valves, used on the exhaust side of very high compression motors, thereby preventing too rapid "erosion" of the valve seat, have demonstrated that for this particular purpose, they are superior to tungsten steel.

Stainless Steel can be supplied in all standard sizes of round, square or flat bar steel. Also a few strip sizes.

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Step by step, with painstaking care, with scientific accuracy, each process in the making of *PANNIER* Steel Stamps is carried out. It took many years to bring them to their present perfection—years of experience, experimentation and development — *PANNIER* Steel Stamps, as they come to you, are all that stamps can be: clean cut, accurate, durable.

For better marking with greatest economy, make your next order read "*PANNIER* Made."

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K 9 Oil-hardening Tool Steel

The Superior Die Steel

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EDGAR ALLEN STEEL CO., Inc.
Sheffield England



JUST as "the spirit of a single mind makes that of multitudes take one direction," so does the excellence of a manufactured product influence every purpose for which it is used.

Inherited pride in the maintenance of Red Cut Quality has descended as one generation of masters in the art of Tool Steel making has followed another. Each has fulfilled his part in perpetuating the perfection of the sacred legacy received from his ancestors.

"Red Cut Superior"

The Nationally Known—First Quality

HIGH SPEED STEEL

The Best for All Machine Work

Are Your Tools Made of "Red Cut"?

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Telephone Canal 1096

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JOHNSON Bronze Bushings



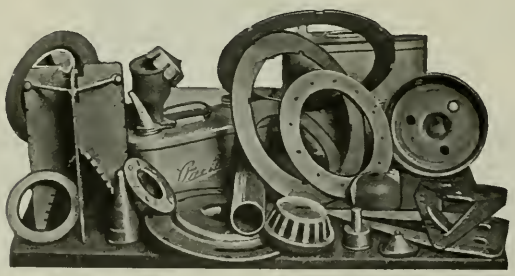
Are designed, manufactured and inspected with all the thoroughness and fineness that enter into the making of a piece of jewelry. Rigid tests at various stages of production insure a definite standard of quality, durability and wear resisting ability in all **Johnson Bronze Bushings.**

Write us for quotations.

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ACKLIN STAMPINGS

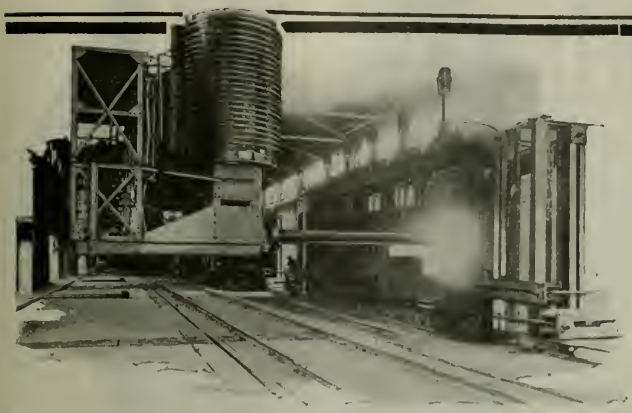


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Acklin engineers are stamping experts, Acklin equipment the most practical they can design or buy, Acklin methods the most efficient they can devise; that is why Acklin's Stampings are well finished and accurate parts are produced at a lower cost than is possible by other methods.

Send us the blue prints of that piece that "cannot be stamped" —let us tell you what we can do to cut your production costs.

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Heating blooms of solid steel for making seamless tubes

From bloom to finished product, the manufacture of "SHELBY" Seamless Steel Tubing is a story of continual effort to produce a material that represents the highest standards of a seamless tube.

"SHELBY"

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SEAMLESS STEEL TUBING

Made in a wide range of sizes, different degrees of anneal, and in special alloy steels and special shapes when required.

Ask for Booklet No. 103—
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PITTSBURGH, PA.

District Sales Offices in The Larger Cities



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Mail us a piece of

High Speed Steel

any size from ½" x 1" up to ¾" x 1½", which has become too short to use in the regular way, and we will weld same and furnish the tool steel shank

FREE OF CHARGE

A round piece of equal area if you wish. You have nothing to risk—much to gain.

DO IT TODAY

We can weld any size up to 1½" x 3", or 3" round.

Write for Catalogue and full particulars

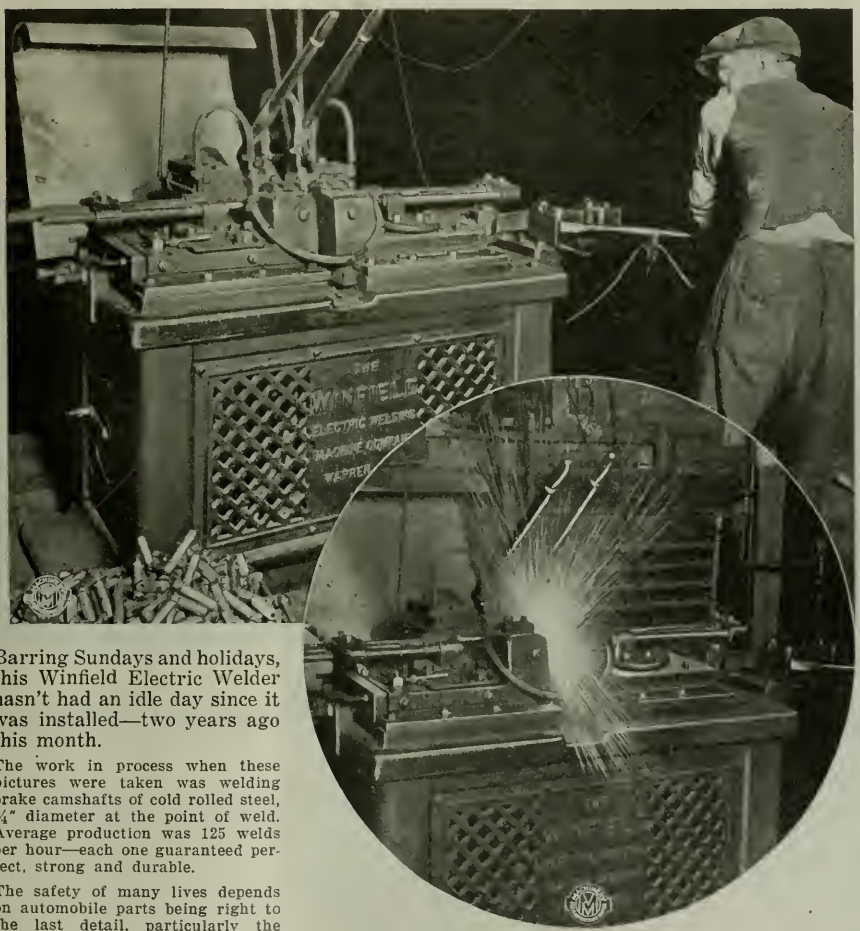
"ELWELD"

THE ELECTRIC WELDING CO.

2114-16 SUPERIOR VIADUCT CLEVELAND, OHIO

Winfield Welding

At the "Timken-Detroit" No. 3 Plant



Barring Sundays and holidays, this Winfield Electric Welder hasn't had an idle day since it was installed—two years ago this month.

The work in process when these pictures were taken was welding brake camshafts of cold rolled steel, ¾" diameter at the point of weld. Average production was 125 welds per hour—each one guaranteed perfect, strong and durable.

The safety of many lives depends on automobile parts being right to the last detail, particularly the brake mechanism, and this whole organization is so imbued with its responsibility in this respect that every man and machine is keyed to attain as close to perfection as possible—every machine in the plant being selected because of its peculiar fitness for its work.

We shall be glad to tell you more about Winfield Welding and to estimate from samples or blue prints of *your* work.



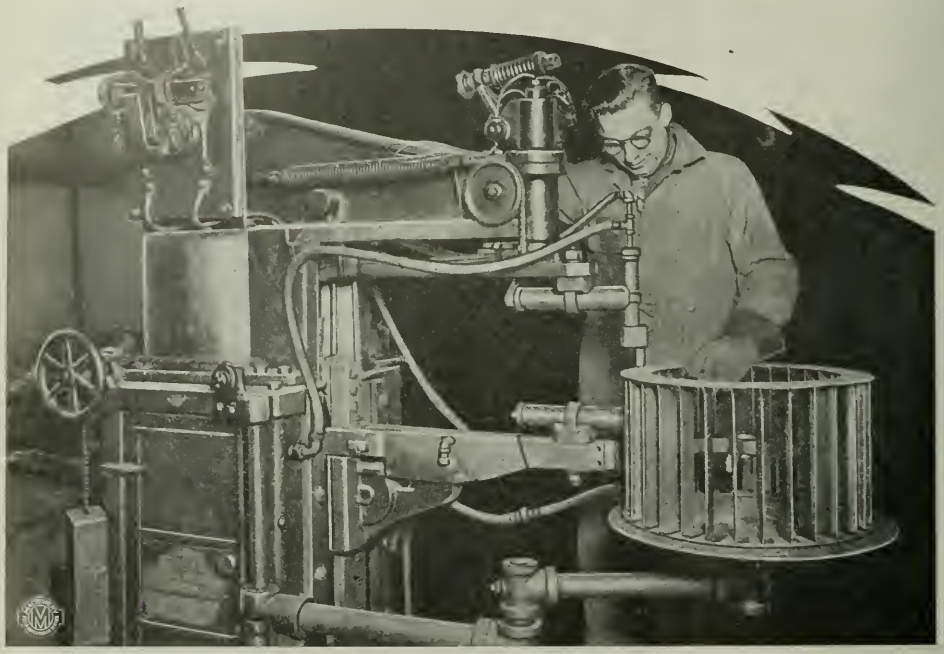
The Winfield Electric Welding Machine Co.

Factory and General Office:

WARREN OHIO, U. S. A.

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Durable Joints, Speedily, Accurately and Economically Made

Correctly welded joints—strong as the original metal—will withstand pressure, shock and constant jarring without separating.

Federal Spot and Butt Welders are made in several sizes for all classes of work. They are *sold outright only*—we have no royalty proposition to offer. Let us tell you about them.

An Efficient and Economical Welding Job



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OXYACETYLENE PROCESS IN PIPE FITTING

The iron pipe shown below is used as a header from a boiler. Previous to installation a 20° bend was made in this pipe. A section was cut off and bevelled by an oxyacetylene cutting torch. Then the two sections were welded at the required angle. The entire job was done quickly and at slight expense.

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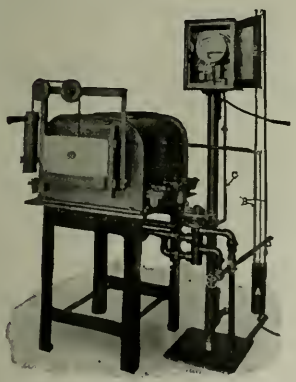
AIR REDUCTION COMPANY, INC
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AIRCO SERVICE—A DISTRIBUTING STATION NEAR EVERY AIRCO USER



AN AMERICAN GAS FURNACE

That Has Filled All Requirements for Eight Years



American Gas Furnaces are the logical equipment for up-to-date heat treating departments and are made in styles and sizes to meet any and every requirement.

Besides building all kinds of special machinery, the Hartford (Connecticut) Special Machinery Co. manufactures a quick acting patented vise of which a number of parts come to this American Gas Furnace for hardening.

The work in process when this photograph was taken was serrated sleeves for the vise. These parts are made of tool steel and must be carefully hardened to stand the strain put on the vise slide. They are kept in the furnace about 10 minutes and heated 1500° F after which they are quenched and drawn in oil to the required temper.

This American Gas Furnace is well liked in this shop, where it has never failed to come up to expectations. The oven can be heated as fast or as slowly as required and held at any specified temperature for any given length of time. It is clean, easy to manipulate and gives uniformly satisfactory results.

Specify your requirements and let us estimate.

AMERICAN GAS FURNACE COMPANY

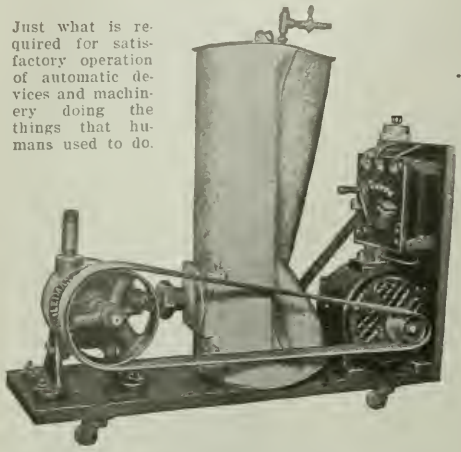
E. P. REICHHELM & COMPANY, Inc.

Sole Distributors

24-26 John Street **New York City**

A POSITIVE and STEADY VACUUM

Just what is required for satisfactory operation of automatic devices and machinery doing the things that humans used to do.



SUCTION COLLAPSES THE TANK!

This shows that the suction is there—it shows that even the small machines can do powerful work. Then there are NINE SIZES.

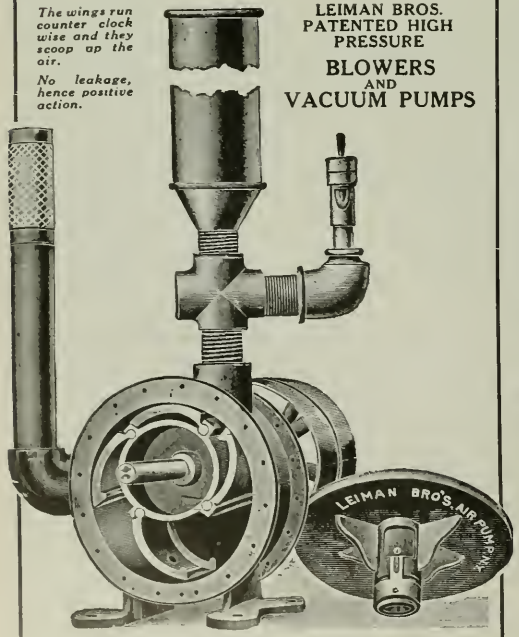
No matter what your problem—perhaps something being done mechanically now—there may be a better way out in the use of VACUUM—or with the same pump—PRESSUURE.

The wings run counter clock wise and they scoop up the air.

No leakage, hence positive action.

LEIMAN BROS. PATENTED HIGH PRESSURE

BLOWERS AND VACUUM PUMPS



Interior View Showing Big Air Space

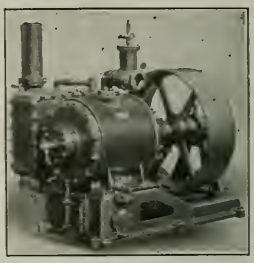
LEIMAN BROS., 81 Walker St., New York City

OVER 30 YEARS IN BUSINESS

A New Type

Simple—Practical—Compact

Concentrated effort to produce a really efficient air compressor has resulted in the development of the practical and serviceable machine shown.



Jackson Rotary Compressors

Rotary type compressors with high driving efficiency; carefully balanced with non-friction bearings and few moving parts amply lubricated. They work with little power waste and with the minimum of wear on the power medium—an important feature in the larger sized compressor.

Ask for the Circulars

THE JACKSON COMPRESSOR CO., Inc.

Office, 239 South Cherokee Street

DENVER COLORADO

K KASENIT

A ASSURES

S SATISFACTION

E EFFICIENT

WITH NON-POISONOUS NON-EXPLOSIVE NON-INFLAMMABLE

I INEXPENSIVE

T TRY-IT.

Case-hardening Compounds for Open Hearth or Oven Work

Ask your dealer or write

KASENIT COMPANY

30 South William St., New York

FURNACES—

From the smallest tool room equipment to the largest continuous billet furnaces used in the Steel Mills. Tate-Jones engineers can solve your furnace problems and supply you efficient and correct equipment for your work. Oil, coal or gas fuel.

Write for booklet "Heat Treatment of Steel"

Tate, Jones & Co. Inc.

Pittsburgh, Penna.

TRADE MARK Reg. U.S. Pat. Off.

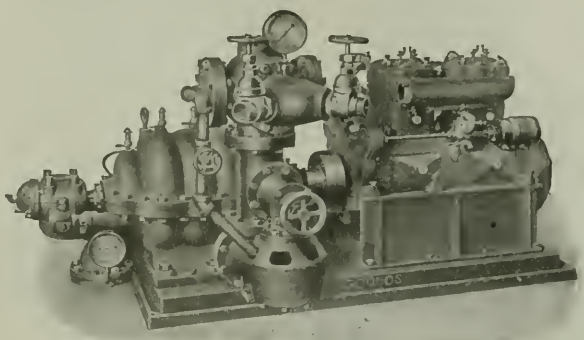
Pumping Outfits for "Stand-by" Service

In case your primary source of power fails, a

GOULDS Centrifugal Fire Pump

driven by a gasoline motor will give you an independent source of power for fire protection.

Those outfits can also be furnished without the underwriters' fittings for general pumping service. They can be furnished with or without electric self-starters, as desired.



Goulds Fig. 3014 Centrifugal Pump direct connected to Sterling engine for "stand-by" service. Many Goulds outfits similar to this are in use in army cantonments, government buildings, etc., as emergency pumps.

THE GOULDS MANUFACTURING COMPANY

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Volyum Pumps

have this advantage—the flow of coolant can be cut down or shut off entirely, without damage to the pump or pipe and without the aid of a relief valve. Many other points of advantage are detailed in our booklet "Full Facts."

THE VOLYUM PUMP COMPANY
2025 Elm Street CINCINNATI, OHIO

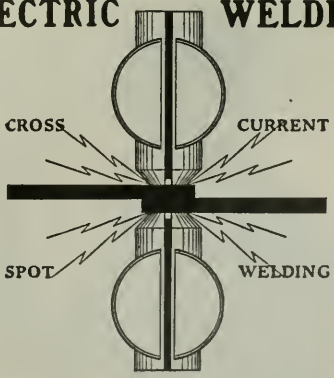
"FULFLO"

—the brief way to specify *the* Trouble-proof Lubricant Pump. Thousands have been convinced by test. Let us show you. Easily attached to any machine in your shop.

The Fulflo Pump Co., Blanchester, O., U.S.A.

X TAYLOR X

ELECTRIC WELDING



The advantages of the Taylor method of spot welding, which provides a greater concentration of heat at the point of contact, not only reduce welding time, current consumption and wear on the electrode points, but also permit welding heavier material. Production records tell the story.

Ask for them when you write for the catalog.

THE TAYLOR WELDER COMPANY
WARREN OHIO, U. S. A.

Thomson Process
Electric Welding

THOMSON Spot Welders

The Choice of Production Engineers

Ask for Bulletin or outline your assembling problems.

A Thomson Spot Welder in your assembling department soon pays for itself by the time and trouble it saves. It eliminates the use of rivets and the necessity of punching and drilling, makes a neat, *permanent* joint and its output is limited only by the dexterity of the operator, who need not be a skilled mechanic.

Thomson Spot Welding has a wide range of application—the lamp shade frames here shown being one of the simpler assembling operations on which this practical, economical process materially reduces the cost.

Thomson Spot Welder Company

LYNN, MASSACHUSETTS, U. S. A.

BUFFALO.....595 Ellicott Square Building
CHICAGO.....817 W. Washington Blvd
CINCINNATI...Knowlton & Langland Streets
DETROIT.....English & Miller Mchy. Co.
DULUTH.....Northern Machinery Company

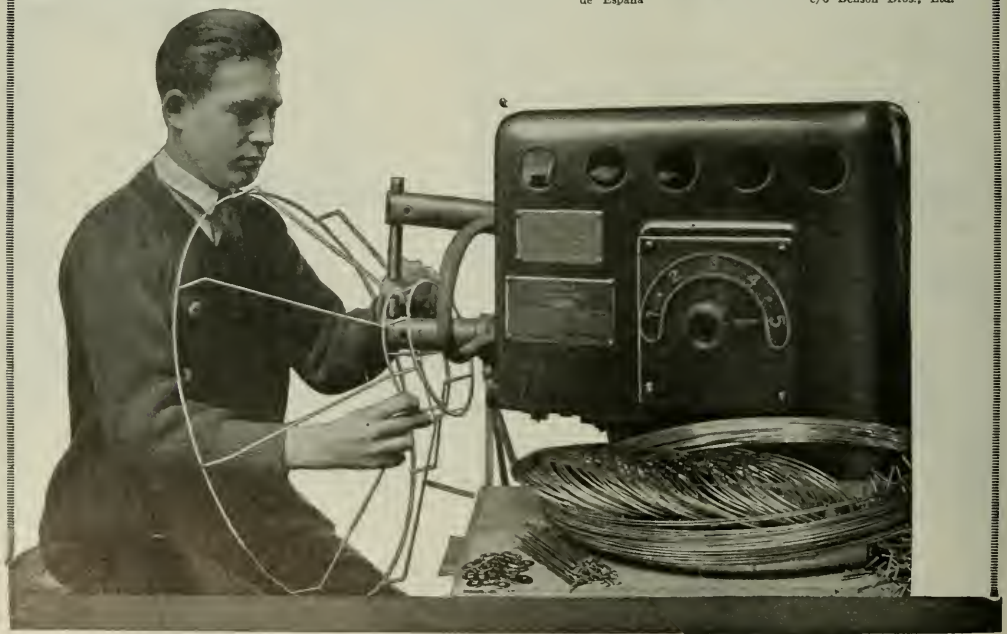
PARIS, FRANCE..Allied Machinery Company de France

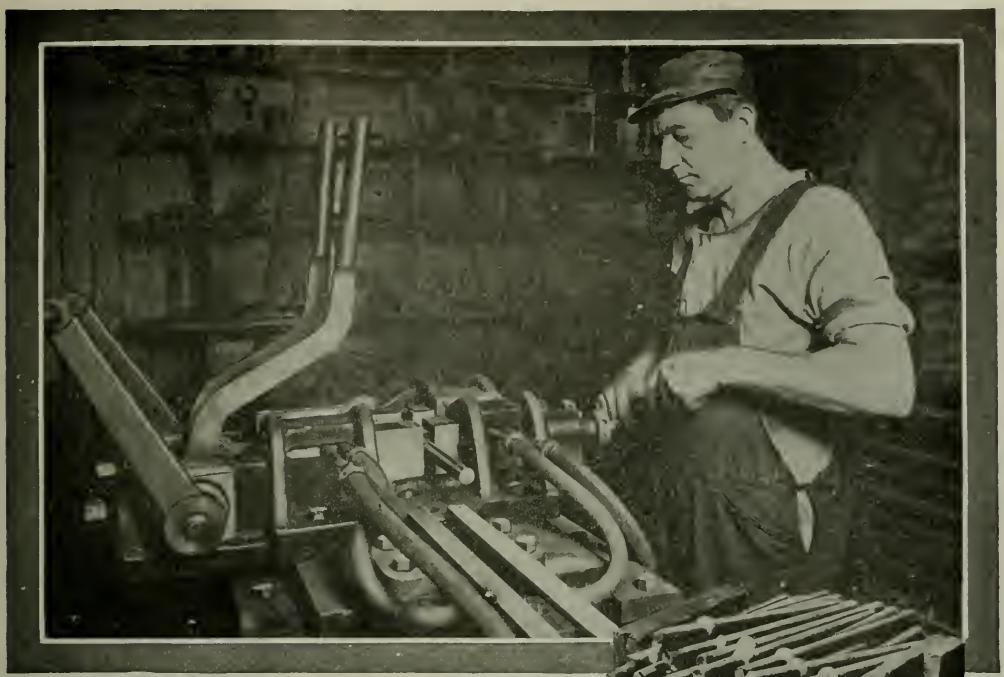
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KANSAS CITY....English Tool & Supply Co.
LYNN.....161 Pleasant Street
MINNEAPOLIS.....Northern Machinery Co.

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LONDON, ENGLAND, Allied Machinery Co., Ltd.
SYDNEY, AUSTRALIA..Allied Machinery Co. c/o Benson Bros., Ltd.





Thomson Process
Electric Welding

The Reputation of Thomson Butt Welding Is Based on 30 Years of Satisfactory Performances

Thomson Butt Welders are substantially built, hard service machines with capacity for 25 to 800 welds per hour according to size of stock, machine, etc., and have a reputation earned by achievement.

Many "Thomson" machines have been 20 to 25 years in daily operation and are still going strong—what's more, the welds they have made during this time are still *holding strong.*

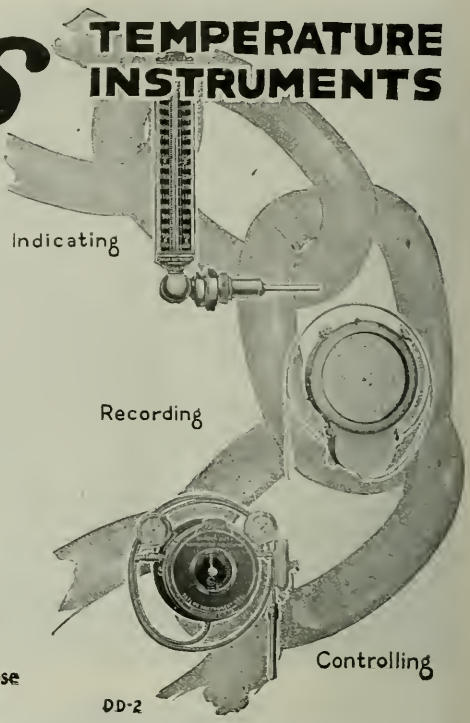
Tell us your welding problems and ask for the corresponding bulletin.

Thomson Electric Welding Company

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DETROIT.....English & Miller Mchy. Co.
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PARIS, FRANCE..Allied Machinery Company de France.
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Tycos TEMPERATURE INSTRUMENTS



The Basic Factors of Industrial Control

IN practically all the process work of modern industry *Tycos* Indicating, Recording and Controlling Temperature Instruments are standard today.

A lifetime devoted to the solution of special temperature problems has resulted in the development of these instruments to a point of dependability and precision which has not been surpassed.

A request for information on Tycos Instruments will bring you complete data without obligation.

Taylor Instrument Companies
ROCHESTER N.Y.
There's a *Tycos* or *Taylor* Thermometer for Every Purpose

FERRO CASE

Compounds

For Economical Case Hardening

FERRO CASE M
for use in Cyanide Melting Furnaces

Non-poisonous and do not deteriorate.

FERRO CASE S
for Sprinkling on Hot Steel

Give a clean, hard case at minimum cost.

Ask us about Ferro Case Compounds
TRY THEM!

C. G. BUCHANAN CHEMICAL CO.
Sta. H, Cincinnati, Ohio, U. S. A.

Scientifically Designed *Substantially Constructed*
One-Valve Control

Gas—INDUSTRIAL FURNACES—Oil

Uniform Temperature *Maximum Output*
Minimum Fuel Cost

These and many other features are what Surface Combustion Furnaces offer. Advise us as to your requirements and we will submit specifications and prices.

THE SURFACE COMBUSTION CO.
Industrial Furnace Engineers and Manufacturers
366-368 Gerard Ave., Bronx, New York, N. Y.
PHILADELPHIA PITTSBURGH CHICAGO

WILSON-MAEULEN CO.
PYROMETERS
Multi Recording
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Vincent Steel Process Does All Kinds of Heat Treating Well—with Browns!



The Brown High Resistance Indicating Pyrometer with Switchboard

HIGH-SPEED steel hardening, carbonizing, annealing and the cyanide process—all come within the regular work of this twenty-seven-year-young Detroit plant. And they do each so well, that night and day their forty furnaces—ranging from 24 feet and smaller—are kept busy turning out vital parts and fine tools for many of the country's highest priced motor cars.

Notwithstanding their twenty-four years' successful experience—or rather, because of it—the Vincent Steel Process Co. three years ago turned to Brown Pyrometers as the better way of knowing temperatures, both in their metallurgical laboratory and at their furnaces. Their judgment has been fully justified by results, and they frankly admit that their Brown Pyrometer Equipment is a big profit-payer, whether figured on a basis of time, labor or material saved.

This installation and 20,000 others point to a Brown Pyrometer Control as the way out of your heat-treating troubles. Write today for a quotation on an equipment to meet your needs. Address The Brown Instrument Co., Philadelphia, or one of our District Offices in New York, Pittsburgh, Detroit, Chicago, Denver, San Francisco, Los Angeles or Montreal.



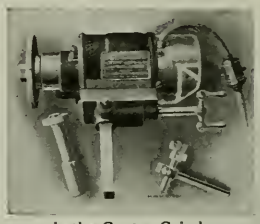
Brown Pyrometers

The World's Standard Heat Meters

How to Grind Dies Without an Internal Grinder

Put a Hisey Portable Electric Grinder on that lathe and presto!—your lathe is all ready for internal grinding, and will give most accurate and satisfactory results.

With a Hisey Grinder you are equipped to do the greatest variety of work without installing a lot of expensive machines which take up floor space and boost your overhead.



Lathe Center Grinder
Made in ¼ H. P. and ½ H. P. sizes

Use a Hisey Portable Electric Grinder

This Hisey Portable Electric Grinder is ready to grind your lathe centers, dies, rolls, etc., and the holes of collars, dies and jig bushings, or for sharpening reamers, milling cutters, gear cutters and tools. The Hisey will earn its cost in the money it saves.

The photograph shows the Hisey Portable grinding a die for motor laminations.

Send for Bulletin No. 1102-M.

The Hisey-Wolf Machine Co.
Cincinnati *Agencies in All Principal Cities* **Ohio**





The Tool You Choose At Once

Sturdy reliability is evident the moment you see it—and its dependability to always "stay on the job" has been built into it by master workmen who for fourteen years have specialized on these tools. *Our new catalogue will interest you.*

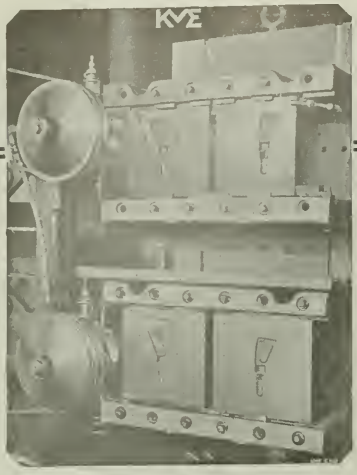
THE VAN DORN ELECTRIC TOOL CO.

CLEVELAND OHIO, U. S. A.

District Sales Offices

New York, Boston, Pittsburgh, Milwaukee, Cincinnati, Chattanooga, St. Louis, Detroit, Philadelphia, Denver, Seattle, San Francisco, Chicago, St. Paul.

Export Office: 152 Chambers Street, New York



Thresher tooth dies being cut automatically on the Keller Machine.

"It beats me!

I've combed the whole city, and I've advertised, and can't find another die sinker. How do you manage to keep up your production?"

"Why, I was up against the same thing: couldn't get dies or die sinkers, and I had to turn down some big orders. Then one day I happened to be going through the Blank Plant, and noticed some machines turning out dies automatically; they were Keller Automatic Die-sinking Machines. I wrote the Keller people for information and as a result, installed two of their machines: now I have two more on order."

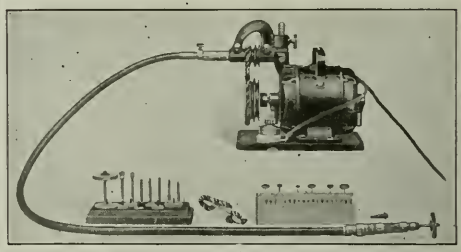
"Keller Automatic Die Sinkers? Why, I saw one some years ago and didn't think so much of it. Doesn't it require a lot of skill to operate and leave a good deal of hand work to be done on the dies?"

"No indeed! I remember that old type, but the Keller Machine of to-day is a different proposition. The beauty of it is that the average mechanic can keep as many as three going and they operate entirely mechanically, beyond a little preliminary roughing they turn out beautifully matched dies. I advise you to write Keller."

That's Good Advice.

Keller Mechanical Engraving Co.
74 Washington St. Brooklyn, N. Y.
KME-11

HASKINS



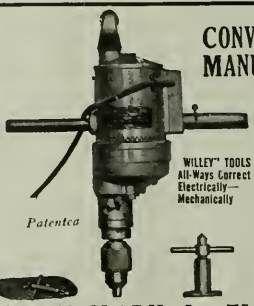
Type MH-4

DIE SINKING EQUIPMENTS

are especially designed to promote production and reduce costs in your plant.

Write today for complete details regarding this and other HASKINS LABOR SAVING EQUIPMENTS.

R. G. HASKINS COMPANY
Manufacturers and Distributors of Portable Machinery
27 SO. DESPLAINES ST. CHICAGO, ILL.



CONVENIENT TOOLS CUT MANUFACTURING COSTS

"WILLEY'
Portable Electric Tools

Can be used anywhere, take their power from the nearest light socket. Convenient, adaptable, fool proof.

Catalog?
Jacobs Chucks used as regular equipment

JAMES CLARK, Jr., ELECTRIC CO., Inc.
522 W. MAIN STREET LOUISVILLE, KENTUCKY

TOOL POST GRINDER

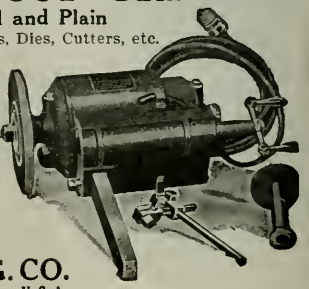
Hand Feed and Plain

For grinding Centers, Dies, Cutters, etc.

Does both Internal and Surface Grinding.

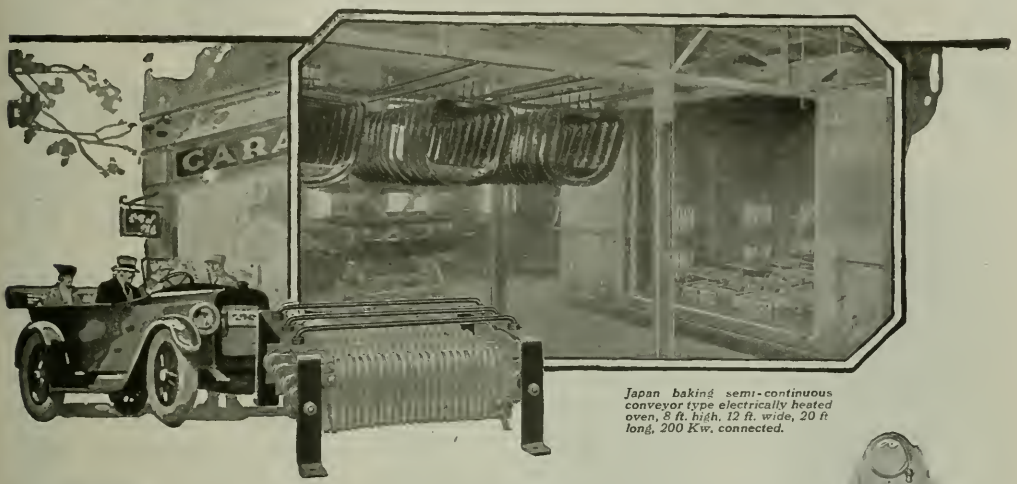
Supplied with ⅜ x 6" wheel internal grinding attachment.

Ten-foot flexible cord and plug to fit any standard lamp socket.



STOW MFG. CO.
BINGHAMTON, N. Y. U. S. A.
London Stock: 85 Queen Victoria St.

Five years ago electric heat was somewhat of a novelty—today it is doing what was then considered impossible with any kind of heat



Japan baking semi-continuous conveyor type electrically heated oven, 8 ft. high, 12 ft. wide, 20 ft long, 200 Kw. connected.



Compound melting pot



Electric soldering iron



Electrically heated glue pot

Beautiful Bodies Help Sell Motor Cars

ANY motor car builder will admit that a large number of cars is sold on "looks." As a result, the finishing of bodies and all enameled parts, such as fenders, wheels, tanks, etc., is a process that requires most careful consideration and the best equipment available.

In this process, the electric oven has come to the front through its obvious advantages over old-fashioned methods of baking. Its use greatly increases production thereby reducing the unit cost, even with higher rates for power than for fuel. Electric heat produces a lustrous, hard finish so essential for lasting beauty, and it requires less time than other forms of heat, with more accurate control, greater safety, and practically no defective work that must be done a second time.

The flexibility of electric heat is remarkable since it permits the use of varying degrees of heat in different parts of the same oven or furnace. For this reason, electric heat is rapidly being applied to the baking of varnish, enamel, japan, and other finishes; to the melting of metals and alloys; to the heating of steel so that it may be chemically treated; to the drying of salts, sand cores, pottery and grinding wheels; to the heating of rivets, soldering irons, etc.; and even to the sherardizing of steel to make it rust-proof by depositing on its surface a coating of zinc about twenty-five ten-thousandths of an inch thick.

To every one of the many uses of electric heat the General Electric Company has contributed in a broad way, until today the mark G-E on any electric heating device is the mark of the master. Thus it is to any manufacturer's advantage to consult G-E engineers before selecting such equipment.



Pyrotip lead burner



Cartridge type electric heating unit



Soldering iron muffle furnace

General Electric Company

General Office Schenectady, N.Y.

Sales Offices in all large cities

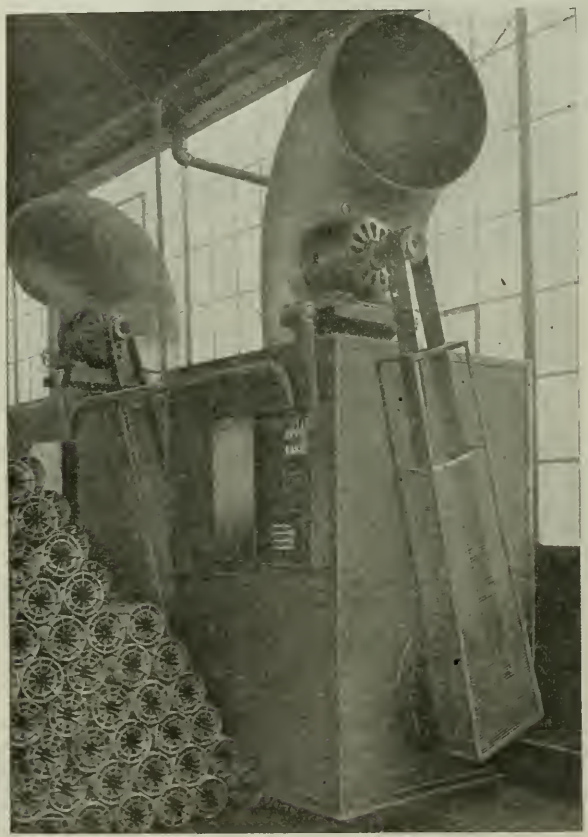
39-40

Put this thought before all others

in buying motors, and assure yourself of continuous, dependable power.



Quality, not first cost should decide



Two fifteen horsepower Wagner Motors, driving air heaters in foundry

You are not buying motors to discard them in a week or a month. The cost of a motor is the final checking up of first cost plus repairs and interrupted production.

Insure your power. It's the Quality that protects you and the preference you pay is the premium. Send for Bulletins 11824 and 12224

Wagner Electric

Manufacturing Company, St. Louis, Mo.

510

The Pioneer Non-sparking Motor

Some 40 years ago E-D engineers announced to the world the first successful non-sparking direct current motor—the E-D Inter-pole. Since that time it has been widely imitated.

But E-D set the pace, and we are confident that the E-D Inter-pole Motor of today, embodying the developments and refinements of the ensuing years, is representative of the highest attainment in sparkless commutation.

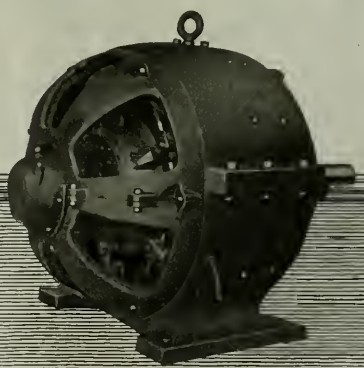
Get acquainted with the entire line of E-D Motors and Generators—A.C. ¼- to 200-hp. D.C. ½- to 300-hp. It has a time-tested record for dependable service. Write for Catalogs.

Electro Dynamic Company, Bayonne, N. J.

BRANCH OFFICES

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Chicago, Peoples Gas Building
New York, 11 Pine Street
Cleveland, Marshall Building
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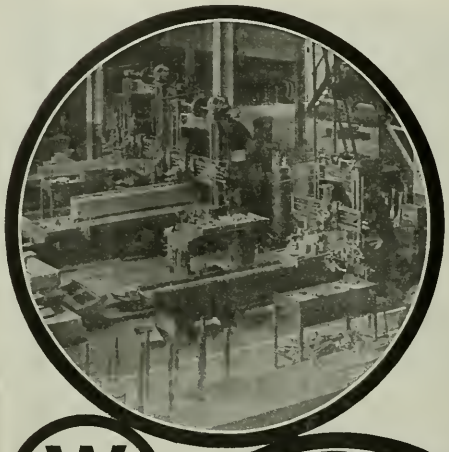


Electro Dynamic Motors

Westinghouse

SPECIALISTS IN THE DESIGN AND APPLICATION OF

Machine Tool Motors and Control



Meeting Requirements With Past Experience—

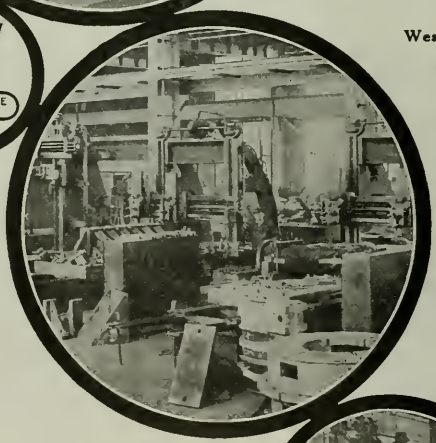
The experience of Westinghouse Engineers in equipping machine tools with motor drive and control has been broad and varied. It is represented by thousands of horsepower of motors and control installed in various machine shops throughout the country.

The capitalization of this experience prevents guess work, and assures the procurement of equipment that meets every requirement.

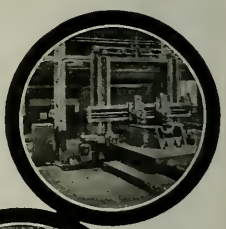
Westinghouse experience covers the entire range of machine tool application, and covers it THOROUGHLY.

W WESTINGHOUSE ELECTRIC

Westinghouse Electric and Manufacturing Co.
East Pittsburgh, Pa.

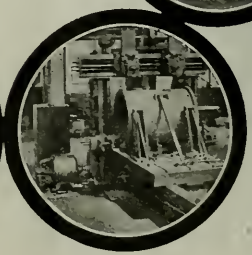


Sales Offices in all large American Cities



1176





Planer
Applications.

ANNOUNCING

Hurlbut-Rogers Broaches

We're making broaches! All kinds of broaches! For all purposes!

We've equipped a plant in Hudson, Mass.; purchased new machines and tools; associated with us skilled and experienced men; and we're booking orders right now for early delivery.

This Hudson shop is entirely distinct from and independent of our South Sudbury plant—the only thing in common being the capital behind both businesses and the four-square policy under which both will be run. Permit us to work with you—we'll make it pay you.

The Hurlbut, Rogers Machinery Co.

SOUTH SUDBURY, MASS., U. S. A.

SELLING AGENTS: E. A. Harper Tool & Supply Co., New York (for New York, Boston, Philadelphia, Baltimore); Cleveland Duplex Machinery Co., Cleveland, Ohio; J. R. Stone Tool & Supply Co., Detroit, Mich.; R. E. Ellis Engineering Co., Chicago; A. D. Heath, Indianapolis; John M. Howett, Dayton, Ohio.

The Monitor System

This Monitor-controlled motor-driven boring mill is started, stopped, reversed, or slowed down from one central Monitor push-button Control-station. Note it, directly above the operator's right shoulder. Briefly, while every operation is simplified, maximum production is secured with assurance of safety to man, motor and machine. The operation of every motor-driven boring mill, lathe, grinder, planer in your shop *can be* similarly controlled and safeguarded by The Monitor System. "Just press a button" to start, stop, reverse, accelerate or decelerate. Our Bulletin No. 1006, "Machine Tool Control," completely describes the System.

Monitor Controller Company

Baltimore, Md., U. S. A.

New York, Chicago, Boston, Philadelphia, St. Louis, Pittsburgh, Buffalo, Detroit, Cincinnati, Minneapolis. 2157

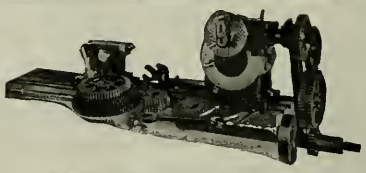


"Just Press a Button"

SIMMONS
OF ALBANY



Plain Index Centers Swing 10" Diam.

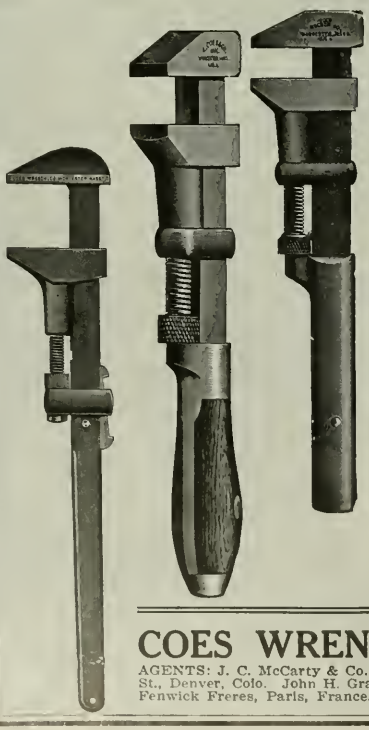


Universal Index Centers with Spiral Cutting Attachments

These Dividing Heads or Index Centers may be used on any milling machine; are well designed; materials are the finest obtainable. The Universal Index with Spiral Cutting Attachment is a quite recent development and will be found remarkably useful in any tool-room. Let us tell you more about these accessories.

SIMMONS MACHINE CO., Inc., ALBANY, N. Y.

BRANCHES: 801 Singer Bldg., New York 358 Ellicott Square, Buffalo, N. Y. Albany and Buffalo Warehouses



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Honest Tools for Honest Service

A Coes Wrench in your kit sets a standard that pays. Good tools are not "cheap," though they cost least in the long run.

For instance, the care taken in designing and manufacturing Coes Wrenches, and in the selection of the materials put into them, the sixteen inspections (eleven during the course of manufacture—five after completion) that insure their perfection, cost money, *but they pay.*

It is these things that make Coes Wrenches practical, convenient tools that give better service and out-wear most tools of their class.

Sizes, 6" to 72". Write for the catalog of styles and prices, or see them at your dealers.

COES WRENCH CO., Worcester, Mass., U.S.A.

AGENTS: J. C. McCarty & Co., 29 Murray St., New York. 438 Market St., San Francisco, Cal. 1515 Lorimer St., Denver, Colo. John H. Graham & Co., 113 Chambers St., New York. London, E. C., 118-122 Holborn. Fenwick Freres, Paris, France.

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Files of Precision—Toolmakers' Files

Our trade-mark — the Swiss Cross flanked by two American stars—is as much your protection as ours. It guarantees you files that are correct in shape and cut, uniformly hardened and made always of the best material. Files with edges and points well covered and points uniformly sharp. Files which are the choice of America's skilled hand-workers, for whom only the best is good enough, and who invariably specify "American Swiss."

Accurate Duplication Also Guaranteed





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Phoenix Extra Tool Steel

(Water Hardening)



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Hammond Steel is used almost exclusively for the construction of press tools, dies and punches, some of which, incidentally, serve the largest single crank press ever built.

Hammond machinery steel bars and forgings hold Phoenix or Phoenix Extra (the Hammond tool steels) punches and dies.

Nine years' satisfactory service from Hammond steels and from the Hammond organization is the reason behind the steady Hammond balances in the stockroom.

Prompt delivery on special jobs. You try a little to start. Send for prices today

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Manufacturers of High Grade Tool and Alloy Steels

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Export Representative: The Dickey Steel Company, Inc., Woolworth Building, New York

U. S. Government

awards the making

of over **90** per cent

of its 1920 shell plug requirements

to the

DOEHLER DIE-CASTING CO.

a total of

11,033,716

die-castings

of the Government's present need of 11,977,103 plugs, Doehler Quality, Doehler Service and Doehler Integrity have merited a contract for making nearly all. The same three factors command the bulk of the die-casting business.

If you use die-castings you need Doehler.



THE WORLD'S LARGEST MANUFACTURERS OF DIE CASTINGS

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Extremely accurate and uniform
Entirely reliable, very economical
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And so far as die castings go to help industrial prosperity

"Quality" Die Castings

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BRASS - BRONZE
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All sizes from 1 ounce to 5000 pounds.

High Conductivity Copper Castings a Specialty.

AMERICAN FOUNDRY CO., Newark, N.J.



ACME-DIE

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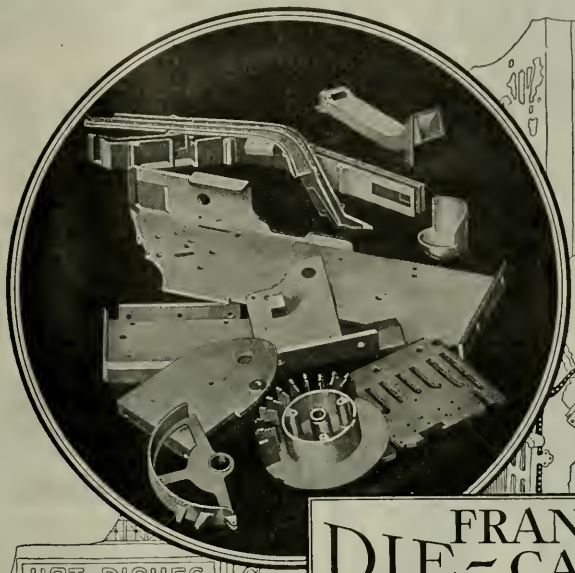
ALUMINUM-ZINC-TIN & LEAD ALLOYS

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Boston Rochester Brooklyn N.Y. Detroit Chicago

DIE CASTINGS
Of Quality

THE DIE CASTING COMPANY OF OHIO
TOLEDO, OHIO, U.S.A.





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In Many Kinds of Vending Machines

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We cast in Aluminum, Tin, Lead and Zinc base alloys. Estimates made from samples, drawings or blueprints. Send for booklet.

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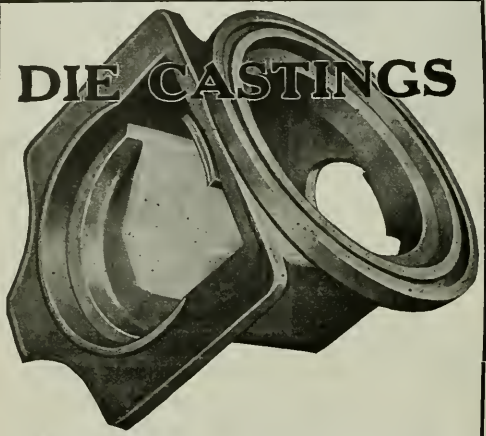
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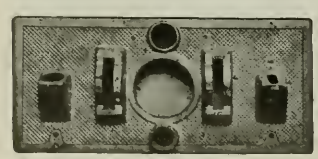
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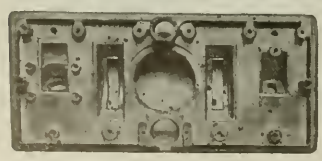
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Clean Cut—Super Cast—Durable Parts

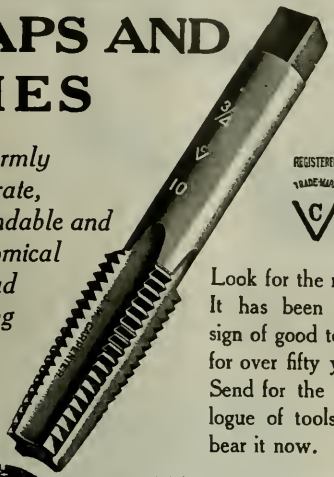
Superior white metal die castings are accurate, reliable and economical. Let experienced engineers, metallurgists and practical men solve your die casting problems.

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TAPS AND DIES

Uniformly Accurate, Dependable and Economical Thread Cutting Tools



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Look for the mark. It has been "the sign of good tools" for over fifty years. Send for the catalogue of tools that bear it now.



THE J. M. CARPENTER TAP & DIE CO.

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Quicker Plant Repairs



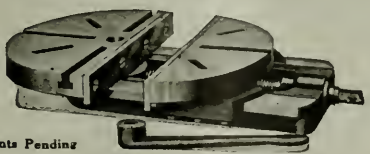
The Underwood Portable Boring Bar

Bores cylinders *in place.* All you have to do is to remove covers and piston. Write for full particulars about our line of labor saving portable tools.

H. B. UNDERWOOD CORPORATION

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A COMBINATION TABLE AND VISE



Patents Pending

Fits any drilling machine. Vise jaws are faced with machine steel; hardened jaws can be furnished upon special order. Four T-slots are machined in the table to provide for clamping work in the usual way. Opens 8 inches; when closed it is 16 inches in diameter. Write for details.

SPRAGUE-HAYES MANUFACTURING COMPANY

40 East Larned Street DETROIT, MICHIGAN



Fundamentally the object of a vise is to grip and hold.

Some people expect just this from a vise and nothing more.

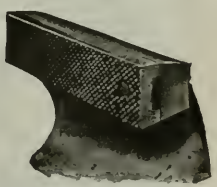
It is true that some vises do just grip and hold; but the wider adaptability of Prentiss vises is due to innovations and outstanding improvements, such as the self-adjusting jaw, the swivel bottom, interchangeable jaw faces, etc. In the hands of a good workman a Prentiss vise is a tool for fine and efficient work.



Figure 3



Figure 2



Detachable jaw faces offer many advantages to the careful workman. It is recommended that the three Prentiss "Ends" be always on hand and used with the same discrimination you would apply, say, to the selection of a milling tool.

Write for the Prentiss Book.

PRENTISS VISE COMPANY

110 Lafayette Street — New York City

Factory — Watertown, N.Y.

DRILL VISE

A good one for your driller, miller, shaper or planer.
The attachments mean that you can do much duplicate drilling without the cost of a jig.
Any vise will pay. More time is consumed in catching work than drilling it.

List Prices

No. 3, Jaws 6" long, with attachments, $45.00, without $40.00
No. 4, Jaws 9" long, with attachments, $60.00, without $54.00
No. 5, Jaws 12" long, with attachments, $85.00, without $75.00
V-Jaws extra, No. 3, $5.00; No. 4, $7.50; No. 5, $10.00 each.
One V-Jaw is usually sufficient per vise.

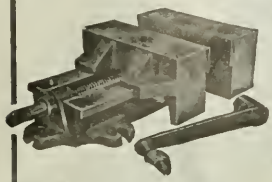


Fig. 2. Without Jig Attachments

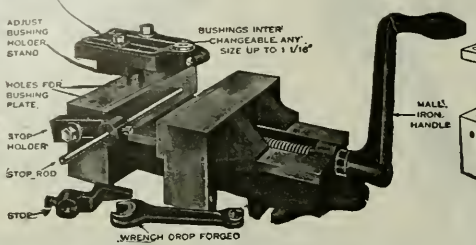


Fig. 1. With Jig Attachments

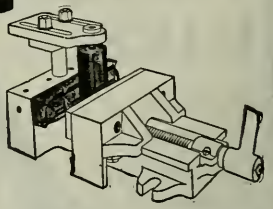


Fig. 3. V-Jaw for Round Work



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Or High Speed Drilling Attachment

Made in three sizes, and three styles, to accommodate straight and taper shank drills from 0 to ¾".

1. Increases the speed three times.
2. For use in all drillers from 20-inch to largest radial.
3. Shanks are made in various standard sizes, or special.
4. Direct end thrust through ball bearing. No pressure in case.
5. Double driven, or balanced.

All Patented. Send for Circular.

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For Turret Machine

Adjustable to any size within their capacity.

No. 2, Knurls up to 1½" diameter. For Turrets 6" diameter and under. List, $30.00.

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In ordering, give diameter of shank and style of knurling.



The Graham Mfg. Co., Providence, R. I.

Great Britain: Burton, Griffiths & Co., Ltd. France, Italy, Switzerland, Spain and Holland: Fenwick Freres & Co.

The Athol-Starrett Vise Is All Features

Beginning with the swivel base, which has the only positive lock on the market, and ending with the jaws, which simply can't slip on account of the buttress type jaw screw, you'll find the Athol Starrett Vise a combination of pleasant surprises and fully able to hold anything within the capacity of its jaws. If it were not we could hardly afford to cover our vises with so liberal a warranty as shown in the copy below. Our customers will tell you that our word is as good as our bond.

All features described in the catalog, which lists the whole line



THIS WARRANTY
STANDS BEHIND EVERY ATHOL AND STARRETT VISE

We warrant all our vises to be free from defects of material or workmanship. Any vise found defective in either particular will be replaced without charge. Any vise part which breaks with reasonable usage will be replaced without charge; and we will leave it entirely with the users to say whether the part broke under reasonable usage or not. YOU ARE THE JUDGE. Your word goes with us.

We are not afraid to endorse our warranty with our signature.

Athol Machine Company
Athol Mass, U.S.A.

"ALERT" Tap Wrenches Make it Easy to Reach into Inaccessible Places

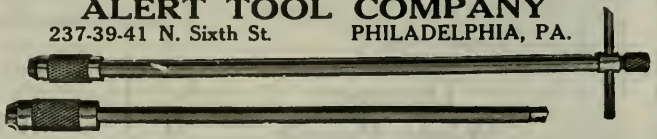


With an "Alert" it is easy to tap at long range—in out-of-the-way places. Alert Tap Wrenches are made in many lengths and capacities. Well tempered tool steel jaws are broached square, insuring a firm grip on the tap.

Write us and we will send name of supply house representing us exclusively in your locality.

Send for circular

ALERT TOOL COMPANY
237-39-41 N. Sixth St. PHILADELPHIA, PA.



THE WINNERS
Used in Every Shop Where Economy and Efficiency Are Practiced



DELTA

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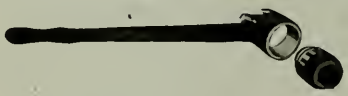
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DELTA FILE WORKS
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Used in Every Shop Where Economy and Efficiency are Practiced

The Awkward Time-Wasting Movements of the Unskilled Operator

May be saved on nut turning by using the

FAVORITE Reversible Ratchet WRENCH



that works with a quick straight ahead ratchet movement, doing away with the half turn of the old-fashioned, open end wrench with its frequent slipping off the nut.

Built Strong for Rough Usage.

GREENE, TWEED & CO.
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109 Duane Street
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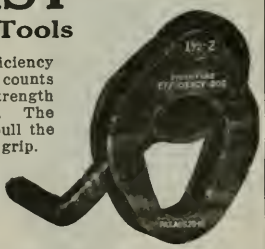


BE AN ECONOMIST
Save Time, Labor, Temper and Tools



The new Efficiency One-hand Pipe Wrench has rigid grip, adjusts automatically, is strong and durable—*an all-round pipe wrench.*

Improved Efficiency Lathe Dog counts for safety, strength and service. The harder the pull the tighter the grip.



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Our improved twelve-inch convertible level has been designed especially for builders, architects and contractors, because it is a level which can also be used for taking angles. This combined arrangement which allows conversion from use as a level to the taking of vertical angles is superior to all others, since the change occupies but a few seconds, and its cost is comparatively small.

Investigate for yourself this really remarkable instrument.

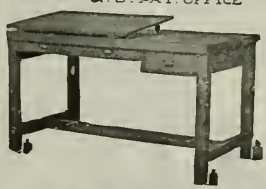
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THE MARK OF QUALITY REGISTERED ECONOMY U. S. PAT. OFFICE TO PROTECT THE USER



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LITTLEFORD Tool Racks

This handy piece of shop furniture saves the machinist miles of steps. It will pay for itself within a very short time.

Made entirely of sheet steel. Can be furnished with or without casters, also with or without drawer. When drawer is provided a locking device is furnished.

Write for details and prices

LITTLEFORD BROS. 354 E. PEARL STREET CINCINNATI, OHIO

"The Craley Master Toolmaker"

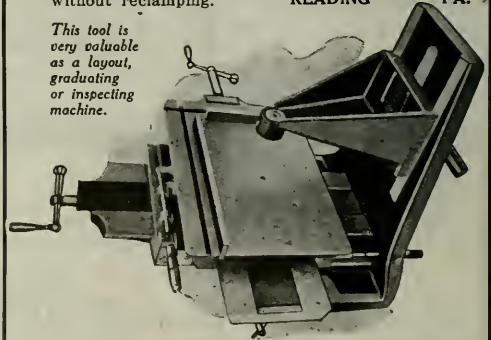
A rapid and accurate device for locating and machining holes in Dies, Jigs, Master-plates, Templets, etc. No laying out required.

Clamp work against guide strips which are a tight fit in work table and form a right angle. This tool is so timed that when the B & S Micrometer Heads read zero the center of the bushing is zero with inner edge of guide strips from which all measurements are taken. The cross slides are adjusted and location determined by standard distance bars and B & S Micrometer Heads.

Bushing support is adjusted to work and you spot, drill and ream holes as with an ordinary jig. Any number of holes completed without reclamping.

Manufactured by
LONG-HENKEL MFG. CO.
3rd & Buttonwood Sts.
READING PA.

This tool is very valuable as a layout, graduating or inspecting machine.





Print Drying Machine

"Not Enough Prints To Justify the Price"

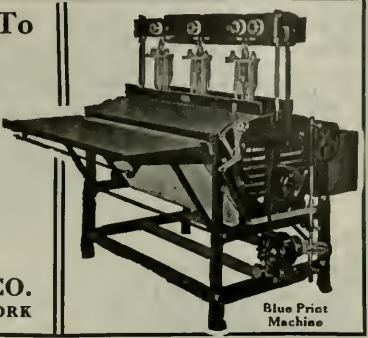
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The first cost of a slower machine is less in some cases, but a slow machine is not a money saver, because it monopolizes the operator's time to the exclusion of other work.

The Paragon prints from 10 to 20 lineal feet per minute, depending upon voltage and kind of paper used.

If you are after speed and economy, write for catalog.

PARAGON MACHINE CO.
ROCHESTER NEW YORK



Blue Print Machine



Electric Blue Printing Machines

Write for Catalogue B-2

Buckeye Engine Co.
Salem, Ohio



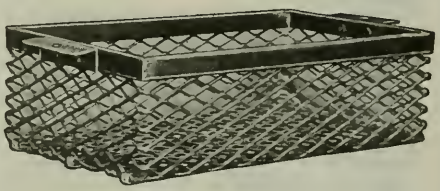
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now equipped with our "Hi-Power" Twin Arc White Flame Lamps, print two to three times faster than any other Vertical Machine. There are over seventeen hundred satisfied users. Write for descriptive literature.

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J. H. WAGENHORST & CO., Youngstown, O.
703 Dollar Bank Building

EXPANDED METAL TOTE BOXES

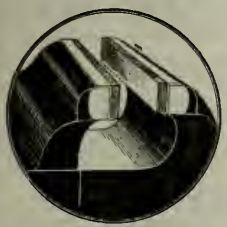


Also plain or perforated styles, with or without skids. Furnished in gauges ⅛ inch thick and lighter, reinforced at top and corners. We can furnish these to suit your individual needs, and invite your inquiries. Machine Safety Guards, solid and expanded metal, Tool Cabinets, Factory Chairs, Forge Hoods, Grease Cans, Waste Cans, Skylights, Ventilators and special sheet metal work for factories. Let us solve your problems.

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Plants Nos. 1 and 2
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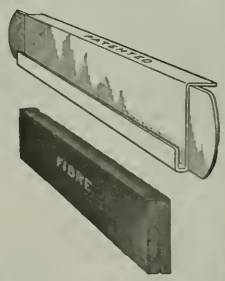


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For Milling Machine, Screw Machine, Lathe or Drill Press



Made to take round stock from 5/16" to ¾" and square or hex stock from ¼" to ½". Slide has a travel of over 2" enabling the operator to bore holes 4" in diameter. Body is bored to fit No. 4 Morse Taper Drill Shanks.

Practical, convenient and economical devices that increase the range and production possibilities of standard machines.

SEND FOR THE DETAILS.



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Simplify shop transportation. Holyoke Trucks—strong, simple, durable, with an easy roll lift, handle the heavily loaded platforms quickly and without difficulty, reducing the time and labor cost of moving the work as well as danger of damage to the work itself.



Stack your work on Holyoke Platforms—move them with Holyoke Trucks.

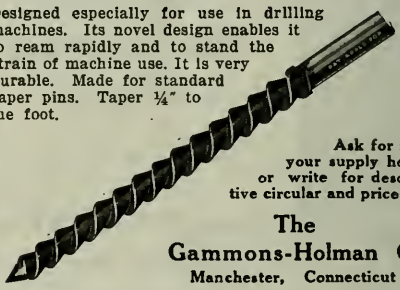
HOLYOKE TRUCK COMPANY
112 RACE STREET HOLYOKE, MASS.

Export Office: 77 Broad Street, New York City.

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The Gammons Taper Pin Reamer

Designed especially for use in drilling machines. Its novel design enables it to ream rapidly and to stand the strain of machine use. It is very durable. Made for standard taper pins. Taper ¼" to the foot.



Ask for it at your supply house or write for descriptive circular and price list.

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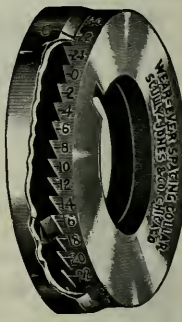
The WEAR-EVER ADJUSTABLE SPACING COLLAR

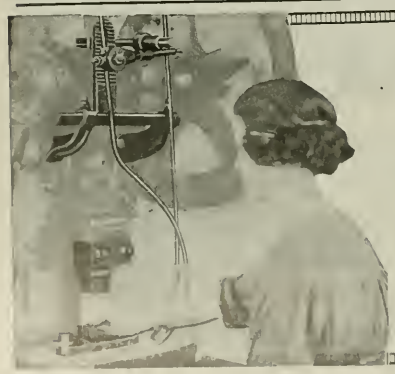
An Inexpensive Time Saver

Guarantees an accurate milling cutter set up. Nine sizes, ¾" to 2½" bore, easily adjustable in 12 steps of .002" each. Rigid as solid metal when set.

Circular?

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IN PROTECTING YOUR EMPLOYES YOU ARE PROTECTING YOURSELF

Wiesman Safety Guards

Are Protection Insurance, and Safety for Power Press Operators

The device is so attached that the arm sweeps three-quarters of the way across the opening and well past the danger point during the first quarter of the stroke of the ram. It sweeps back four-fifths of the way on the third quarter of the stroke. Some of the features are that the guard possesses but two moving parts, consequently there is but little wear or need for frequent adjustment. It is positively automatic and does not interfere with the operator's work.

More particulars on request. Ask for our free trial offer, giving number and name of press.

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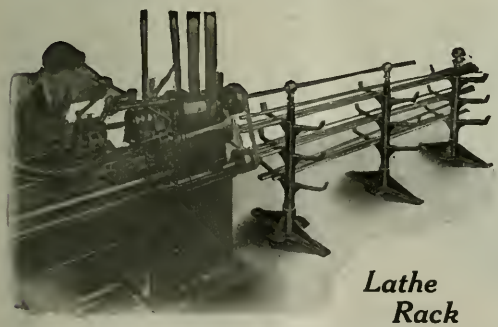
DISCOVERED!



"Yes sir, we discovered about twice the storage space in the same quarters. WHEN?—why, just as soon as we put in those *'sidelift'* BROWN SECTIONAL STOCK RACKS. They're saving time, temper and shoe leather, too."



Brown Sectional Stock Rack



Lathe Rack

Brown Sectional Racks are made of metal, built up of interlocking sections—can't lean, can't topple no matter how heavily laden—one man can assemble them.

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BROWN ENGINEERING CO.
133 No. Third St. READING, PA.
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STYLE "A"

G & P
Universal Joints

A Size for Every Purpose

No matter what your universal joint requirements may be, we are ready to make prompt delivery.

We find from years of experience that it is a rare occasion when our standard stock sizes can not be used.

In the construction of G & P Universal Joints, all parts subject to wear are "case hardened," thus adding greatly to the life of the joint. Our style "A" universal joint (as shown above), comes with solid blank ends and is carried in seven sizes for immediate delivery.

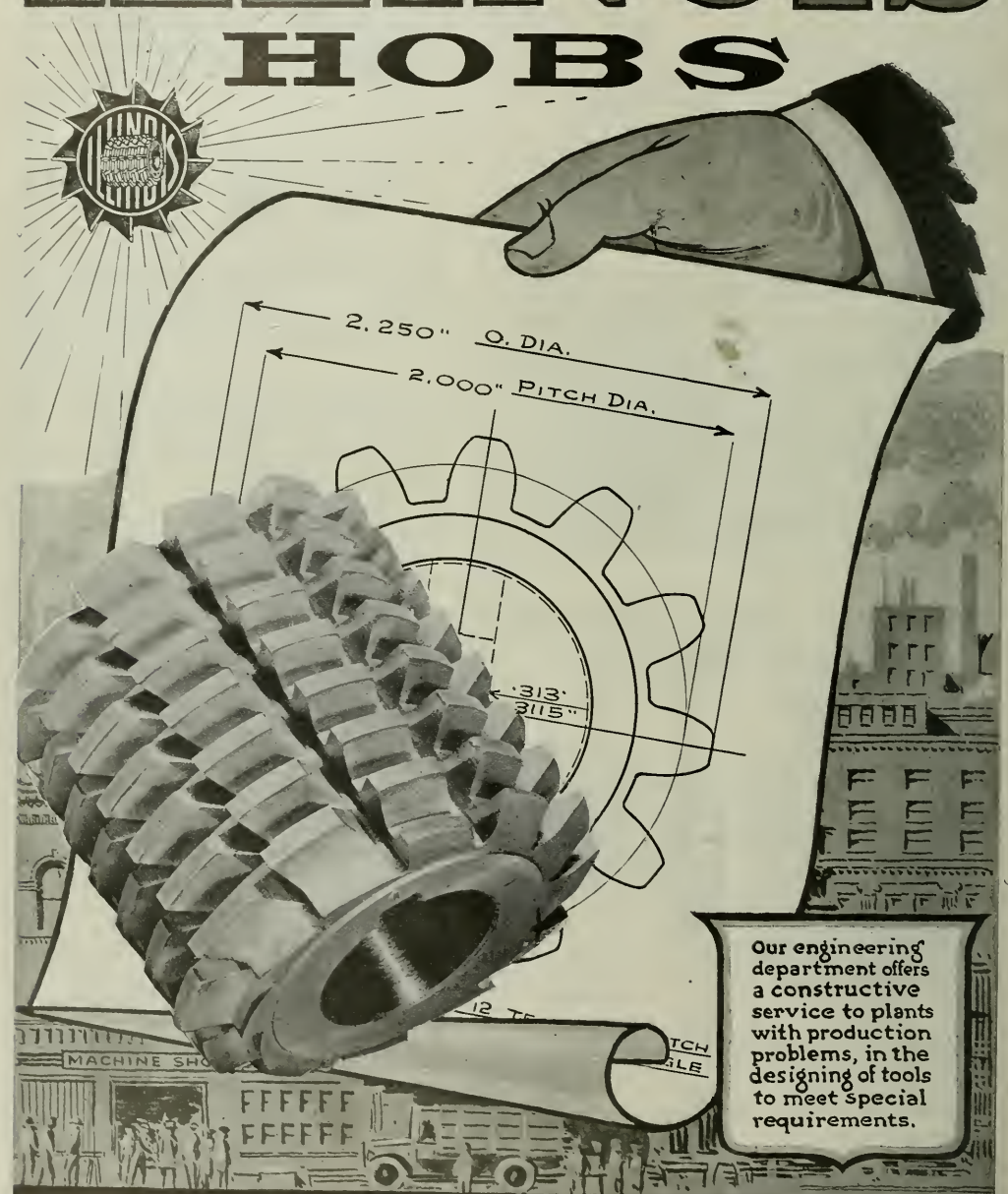
Thousands of these joints are in daily use, and among our best customers are many who started using G & P Universal Joints when they were originally put on the market.

Write for circular

Manufactured by
GRAY & PRIOR MACHINE CO.
38 Suffield St., Hartford, Conn.

ILLINOIS

HOBS



Our engineering department offers a constructive service to plants with production problems, in the designing of tools to meet special requirements.

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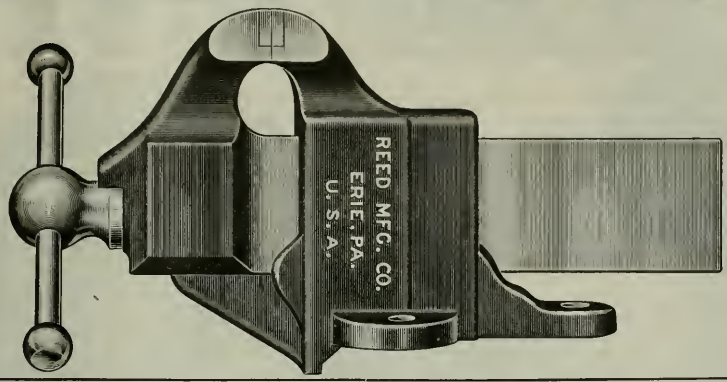
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Copenhagen, Denmark.

REED VISES



The Primary Function of a Vise

A Little Essay Short Enough for Business Hours

Too many persons, in considering vises, seem to think that "a vise is a vise." Likewise "bread is bread," but there is a lot of difference. TOO FEW think of the effect a vise has on work done in it.

The primary function of a vise is to hold an object so that work may be performed on it. If the object be rigidly held all the force of the work performed is delivered to that object, but if the object is not rigidly held more or less of the work is spent for nothing—wasted through the springing of the vise or lost through its recoil. A good job of filing cannot be done in a vise which allows the object to vibrate and causes the file to chatter. Chipping or similar work cannot be efficiently done in a vise which does not wholly resist the shock of the hammer blows.

In the familiar effort of driving a nail through a thin wood partition the same principle is involved. Back the partition up with a heavy object and the nail goes through easily.

A vise must be sufficiently rigid to resist the working force exerted. This rigidity can be secured only through proper design and placing of material, ample weight, use of proper material, and careful workmanship. Weight in itself is of little effect unless properly placed. Cast iron of the best grade is the most rigid of all materials practical to use for vise making.

In making Reed Vises for many years, it has been our constant endeavor through careful investigation, elaborate tests, and close contact with users to develop vises of an ideal type.

Inasmuch as nothing in this world of ours is absolutely rigid, we can never hope to attain true rigidity. We have, however, developed our vises to the point where we feel no equal exists.

Reed Vises are made of the best grade of cast iron. Every contact point is painstakingly machined to close limits. This gives snug, easy working fit without undue wear at any point, and perfect interchangeability of parts. Good fit contributes much to RIGIDITY of Reed Vises.

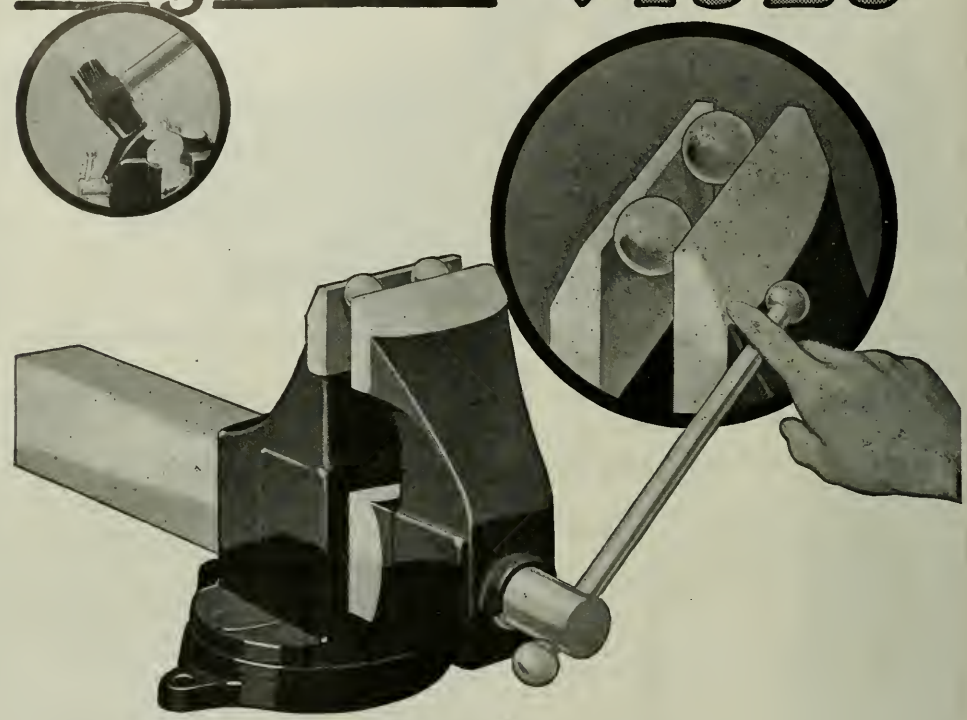
Weight is properly distributed to give greatest strength and rigidity. Because of the greater rigidity of a Reed Vise, the work performed is more quickly and efficiently done, and the life of the vise is greatly lengthened.

Widespread preference for Reed Vises is, we believe, based on our accomplishments.

REED MANUFACTURING CO., Erie, Pa.

COLUMBIAN

Sledge-Tested VISES



Will Your Vise Do This?

No one expects a vise to be made with micrometer accuracy. Yet the jaws of this Columbian Sledge-Tested Vise are so nearly parallel that when two steel balls of equal size are placed in the vise the minimum compression required to hold one ball will just be enough to hold the other.

This particular vise has smooth jaw facings, which makes the test more difficult than with the roughened jaws which are used on all Columbian Vises of machinists' type.

Of course, this is an unusual test for a tool with a tolerance of .002″ and it is likely that out of the hundreds of thousands of Columbian Vises in use the world over, there are some that will not easily stand so rigid a test, but the majority of Columbian Vises will.

Skilled mechanics demand the Columbian Vise for exacting work. The extra large, carefully fitted beam not only keeps the jaws parallel but slides freely and without play.

Columbian machinists' vises are the only malleable iron vises made and are twice as strong as cast iron. The famous Sledge-Test proves this.

Columbian Hardware Division

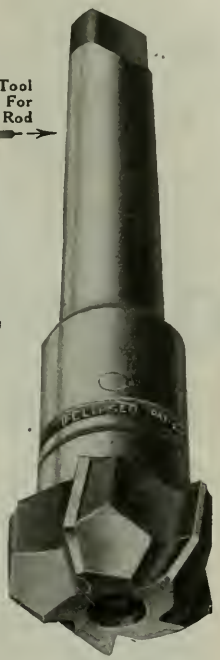
of The Consolidated Iron-Steel Manufacturing Co.

World's Largest Makers of Vises and Anvils

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Greater Production

Accuracy and Efficiency are the Results in Every Manufacturing Plant Equipped With



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Interchangeable
BORING TOOLS

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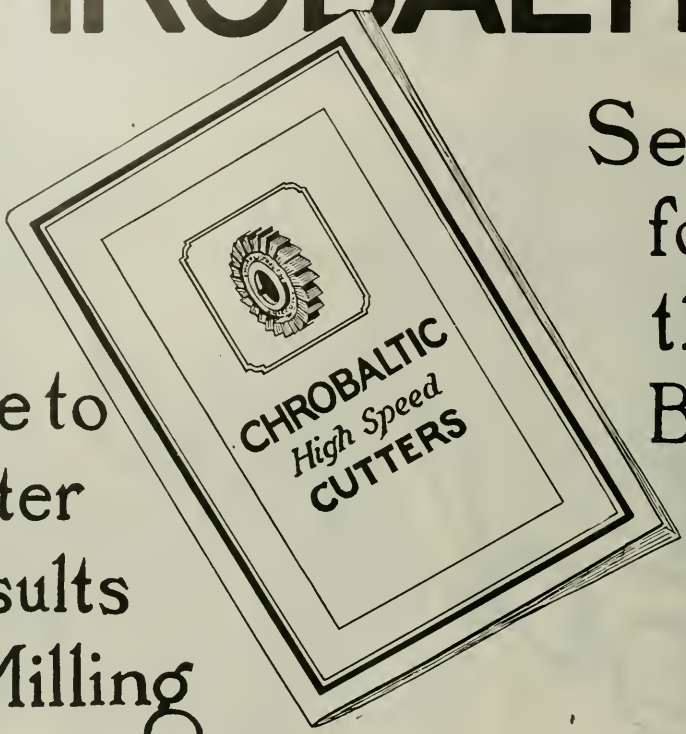
The Cost is Less Than Others
and the Production Greater

Write for catalog and discounts

THE ECLIPSE INTERCHANGEABLE COUNTERBORE COMPANY

1620 ST. AUBIN AVE. DETROIT, U. S. A.

CHROBALTIC



Send for this Book

Guide to Better Results in Milling

CHROBALTIC—A Forward Step Milling Cutter Practice

CHROBALTIC AND MONEL METAL

In tests made on Monel Metal by the Bethlehem Shipbuilding Corporation, Fore River Plant, Quincy, Mass., it was found that in comparison with ordinary high speed cutters, Chrobaltic cutters machined from two to three times as many pieces without regrinding.

In one of the tests a 4" diameter 5/8" face side milling cutter was used. At 115 R. P. M. and table travel 2½" per minute, it milled a cut 3/16" deep, removing .586 cubic inches of metal per minute.

If you are interested in milling, you should have the Chrobaltic Book and post yourself on the new alloy for present day requirements in this field.

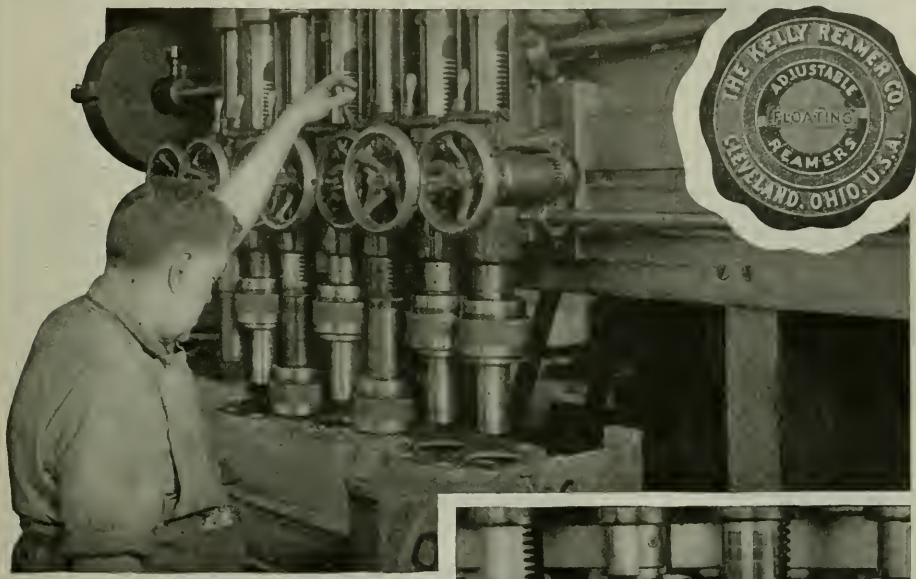
Whether measured by quantity or quality of work performed—Chrobaltic high speed cutters are giving most satisfactory results; and they measure a positive forward step in milling cutter practice.

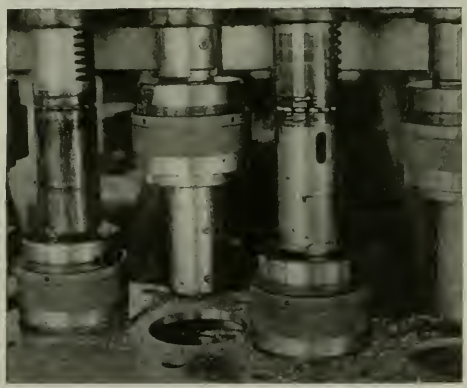
Chrobaltic Cutters distinguished themselves during the war, and they are now at the service and disposal of manufacturers who are looking for unusual results from milling cutters.

CHROBALTIC TOOL CO.

502 Railway Exchange CHICAGO

DAYLIGHT SAVING THAT'S WORTH WHILE





Boring and recessing bronze crank cases—in one operation

Kelly Production Tools

These Kelly Production Tools were photographed "in action" in a nationally famous automotive manufacturing plant.

These tools are doing, in a few minutes, work which formerly took close to an hour, and which would have occupied the time of expert mechanics, and besides this they insure duplication to a thousandth of an inch.

Kelly Production Tools are daylight savers which are truly worth while. We can furnish special tools to meet almost any production requirement on short notice. ***We Specialize on Boring and Reaming Tools.***

Get in touch with us, and let our engineering service show you what Kelly Tools will do for you. Send us your prints. No obligation incurred.

Our Catalog and photo albums are sent on request. We have district offices in principal cities.

THE KELLY REAMER COMPANY

Cleveland **3705 W. 73rd St.** **Ohio**



Guaranteed

To Increase Production 15 to 50 Per Cent.

We are ready, at all times, to stand behind this statement. We know what Cost-cutter Counterbores will do. Our customers have increased production from 15 to 50 per cent.

All we ask is this opportunity to prove our claim. There is no qualification to our guarantee—Cost-cut Counterbores must either increase production or the sale is not completed.

Under these terms we have been selling Cost-cut Counterbores for years, and we are yet to hear of one that has failed to make good, when operated under proper working conditions.

The cutter is the only part of a Cost-cut Counterbore that is subject to wear. Thus we figure that about 75 per cent of the complete Counterbore has indefinite life, and but one initial cost.

The cutter can be ground or resharpened over and over again, until it is entirely used up. These cutters are made in forty-four standard sizes, ranging in diameter from ¼″ to 3″.

It will pay you to look into this subject. Send for our Catalog.

COST CUTTER

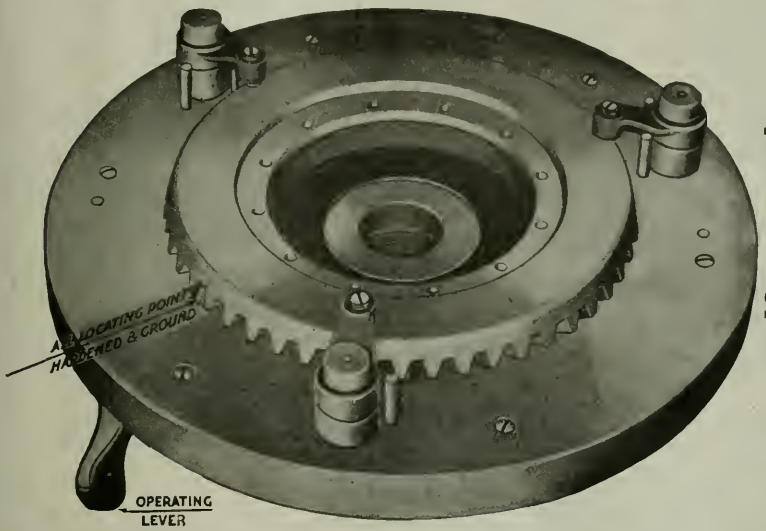
Cost-Cut Counterbore Company

DETROIT DEPT. A MICH., U. S. A.

These GEAR CHUCKS are but two of our complete line for CHUCKING GEARS, SPROCKETS, SPLINES, WORMS AND WORM WHEELS by the PITCH DIAMETER

ALL CHUCKS are simple but VERY ACCURATE and chuck EXCEEDINGLY FAST and also are designed as FOOL PROOF as possible.

Our chucks do not require skilled operators, and RETAIN THEIR ACCURACY through years of hard use. The above statements are evidenced by the numerous repeat and telegraph orders we receive.



The O. G. Bevel Gear Chuck

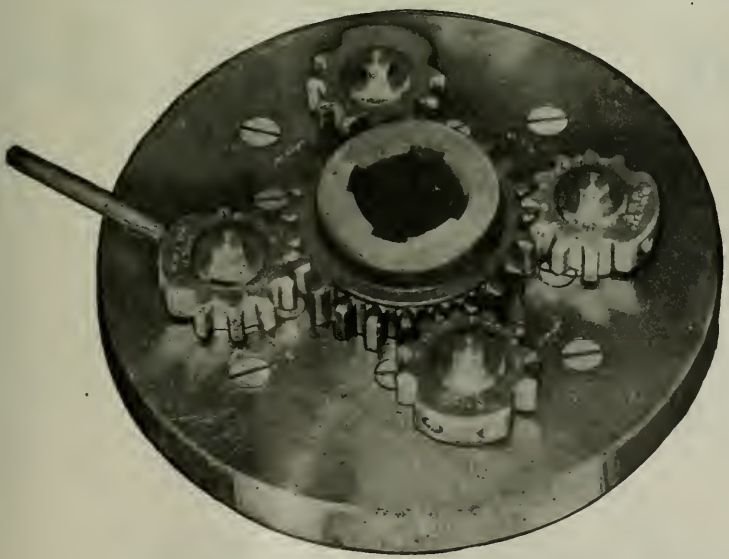
for both

SPUR and SPIRAL

Bevel Pinions and Gears

Chucks for any kind of Gear, Worm, Worm Wheel or Sprocket, regardless of pitch, type or size

AND THEY ALL CHUCK FROM THE PITCH DIAMETER



The Johnson Spur Gear Chuck

for

Spur, Spiral and Internal Gears

Send Blue Print of Those You Grind, for Quotations on Your Requirements.

GARRISON MACHINE WORKS, Dayton, Ohio

The Only Exclusive Gear Chuck Manufacturers.

SCULLY-JONES KEYSEAT CUTTERS

With Square Shanks



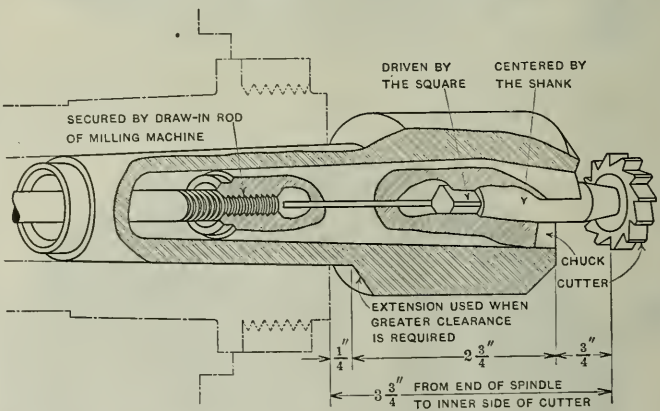


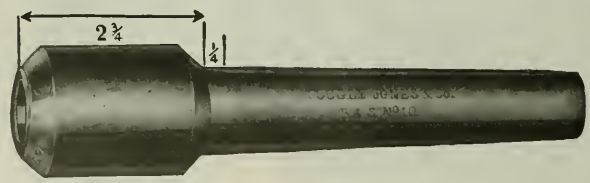
CHUCK FITS ALL SPINDLES

Made in One Piece

No Screws to Adjust

Cutter Cannot Slip





Where greater clearance is required use our extension.

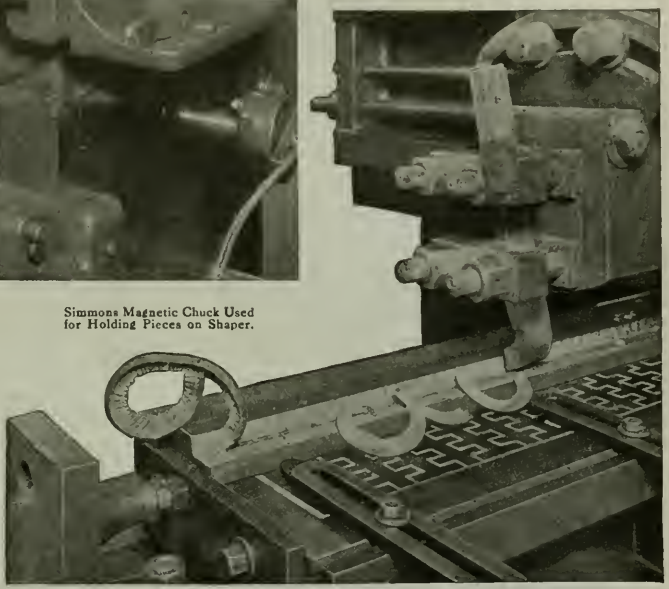
Mail us your order

SCULLY-JONES & COMPANY

647 Railway Exchange Building, CHICAGO ILLINOIS



TRADE T-P MARK



Simmons Magnetic Chuck Used for Holding Pieces on Shaper.

Simmons Unit-Pole Magnetic Chucks

The Simmons Unit-Pole Magnetic Chuck is a perfect work holder. All the drawbacks which formerly limited the use of chucks of this character have been eliminated.

In actual service this chuck is used in many ways to speed production by saving time. In the Simmons Chuck no magnetism "leaks" through the body to cause trouble. The magnetic circuit is a complete unit, separate and distinct from the chuck body.

As to heavy jobs, the 30-in. x 10½-in. rectangular chuck above held the piece of cold rolled steel against a pull that stalled the machine. The chip is ⅝ in. deep, 3/16 in. thick, the table feed 40 ft. per minute. The machine is a 30-in. Gray Planer, which "stalled" before the cut was finished, but the chuck did not yield its hold on the steel bar.

Simmons Unit-Pole Magnetic Chucks are adapted for a variety of uses. Safe, sure, economical from every standpoint. Write for descriptive bulletin 107-B.

THE TAFT-PEIRCE MFG. COMPANY

WOONSOCKET TRADE T-P MARK RHODE ISLAND, U.S.A. 2113A

New York: Woolworth Building Chicago First National Building Detroit: Majestic Building

TAFT-PEIRCE PRODUCTS CARRIED IN STOCK BY Syracuse Supply Co., Syracuse, Buffalo, Rochester; Cadillac Tool Co., Detroit; Sherritt & Stoer Co. Philadelphia; Wm. M. Pattison Supply Co., Cleveland; Northern Machinery Co., Minneapolis; Mid-West Machine & Tool Supply Co., Davenport, Ia.

"PRODUCTION"
Surface Milling Cutters



Adopted by the Mitchell Motors Company

Finishing the sides of the large ends of connecting rods is one of the ways in which "Production" Surface Milling Cutters are boosting production for the Mitchell Motors Co., Inc., Racine, Wis. A duplex indexing fixture is used enabling the operator to remove a completed connecting rod and clamp an unfinished connecting rod in place without stopping production.

The "Production" Cutter is 4⅛″ in diameter and has 11 teeth of ⅜″ tool bits. It runs 60 R.P.M., and the feed is 4½″ per minute, or 0.075″ per revolution of the cutter. About 1/16″ material is removed from each side, and production runs 400 large ends per ten-hour day.

"Production" Surface Milling Cutters are equipped with either high-speed steel bits or Stellite blades.

Production Tools will increase your output—let us show you

PRODUCTION TOOL CO. OF AMERICA

Manufacturers of Surface Milling Cutters, Side Milling Cutters, Arbors, Spot Facers, Counterbores, Back Facers and Countersinks

DETROIT MICHIGAN

Fastfeed Drills Reamers and Cutters

are good, reliable tools because they are

—Made from the best tungsten tool steel,
—Heat treated by experts,
—Accurately machined,
—Rigidly inspected from first to last.

When in the market for production tools of guaranteed quality, GIVE FASTFEED TOOLS A TRIAL.

Fastfeed Drill and Tool Corporation

TOLEDO OHIO

New York Office, 21 Murray St.



Write for new catalog now on the Press and current Price List.

FLE X MET

Flexible Metal Hose

Some Typical Uses



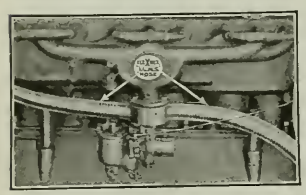
Fle-X-Met Used as Cooling Compound Conveyor and as Flexible Arm for Adjustable Lamp.



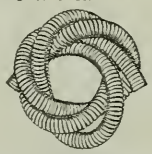
Fle-X-Met Arm Used on Scale Made by Standard Computing Scale Co.

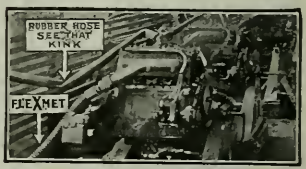


Rotary Ship-side and Boiler Scraper with Fle-X-Met I. L. N. S. Casing over Drive Shaft. Used by the U. S. Government for Cleaning Sides of Battleships.



Fle-X-Met Used for High-Temperature Exhaust Lines on Thurston Fuel Gasifier for Low Grades of Fuel.





Fle-X-Met Used in Testing Room, Republic Motor Truck Co. Note the Kinks in the Rubber Hose.



Fle-X-Met Used to Carry Exhaust Gases to Outside Air.



Fle-X-Met Used for Conveying Oxygen and Acetylene in Oxy-acetylene Welding.

YOU CAN USE FLE-X-MET

To Advantage
In the Shop or On Your Products

Fle-X-Met is made in any size, any length and of various metals to withstand the chemical action of most liquids, gases, etc., at various temperatures.

When packed, armored or packed and armored, it withstands high pressures and vacua. If unpacked and unarmored it, like all other metal flexible hose, cannot withstand pressures or vacua and is suited for conveyor casing and covering purposes only.

Only a few of the innumerable purposes to which Fle-X-Met is adapted can be shown here.

Do you want our 32-page Reference Book? It tells about flexible metal hose of all kinds.

Write for our Prices and Samples.

They sell Fle-X-Met.

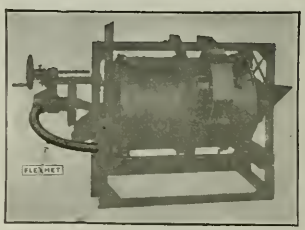
BREEZE MANUFACTURING CO.

Write for our Manufacturers' Sales Agents' Proposition. Give full particulars of the territory covered and lines carried.

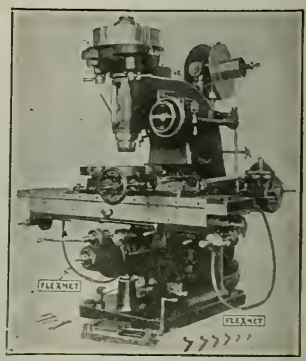
256 SOUTH STREET NEWARK, N. J.



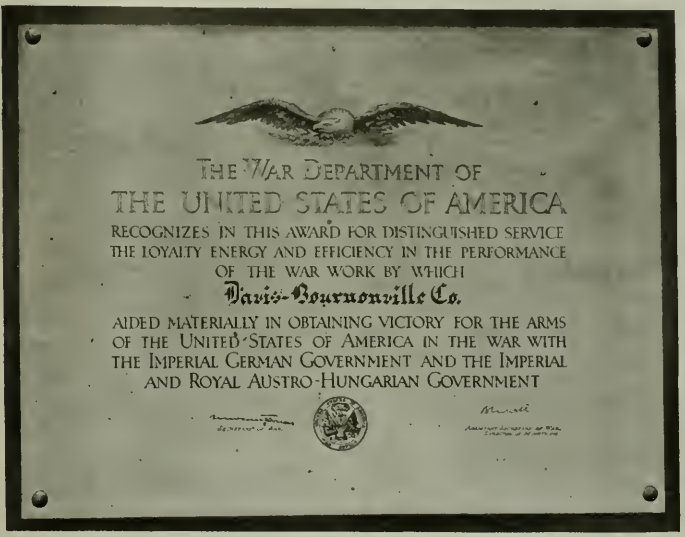
Fle-X-Met Used as Oil-Can Flexible Neck.



Fle-X-Met Used as Dust Conveyor on Ideal Concrete Machinery Co.'s Tumbling Barrel.



Fle-X-Met Used for Oil Drain Lines on Continuous Milling Machine.



Citation by U. S. War Department, January 31, 1920.

Commended by the U. S. War Department

The U. S. War Department bought more Davis-Bournonville oxy-acetylene and oxy-hydrogen welding and cutting apparatus than of all other makes combined.

This was doubtless due to two reasons: the reputation for efficiency established by long previous use of the company's product, and to official investigation of the company's facilities for production and service.

The Davis-Bournonville Company was and is the only concern in the industry supplying complete systems manufactured in its own factories, combining the production of acetylene, oxygen and hydrogen, portable and stationary welding and cutting outfits, and automatic and semi-automatic welding and cutting machines—the widest range of equipment manufactured for oxy-acetylene and oxy-hydrogen welding and cutting.

The requirements of the U. S. Government did not prevent the company from meeting greater demands than ever before from the commercial industries of the United States for its welding and cutting apparatus for use in "war work" in shipyards, munitions plants, and all metal-working industries. The value of the oxy-acetylene process in cutting and welding was so emphasized during the war period, that the demand for Davis-Bournonville equipment has progressively increased, and the output for the first half of 1920 to commercial industries is greater than in any previous year—a demand that is being met promptly through its great organization embracing branches in twenty principal cities of the United States and Canada.

DAVIS-BOURNONVILLE COMPANY

Factories at Jersey City, N. J., and Toronto, Canada.
General Offices: Jersey City, N. J.



Who?

A list of users of Rich Tools would make a Blue Book of American Industry.

The exceptional staying qualities of Rich Tools, due to their tougher, denser structure, make them favorites where hard service is required.

Forged from the bar, twisted into shape, heat treated and ground to an accurate cutting edge, the result is a tool which can have no superior.

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Ask for Literature and Prices

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CHICAGO

WESTERN TOOL & MFG. CO.

MAKERS OF

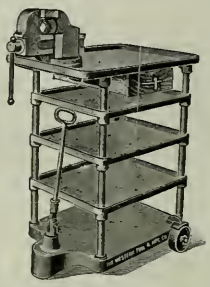
Champion Tool Holders

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Emery Wheel Dressers

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Lathe Dogs

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FOREIGN AGENTS: Alfred Herbert, Ltd., Grest Britain, Italy, France, etc. V. Lowener, Copenhagen, Stockholm. Spliethoff, Beeuwkes & Co., Rotterdam. W. R. Grace & Co., Chili, Peru and Bolivia.

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Wizard Hack Saw Blades



Wizard Hack Saws are made to sell—on the theory that the best made tool sells best.

Wizard Saws are manufactured from the best tungsten steel with flexible soft back or all hard blade as desired. The number of teeth to the inch varies in accordance with material to be cut.

Ask for Sample and Price.

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Colonna & Jonic TRACING PAPERS *Send for* SAMPLES

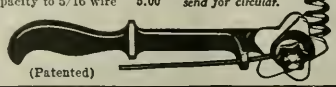
NEW YORK **KEUFFEL & ESSER CO.** HOBOKEN, N.J.
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Hjorth Perfection Spring Winder

No factory complete without one. Makes every kind of springs. Right or left-hand.

Capacity to 3/32 wire	$1.25
Capacity to 3/16 wire	2.50
Capacity to 5/16 wire	5.00

If interested, send for circular.



(Patented)

Hjorth Lathe & Tool Company
27 School St., Boston, Mass.
Works: Woburn, Mass.

SECOND HAND MACHINE TOOLS

BORING MACHINES

34″ Colburn vertical, turret head.
38″ Niles vertical, 2 hds.
42″ Bullard vertical, 2 hds.
Bement Miles horizontal, 2½″ bar.
No. 2—4″ Detrick & Harvey horizontal.
3″ Lucas horizontal, table type.

DRILLS

20″ Prentice Br. sl. hd., B.G.
42″ Cinn., sl. hd., B.G., tapping att., compound table.
24″ Pratt & Whitney, B.G., Power feed.
3 sp. Taylor & Fenn sensitive.
No 310 Baker Bros. high speed.
No. 37—16 spindle Natco multiple.
No. 12—12 spindle Natco multiple.
No. 12—12 spindle Natco multiple.
6 sp. Hendey, power feed to each spindle.

GRINDERS

10″ x 30″ Landis plain.
No. 4—12″ x 60″ Landis universal.
No. 3—12″ x 40″ Landis universal.
18 x 96 Norton, arr. for self-contained motor drive.
No. 18—12″ x 120″ Landis plain.
No. 6 Rivett internal.
26″ Blanchard H.P. vert., surface.

GEAR CUTTERS

No. 1 Dwight Slate auto. pinion.
34 x 10 B. & S. automatic spur.
24 x 12 G. & E. auto, gear hobbers.

LATHES

13″ x 6′ Willard C.R., P.C.F.
16″ x 6′ Porter, C.R., P.C.F., chuck.
16″ x 8′ Flather, P.C.F., C.R.
18″ x 6′ Hendey, taper att., C.R., P.C.F.
18″ x 8′ Prentice Bros., geared head, oil pan.
18″ x 10′ Reed. C.R., P.C.F.
18″ x 8′ Fitchburg, C.R., P.C.F.
20″ x 19″ F. E. Reed, C.R., P.C.F.
26″ x 12′ Putnam, C.R., D.B.G.
32″ x 14′ Hamilton, triple geared headstock, set of raising blocks, C.R., P.C.F.
38″ x 20′ New Haven, C.R., P.C.F.

MILLERS

20″ x 20″ x 8′ Ingersoll slab miller.
No. 14 Garvin plain.
No. 2 Cincinnati plain.
No. 2A Kempsmith plain.
No. 1½ LeBlond univ., motor drive.
No. 4B Becker vertical.
No. 5-C Becker vertical.
No. 5 Hendey Lincoln type.
No. 3 Cincinnati high power vertical.
No. 4 Cincinnati high power vertical.

PLANERS

24″ x 24″ x 6′ Putnam, one head.
24″ x 24″ x 6′ Flather, one head.
30″ x 30″ x 8′ Pond, 2 heads.
30″ x 30″ x 8′ Cleveland openside, 2 heads on cross rail, one side head.
48″ x 48″ x 16′ Sellers, 3 heads.
60″ x 60″ x 14′ Gleason, 2 heads.

SHAPERS

15″ Hendey, motor driven.
20″ Milwaukee crank, vise.

SCREW MACHINES AND TURRET LATHES

1¾″ Bardons & Oliver turret.
No. 3 Windsor wire feed screw machine.
No. 2½ Garvin single geared screw mach., with air chuck.
2″ x 24″ J. & L. turret lathe with bar equipment.
3″ x 36″ J. & L. turret lathe with bar equipment and chucking equip.
16″ Acme universal turret.
24″ Gisholt turret lathe, 6½″ H.S.
24″ Steinle heavy turret lathe.
½″—4 spin. National Acme.

MISCELLANEOUS

Broaching Machine, No. 5 J. N. Lapointe.
Broaching Machine, No. 4 J. N. Lapointe.
Keyseater, No. 2 Baker Bros.
Pipe Machine, 4″ Curtis & Curtis.
Slotter, 14″ stroke Betts.

HENRY PRENTISS & COMPANY

INCORPORATED

149 BROADWAY NEW YORK

BOSTON BUFFALO HARTFORD ROCHESTER SYRACUSE

Warehouse: JERSEY CITY

Re MANUFACTURED -(ORIGINATED BY US)- MACHINE TOOLS

TRADE MARK

GET MORE FOR LESS MONEY!

You always got MORE FOR YOUR MONEY when you bought RE-MANUFACTURED MACHINES. But now you get MORE for LESS money. We are buying only LATE MODEL machines and only those which we can sell at REAL BARGAIN PRICES. We aim to give you RE-MANUFACTURED machines, which compare favorably with NEW, at prices even lower than you pay for ordinary used machines.



One Section of Our Re-manufacturing Shop

Briefly outlined, the Re-manufacturing process is as follows: Every machine which is to be Re-manufactured is completely taken apart even if practically new. Flat surfaces are hand scraped to Brown & Sharpe Surface Plates. Cylindrical Bearings are renewed when necessary, then accurately aligned under the supervision of experts.

Old enamel is completely removed, then renewed, and bright parts are polished.

Results—a machine outwardly and inwardly "new." Hence the unconditional Hill Clarke guarantee.

LATHES

1—45" x 24' Pond Trip. Gd. C.R.
4—40-in. x 18-ft. Fifield Engine Trip. Gd., C.R.
4—40-in. x 12-ft. Fifield Engine, Trip. Gd., C.R.
2—36-in. x 10-ft. Johnson Trip. Gd. Motor.
3—36-in. x 14-ft. Johnson Trip. Gd. Motor.
23—32-in. x 12-ft. Pittsburgh Engine. C.R., Q.C.G.
5—30-in. x 11-ft. American Gd. Hd. Engine. C.R., Q.C.G.
5—26-in. x 20-ft. Bridgeport Engine. D.B.G., C.R., Q.C.G.
10—26-in. x 18-ft. Bridgeport Engine. D.B.G., C.R., Q.C.G.
20—26-in. x 12-ft. Bridgeport Engine. D.B.G., C.R., Q.C.G.
75—26-in. x 10-ft. Bridgeport Engine. D.B.G., C.R., Q.C.G.
3—26-in. x 10-ft. Putnam Motor Driven Engine, C.R.
30—26-in. x 10-ft. Niles Engine. D.B.G., C.R., Q.C.G.
10—25-in. x 10-ft. LeBlond Engine. D.B.G., C.R., Q.C.G.
52—21-in. x 10-ft. LeBlond Engine. D.B.G., C.R., Q.C.G.
99—20-in. x 8-ft. American Engine. D.B.G., C.R., Q.C.G.
16—20-in. x 8-ft. American Engine. D.B.G., C.R., Q.C.G., P.F.T.
3—20-in. x 8-ft. American Gd. Hd. Engine.
14—20-in. x 8-ft. LeBlond Engine. D.B.G., C.R., Q.C.G.
30—19-in. x 8-ft. LeBlond Engine. D.B.G., C.R., P.F.T.
44—19" x 8' LeBlond Engine. D.B.G., C.R., Q.C.G.
14—18-in. x 8-ft. LeBlond Engine. D.B.G., C.R., Q.C.G.
8—18-in. x 8-ft. Boye & Emmes. D.B.G., C.R., Q.C.G.
21—18-in. x 8-ft. Boye & Emmes. D.B.G., C.R., belt.
12—17-in. x 6-ft. LeBlond Mfr's. Automobile.
7—16-in. x 6-ft. Reed Engine. C.R.
42—14-in. x 6-ft. Reed Ex. Hvy. Pl.

SHAPERS

2—24-in. Rockford.
1—26-in. Springfield.
9—26-in. Niles-Bement-Pond.
1—28-in. Gould & Eberhardt.
1—24" x 24" x 6' American.
2—36-in. x 13-in. x 14-ft. Niles Frog.
1—56-in. x 56-in. x 10-ft. Gray.

TURRET LATHES

5—19-in. LeBlond Universal.
34—19-in. LeBlond Combination.
16—20-in. American Combination.
12—21-in. LeBlond Universal.
32—24-in. Steinle.
8—24-in. Gisholts.
3—No. 3-A Warner & Swasey.

MILLING MACHINES

10—No. 6 Whitney Hand.
5—No. 3½ Fox.
1—No. 2 Becker Plain.
2—18-in. Cincinnati Auto Millers.
3—No. 7-H Becker Lincoln.

BORING MACHINES

1—3½-in. bar Binsse Horizontal.
1—4-in. bar Niles Horizontal.
1—2-spindle Beaman & Smith Cylinder.
1—3¼-in. Bullard.

DRILLS

1—No. 2-K Henry & Wright.
1—No. 4-B Henry & Wright.
2—No. 6-B Henry & Wright.
4—3-ft. American Sensitive.
1—3-ft. Fosdick Radial.

GRINDERS

1—8-in. x 48-in. Thompson Surface.
1—No. 2 Bath Surface.
1—No. 10 Brown & Sharpe Pl.
1—No. 70 Heald Internal.

MISCELLANEOUS

1—2¼-in. Cleveland Automatic.
4—6-in. x 14-in. P. & W. Thread Miller.
1—30-in. Flather Gear Cutter.

OUR GUARANTEE: YOUR MONEY BACK IF YOU RETURN MACHINE WITHIN 30 DAYS OF DATE OF SHIPMENT, FREIGHT PREPAID NO EXCUSES NECESSARY!

HILL, CLARKE & CO. OF CHICAGO

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THIS IS

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A Selection From 476 Machines

8-5C Becker Vertical Milling Machine, New—$500 below to-day's price.
84-in. x 84-in. x 10-ft. Sellers Planer, 4 heads.
48-in. x 48-in. x 14-ft. Powell Planer, 4 heads, almost new, heavy type, with new reversing type motor, complete.
48-in. x 48-in. x 16-ft. Bement-Miles Planer, 4 heads.
6-ft. Niles-Bement-Pond Full Universal Radial Drill, motor driven (D.C.)
6-ft. Dreses Full Universal Radial Drill, motor driven (D.C.)
6-ft. Baush Radial, heavy type.

Now What About the Following Selections from Our 476 Machines

VERTICAL BORING MILLS

100-in. Betts, three heads. Very heavy.
76-in. Betts, 2 swivel heads.
60-in. Niles-Bement-Pond, 2 swivel heads, S.P.D., good as new.
60-in. Bickford, two heads.
48-in. Colburn, 2 swivel hds., rapid traverse.
36-in. Bullard Vertical Turret Lathe, side head type.

GEAR CUTTERS

60-in. x 8-in. Gould & Eberhardt, spur gears.
36-in. x 10-in. Gould & Eberhardt, spur.
36-in. x 10-in. Flather.

GRINDERS

No. 28 Brown & Sharpe, 18-in. x 96-in., good as new, weighs 18,000 lbs.
Landis 10-in. x 36-in., Universal.
No. 23 Brown & Sharpe, Cylinder.
No. 5 Bath Duplex, complete.
No. 15 Besley Pattern Makers, Disc (30-in.)

ENGINE LATHES

60-in. x 20-ft. Fifield, C.R., P.C.F. Motor Driven.
48-in. x 20-ft. Fifield, C.R., P.C.F.
42-in. x 21-ft. New Haven, C.R., P.C.F.
36-in. x 16-ft. Niles, C.R., P.C.F.
36-in. x 14-ft. Putnam, heavy duty, taper att.
36-in. x 12-ft. Pond, motor or belt drive.
30-in. x 12-ft. Israel Johnson, heavy duty.
20-in. x 8-ft. Lodge & Shipley, geared head, S.P.D.

PUNCHES AND SHEARS

32-in. Sellers Punch and Shear. Punches 2-in. hole thru 1½-in. thickness. Shears 2½-in. round. Very heavy type.
Carlin Alligator Shear. Cap. 5-in. rounds.

MILLING MACHINES

Two (2) 50-in. x 8-ft. Ingersoll Slab Millers.
No. 3 LeBlond, high power, geared head.
No. 3 LeBlond, plain, all geared feeds.
No. 3 Hendey, plain, geared feeds.
No. 24 Brown & Sharpe, 81-in. table.
No. 2 Hendey, plain.
No. 7H Becker, Lincoln Type, like new.
Two (2) No. 6 Whitney Hand Millers, like new.

PLANERS

48-in. x 48-in. x 14-ft. Powell, 4 heads.
42-in. x 42-in. x 12-ft. Pond, 2 rail heads.
36-in. x 36-in. x 18-ft. Pease, 2 rail heads.
36-in. x 36-in. x 12-ft. Niles-Bement-Pond, 2 rail, 1 side head.
30-in. x 30-in. x 6-ft. Gray, 1 rail, 2 side hds.

PRESSES

No. 512 Bliss Special Triple Acting. 33 tons pressure, excellent condition.
Five Farrell D.A.—1 to 3-in. strokes.
DD4 Ferracute, roll feed, double acting, open back inclinable.

MISCELLANEOUS

25 lb. Bradley Helve Hammer.
3¼-in. Gridley Automatic, complete with 2 motors.
No. 2 Barrett Horizontal Boring Machine, 5-in. bar. Heaviest pattern, 98% new; full equipment.
5 Baush Multiple Drills, five, six and eight spindles.
8-in. Newton Slotter, like new.
Two (2) 2-in. x 24-in. Jones & Lamson Turret Lathes, Geared Head.

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USED MACHINERY

LATHES

2—12" x 4' Mulliner Lathes, with quick change gear, compound rest.
12" x 4' Mulliner Lathe, with quick change gear, compound rest, and taper attachment.
14" x 6' Monarch Lathe with compound rest, loose change gears.
14" x 6' Bradford standard engine lathe, with compound rest.
2—14" x 6' Bradford standard engine lathes, with taper attachment and compound rest.
16" x 8' Reed Lathe, with elevating rest.
15" x 6' Old Style Blaisdell lathe, with rise and fall rest.
17" x 6' LeBlond Heavy Duty Manufacturing Lathe, with turret on car.
18" x 14' Bradford Standard Engine Lathe, with compound rest.
19" x 10' LeBlond Heavy Duty Manufacturing Lathe, with plain rest, longitudinal stops, taper attachment.
25" x 12' American Tool Works' Geared Head Lathe, single pulley drive, compound rest, quick change gear.
30" x 10' Niles-Bement-Pond Double Back Geared Motor Driven Engine Lathe.
36" x 16' Niles-Bement-Pond Triple Geared Motor Driven Engine Lathe.

PLANERS AND SHAPERS

12" Cincinnati Crank Shaper.
14" Juengst Shaper.
30" x 30" x 8' Whitcomb-Blaisdell Planer with two heads on cross rail.

DRILLS

Three-spindle 16" Sipp High Speed Ball Bearing Drill.
2-ft. arm Fosdick Radial Drill.
3-ft. arm Bickford Radial Drill.
6-ft. arm Niles-Bement-Pond Universal Radial Drill with 220 volt D.C. motor.

GRINDERS

No. 1 Norton Universal Tool and Cutter Grinder.
10 x 20 Acme Universal Tool and Cutter Grinder.
No. 11-B Brown & Sharpe Plain Grinding Machine.
12" x 24" Landis Grinding Machine.

MILLING MACHINES

12" x 36" Eynon & Ingersoll Slab Milling Machine.
No. 2 LeBlond Universal Milling Machine.
No. 2-H Becker Vertical Milling Machine with rotary.
2—Sloan & Chace Hand Millers.

GEAR CUTTING, HOBBING AND SHAPING MACHINES

No. 3 B. & S. Spur Gear Cutting Machine.
2—Fellows Gear Shapers.

SCREW MACHINES AND TURRET LATHES

3—2¼" Single Spindle Gridley Automatic Screw Machines.
No. 6—2¼" capacity Warner & Swasey Turret Lathe with automatic chuck and wire feed and power feed to turret; oil pan, pump and tools.
2 x 24" Jones & Lamson Flat Turret Lathe.

MISCELLANEOUS

48" Bertsch Power Gap Squaring Shear.
Houghton & Richards Band Saw Machine.
2—10" Niles-Bement-Pond Vertical Slotters.
2½" bar Niles cone type horizontal boring machine.
4-spindle Whiton Centering machine.
4 x 80 Pratt & Whitney Thread Miller.
Waltham Thread Miller.
200-lb. Beaudry "Champion" Power Hammer.
300-lb. Beaudry "Champion" Power Hammer.
Electromobile Truck, carrying capacity 3000 lbs.; pulling capacity 10,000 lbs., two 4-wheel wagon trailers and charging outfit.
Type 3-V.S.-23 National Brake & Electric Co.'s Motor Driven Air Compressor; having a piston displacement of 300 cu. ft. per minute against 90-lb. pressure; including 54 H.P. Allis-Chalmers 3-phase 60 cycle 200 volt A.C. motor.. Type HB control; comprising automatic governor, unloader and water valve; all mounted on common bed-plate making complete self-contained unit.

22"x84" PRATT & WHITNEY Surface Grinder: Size of Table, 22"x84". 3⅝" T-slots. Travel of table, 84". From centre of wheel spindle to column, 20⅛". From table to face of wheel up, 18". Size of pulley on wheel spindle, 9"x22". Equipped with 1—40 HP Westinghouse Motor and Starting Box; 220 volts, 3-phase, 60 cycle, type C.S.; 1—12"x24" Heald Magnetic Chuck, type 1224 No. 20, 220 volts; Pump Tank and Water Guards. Weight 17,000 lbs. In excellent condition.

THE W. M. PATTISON SUPPLY COMPANY

CLEVELAND *Machinery Department* OHIO, U. S. A.

EXCEPTIONAL LISTING
OF
First Class Used Tools
FOR PROMPT DELIVERY

BALANCING MACHINE

1—66" Norton Running Balance Indicating Machine.

BORING MACHINES

1—20" Baker Cylinder Borer.
1—42" Bullard.
2—54" Bullards.

CUTTING OFF MACHINE

1—2" Rogers Cutting Off Machine.

DRILLING MACHINES

1—26" Aurora Sliding Head.
1—46" Henry & Wright Radial.
2—No. 1 S Garvin Duplex.
1—4' Cincinnati Bickford Radial—Speed Box Drive.

GEAR CUTTERS

2—36 x 9 Gould & Eberhardt Horizontal Type Automatic.
1—No. 2 Whiton Automatic.

GRINDERS

1—No. 20 Bryant Semi-Automatic Cylinder Grinder.
3—No. 18 Bryant Semi-Automatic Cylinder Grinder.
2—10 x 24 Norton Special Purpose.
1—No. 2 Leland & Faulconer Double Wheel Wet Grinder.
1—No. 2 Wilmarth & Morman.
2—No. 1 Cincinnati Cutter and Tool Grinders.
1—Blanchard Vertical Surface Grinder.
2—No. 10 Bryant Semi-Automatic Cylinder Grinders.

HAMMERS

1—No. 35 Williams & White Tire Welding.
1—No. 4 Champion.

KEYSEATER

1—No. 2 Baker Keyseater.

LATHES

6—8 x 60 Lo-Swing Lathes.
1—16 x 8 Draper 3-step cone double back geared engine lathe.
1—26 x 10 Reed Lathe.

MILLING MACHINES

3—No. 2 Cincinnati Plain High Power
2—No. 7 Becker Lincoln Type
2—No. AB-1 Becker High Power Vertical
1—6 x 29 Brown & Sharpe Plain
1—No. 1 Brown & Sharpe Plain
1—No. 2 Brown & Sharpe Vertical
1—No. 3 Brown & Sharpe Vertical
2—No. 2 Cleveland Plain
1—No. 14 Garvin
1—8" Pratt & Whitney Automatic
6—No. 6 Whitney Hand
1—No. 10 Moline Thread Miller
1—Taft Pierce Thread Miller

PISTON RING MACHINES

3—Gridley Plain Automatic
2—Gridley Eccentric Automatic

PLANERS

10—30 x 30 x 14' Cincinnati Heavy Pattern—two heads.
1—24 x 24 x 6' Whitcomb—one head

PROFILERS

3—2-Spindle Pratt & Whitney with 12 x 15 tables.
1—No. 12 Single Spindle Leland & Gifford
1—No. 3 Single Spindle Garvin

SCREW MACHINES

1—No. 55 Acme Automatic
1—3" Foster Screw Machine
1—2" Cleveland Automatic.

TURRET LATHES

6—24" Gisholts
1—4 3/16" Bardons & Oliver

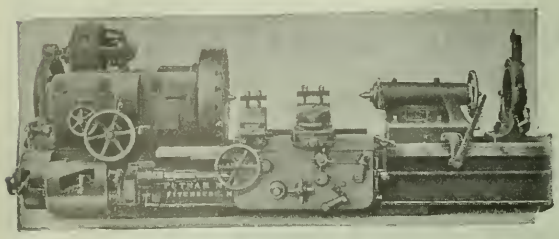
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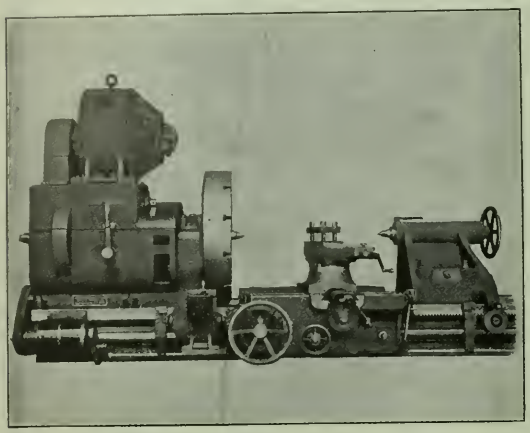
Ask us for our complete lists.

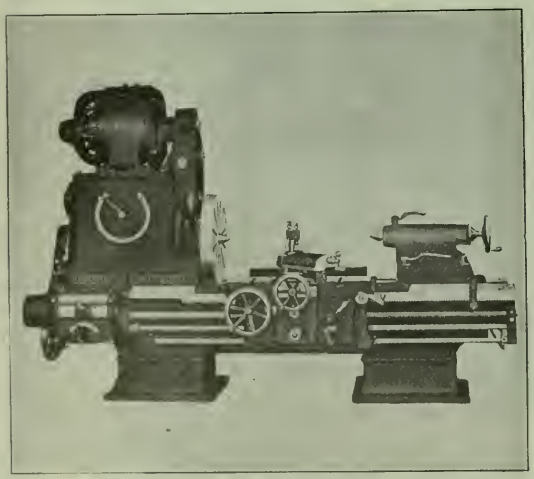
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Branches:
CINCINNATI DETROIT PITTSBURGH







SIMM RELIA— MACHINE

SPECIALS

15—27″ x 18′ LeBlond All Geared Head Lathes, motor drive, 220 volt D.C.
1—48″ x 56′ Niles-Bement-Pond, all geared head, arranged for motor drive.
1—60″ x 60″ x 20′ Woodward-Powell Planer, 4 heads.
3—36″ x 36″ x 20′ Woodward-Powell Planer, 4 heads.
1—42″ x 42″ x 12′ Simmons Openside, 2 heads, new.
3—36″ x 14′ Putnam Lathes, all geared head, motor drive.
1—48″ x 56′ Bridgeford Lathe all geared head, motor drive.
No. 5 Brown & Sharpe Universal Grinder.

LATHES

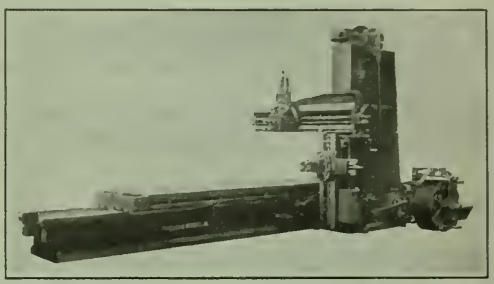
1—New 84″ x 25′ Putnam All Geared Head Lathe, steel gears throughout, with 35 hp. 230 variable speed motor.
1—84″ x 30′ Niles-Bement-Pond High Duty Lathe.
60″ x 30′ Niles-Bement-Pond High Duty Lathe.
1—64″ x 51′ Detrick & Harvey Lathe, all geared head, arranged for motor drive.
2—48″ x 54′ Bridgeford Lathes, all geared head, arranged for motor drive.
9—48″ x 56′ Niles-Bement-Pond, all geared head lathe, arranged for motor drive.
2—48″ x 32′ Bridgeford, all geared head, arranged for motor drive.
3—New 36″ x 40′ Bridgeford Lathes, all geared head.
1—42″ x 18½′ New Haven, all geared head, arranged for motor drive.
3—36″ x 14′ Putnam Lathes, all geared head, motor drive, 220 volt DC.
2—36″ x 18′ American, all geared head, motor drive, 220 volt DC.
1—New 30″ x 34′ American Lathe, taper attachment, gelt drive, double carriage.
1—36″ x 38′ Pittsburgh, all geared head, arranged for motor drive, two carriage.
1—New 36″ x 18′ Putnam, belt drive complete.
15—27″ x 18′ LeBlond, all geared head, motor drive, 220 volt DC.
4—32″ x 25′ Ricon, Shafting Lathes, all geared head, arranged for motor drive.
1—28″ x 18′ Pond Lathe, all geared head, arranged for motor drive.
2—24″ x 10′ Greaves-Klusman, High Duty complete.

SIMMONS MACHINE COMPANY

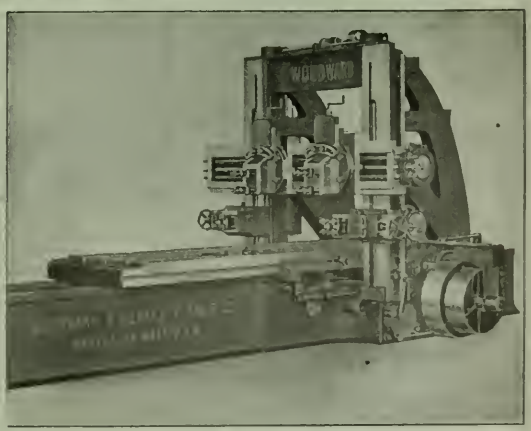
BRANCH OFFICES: 801 Singer Building, New York, N. Y.

ONS
-BUILT
TOOLS









BORING MILLS

1—New 36" Bullard New Era Type Vertical Boring Mill, complete with four jaw chuck, 10-15 hp. 230 volt motors, 1100 rpm., with lubricant system.
1—72" Cincinnati Vertical Boring Mill, two swivel heads.
1—Beaman-Smith Horizontal Boring Mill, 3" bar.

PLANERS

1—60" x 60" x 20' Woodward-Powell Planer, 4 heads, reversing type 220 DC motor.
1—New 48" x 48" x 28' Cincinnati, 2 heads, reversing type 220 volt DC motors.
1—New 48" x 48" x 14' Cincinnati Planer, 2 heads, arranged for motor drive.
1—New 48" x 48" x 20' Niles-Bement Pond Planer, 4 heads, belt drive.
1—48" x 48" x 20' Ridgeway Planer, 3 heads, motor drive.
1—New 42" x 42" x 12' Simmons Openside Planer, 2 heads.
3—36" x 36" x 20' Woodward-Powell Planers, 4 heads, motor drive.
1—30" x 30" x 18' Cincinnati Planer, two heads.

RADIAL DRILLS

1—5' Prentice Plain Radial Drill, arranged for motor drive.
1—7' Warren Semi-Universal Radial Drill, arranged for motor drive.
1—Four Spindle Harrington Adjustable Head Drill.
2—20" Barnes Drill Presses.

MILLERS

1—No. 2 Brown & Sharpe Vertical Miller.
1—Model B Gooley-Edlund Miller.
1—No. 5 Brown & Sharpe Plain Miller.
1—Pratt & Whitney Heavy Duty Slab Miller.
25—Whitney Standard and Becker Hand Millers.
2—No. 5 Brown-Sharpe Vertical Millers.

MISCELLANEOUS

10—32" Cincinnati High Duty Shapers, complete.
1—No. 4 La Pointe Broaching Machine.
1—No. 1 La Pointe Broaching Machine.
2—36" Fellows Gear Shapers.
1—No. 2-A Warner-Swasey Turret Lathe, complete with bar equipment.
1—96" Gould & Eberhardt Gear Hobber.
1—New 14" x 96" Norton Plain Grinder.
1—18" x 96" Norton Plain Grinder
1—18" Betts Slotter Complete.

Write for Complete List

INC., ALBANY, N. Y., U. S. A.

86-88 Exchange Street, Buffalo, New York

PRATT & WHITNEY

STANDARD AND SPECIAL

MACHINERY

The Pratt & Whitney Standard and Special Machines advertised on this page are offered for sale by negotiation. Proposals to purchase should be addressed to Chairman, Rochester District, Ordnance Salvage Board, 1044 University Ave., Rochester, N. Y.

The Machines listed as "Special" were designed for special war work, but may be readily converted into standard machines.

23 Gun Barrel and Tube Drilling Machines, 2 Spindle, 9½ ft. bed. No. 1 Location: Savage Arms Corp., Utica, N. Y. Maker, Pratt & Whitney Co.

23 Gun Barrel and Tube Drilling Machines, 2 Spindle 6 ft. Bed. Location: R.O.S.D., Rochester, N. Y. Maker, Pratt & Whitney Co.

79 Gun Barrel and Tube Drilling Machines, 2 Spindle, 9½ ft. bed. Location: R.O.S.D., Rochester, N. Y. Maker, Pratt & Whitney Co.

44 Form Turning Machines. Used for turning Gun Stocks. May be used for turning any forms. Approximately 6" in dia. 4' lengths. Equipped with copying device, head and tail stock for Form Driving head and tail stock for work. Cutter head approximately 8" in dia. Location: R.O.S.D., Rochester, N. Y. Maker, Pratt & Whitney Co.

15 Grinding Machines, Small Belt Driven Bench Grinders, Bench Lathe type bed. Cross slide and compound rest, grinding head with pinion and quadrant. May be adapted for grinding small cutters. Location: R.O.S.D., Rochester, N. Y. Maker, Pratt & Whitney.

6 Gun Barrel Drill Grinders. Location: R.O.S D., Rochester, N. Y. Maker, Pratt & Whitney.

4 Profiling Machines, one-spindle No. 13. Location: R.O.S.D., Rochester, N. Y. Maker, Pratt & Whitney Co.

Special Machinery of Other Makes

14 Engine Lathes. 14" x 6'. Equipped with Special Carriage. Without Tail Stock, Lead Screw and Gears and Automatic Power Feed. Location: Curtiss Plant, Buffalo, N. Y. Maker, Hendey Machine Co.

65 Special Single Purpose Lathes. 20" x 8' 2 Step Cone, Double Back Geared. Cross Slide and Compound Rest. Longitudinal and Automatic Feed. Six feed changes. Location: Curtiss Plant, Buffalo, N. Y.

6 Special Single Purpose Lathes, 20" x 8' tight and loose pulley drive, fixed gear reduction. Carriage equipped with special cross traverse tool slidh, longitudinal and cross traverse hand feeds, longitudinal antomatic fixed feed with fast reverse or vice versa, including automatic stops. Provided with special tail stock which sets in three fixed positions. Location: Curtiss Plant, Buffalo, N. Y. Maker. Duff Mfg. Co., Pittsburgh, Pa.

40 Turning Lathes. Used for turning Gun Barrels. Max. Swing. 8" x 5' Bed. Equipped with Sprocket and Feed Tension Pulleys. Brackets and Feed Chain for carriage. Location: R.O.S.D. Rochester, N. Y. Maker, Providence Engineering Works, Providence, R. I.

29 Straightening Machines, Gun Barrel or Shaft Straightening Fixtures. Mounted on Column 5 ft. high. Adjustable for height and swung into vertical or horizontal position. Location: Curtiss Plant, Buffalo, N. Y. Maker, Carter & Hakes, Winston, Conn.

This equipment is ready for immediate delivery. Terms of sale are not complicated. For full directions to purchasers, and for details of the large assortment of materials and equipment in the Rochester District, write for the District Bulletin.

3 Profiling Machines, two-spindle No. 13. Location: R.O.S.D., Rochester, N. Y. Maker, Pratt & Whitney Co.

26 Profiling Machines, special six spindle. Used for bedding barrel into gunstock. Equipped with bedding fixtures and cutters. Location: R.O.S.D., Rochester, N. Y. Maker, Pratt & Whitney Co.

65 Spline Shaving Machines, ¾" double head. Max movement of table 12". Operated by crank and adjustable connecting rod. Location: Curtiss Plant, Buffalo, N. Y. Maker, Pratt & Whitney Co.

10 Reaming Machines. Gun Barrel two spindle 8½ ft. bed. Max. capacity 13/16" x 36". Location: Savage Arms Corp., Utica, N. Y., Maker, Pratt & Whitney Co.

14 Reaming Machines, Gun Barrel two spindle 8½' bed. Max. capacity 13/16" x 36". Location: R.O.S.D., Rochester, N. Y. Maker, Pratt & Whitney Co.

53 Rifling Machines, Gun Barrel single spindle No. 3. Location: R.O.S.D., Rochester, N. Y. Maker, Pratt & Whitney Co.

11 Rifling Machines, Gun Barrel, four spindle No. 3. Location: Savage Arms Corp., Utica, N. Y. Maker, Pratt & Whitney Co.

2 Tapping Machines, horizontal. Will take No. 2 Taper Shank Chuck. Location: R.O.S.D., Rochester, N. Y. Maker. Pratt & Whitney Co.

Rochester District Ordnance Salvage Board

1048 University Avenue *Telephone Chase 4480* ROCHESTER, NEW YORK

You Might Find It Here

PLANERS

Hendey 22″ x 22″ x 5′. One Head. Friction Type.
Powell 30″ x 30″ x 8′. Two Heads on rail.
Woodward & Powell 30″ x 30″ x 8′. Two Heads on rail.
Putnam 48″ x 48″ x 18′. Two Heads on rail.

TURRET LATHES AND SCREW MACHINES

Jones & Lamson 2″ x 24″ Flat Turret Lathe with Bar Outfit.
Jones & Lamson 3″ x 36″ Flat Turret Lathe with Bar and Chucking Outfit.
Pratt & Whitney No. 2 Hand Screw Machine.

GRINDING MACHINES

Norton Emery Wheel Co., Universal Cutter & Tool Grinder.
Oesterlein No. 2 Universal Cutter & Tool Grinder.
Modern No. 12 Plain Grinder; Capacity, 5″ x 30″.

SHAPERS

Smith & Mills 14″ Plain Crank Shapers.
Ohio 22″ Back Geared Crank Shaper.

MILLING MACHINES

Oesterlein No. 20 Universal. Cone Drive. Back Geared.
Oesterlein No. 20 Plain. Cone Drive. Back Geared.
Oesterlein No. 24 Plain. Cone Drive. Back Geared.
Dow No. 1 Plain Milling Machine. 24″ Feed. Back Geared.
Becker Model "AB" Vertical Milling Machine. Without Rotary.
Hendey No. 2½ Lincoln Type Milling Machine.
Pratt & Whitney No. 0 Hand Milling Machines. Power Feed.

MISCELLANEOUS

Niles 60″ Vertical Boring & Turning Mill. Two Swivel Heads.
Dreses 4′ Plain Radial Drilling Machine.
Bement 6″ Slotting Machine.
J. N. Lapointe No. 1 Broaching Machine.

This is only a partial List

HILL, CLARKE & COMPANY, Inc.

The Machinery Merchants

156 OLIVER STREET **BOSTON 9, MASS.**

Telephone, Main 4438

NEW MACHINERY OMC USED MACHINERY

DAY MACHINERY CO.

BUFFALO, N.Y.

6—24" Bullard New Era Type Vertical Turret Lathes. Belt driven. Three jaw chuck table.

1—42" Bullard New Era Type Vertical Turret Lathe. Motor driven. Three jaw chuck table.

1—42" Putnam Vertical Boring Mill. Two swivel heads. Power rapid traverse. Belt driven. Latest Type.

2—No. 2-G Brown & Sharpe Automatic Screw Machines.

1—Model C-2 Becker Vertical Miller. No rotary. Arranged for motor drive.

1—5' American Full Universal Radial Drill. Arranged for motor drive through gear box. Latest type.

Over Sixty Radial Drills Available
Sizes 2½' to 6

15 Ingersoll Millers Available

Complete Machine Shop Equipment

What Have You for Sale? Send Us Your Inquiry

4—3" x 36" Jones & Lamson Flat Turret Lathes. Chucking equipment. Latest type.

1—24" x 10' Greaves-Klusman Heavy Duty Lathe. Quick change geared. Three step cone. Double back geared. With full swing rest.

3—No. 3 Baush Multiple Spindle Drills. Thirty ½" dia. spindles. 20" x 40" rectangular head.

2—2000 lb. Chambersburg Steam Drop Hammers.

2—3000 lb. Chambersburg Steam Drop Hammers.

Used Machinery For Sale

1—2¾" bar Binssee Horizontal boring Mill.
1—10 x 30 Landis Plain Grinder.
1—No. 2 Hendey-Norton Plain Milling Machine.
1—No. 2 B. & S. Universal Milling Machine.
1—10 x 30 Landis Universal Grinder.
3—24" Fellows Gear Shapers.
1—No. 23 New Britain Automatic Chucking Machine.
1—No. 4A High Speed Riveting Hammer.
Several 5A and 6A Potter & Johnson Automat.
Several National Acme Automatics.
Several No. 6 Whitney Hand Millers.

VONNEGUT MACHINERY CO., Indianapolis, Ind.

This List Should Help You

5—Single Spindle Bench Buffing Heads.
1—"Lodge & Shipley" 16x6' Tool-room Engine Lathe; T. A. Draw-in Attachment Chucks.
2—77x8" "Sidney" H.D. 2 C.C.R. Lathes.
1—"Bridgeford" 36"x24' Geared Head High Duty Engine Lathe C.R. T.A. Motor Drive with 25 H.P. Motor.
1 "Brown & Sharpe" Vertical Milling Machine with 18" Circular Attachment.
1 "Brown & Sharpe" No. 1 Universal Grinding Machine.
1 -18" Niles Plate Planer for ¾" plates, belt driven, in excellent condition.
1—Bennett O'Connell Buffing Machine, 1 spindle.
1 Blount 14" Wet Tool Grinder
3 No. 6 Whitney Hand Millers
1—Lincoln Type Mitts & Merrill Slab Milling Machine, Automatic Feed.
1 54x44x6 Gray Planer, 4 heads.
1 62" Niles Boring Mill, 2 Swivel Heads.
1 -Ferracute Kick Press, Type F.
2—17x6 LeBlond Turret Lathes. Carriage Turrets and Air Chucks.
1—24x26' Porter Q.C. Engine Lathe.
1—15x6' Von Wyck Engine Lathe, C.R.
1 No. 2 Fosdick Horizontal Milling Machine.
1—Wilmarth & Morman Style J Drill Grinder.
1 No. 11½ "Landis" Internal Grindle.
1—No. 2 "Landis" Internal Grinder.
1—17x6' "LeBlond" Turret Lathe.
1—No. 00 "Baker" Keyseater.

THE E. A. KINSEY COMPANY, CINCINNATI INDIANAPOLIS

P. D. Q.

That's how we are Compelled To Dispose of over $300,000.00 Worth of Practically New Machinery

The result is that we are offering some very unusual bargains on lathes, millers, profilers, grinders, tanks, blowers, pumps, screw machines, nailing machines and presses.

Send us your requirements, we have it or can get it. Let us prove this assertion.

SAXER MACHINERY CO.
ERIE PENNA.

UNUSUAL OFFERINGS
In
New and Second Hand High Grade Modern Machine Tool Equipment

Consisting of 1500 Items **All Styles and Sizes**

Barnes Drills.
Natco Adjustable Spindle Drills.
Baker Heavy Duty Drills.
Berlin Bracket Drills.
Superior Drills.
American Lathes.
Reed Prentice Lathes.
Lodge & Shipley Lathes.
Walcott Lathes.
Fitchburg LoSwing Lathes.
Gisholt Automatic Lathes.
Potter & Johnston Automatic Lathes.
J & L Turret Lathes.
Libby Turret Lathes.
Bullard Turret Lathes.
National Acme Turret Lathes.
Cleveland Automatic Turret Lathes.
Universal Automatic Turret Lathes.

Gridley Automatic Turret Lathes.
Cincinnati Automatic Milling Machines.
Kempsmith Milling Machines.
Becker Vertical Milling Machines.
Ingersoll Milling Machines.
Lees-Bradner Hob Mills.
Gould-Eberhardt Hobbing Machines.
Fellows Gear Shapers.
New Britain Automatic Screw Machines.
Norton Grinders.
Bryant Chucking Grinders.
Gardner Disc Grinders.
Besley Disc Grinders.
Blanchard Vertical Grinders.
Landis Internal Grinders.
Heald Grinders.
Rivett Internal Grinders.
Davis Keyseaters.

Already 25 carloads have been unloaded in our warerooms and many more are in transit. Complete detailed lists are being prepared and will be sent on request. Let us have your inquiries?

PENINSULAR MACHINERY COMPANY
279 E. Jefferson Ave. DETROIT, MICHIGAN

UNITED STATES NAVY
LATHES LATHES
TURNING AND BORING

The Navy Department has for sale a large number of lathes, which were used for ordnance work during the war. The majority of these are turning and boring lathes with a few engine lathes. All of the lathes may be used for heavy duty work, with swing from 18 inches to 42 inches and bed plates from 28 ft. to 66 ft.

These lathes are of the following manufacture:—

LeBLOND **BRIDGEFORD** **PUTNAM**
AMERICAN **McMYLER** **POND**
RITTER & CONLEY **ELECTRIC DRIVE**

These lathes may be inspected at naval stations near Philadelphia and near New York. For further information and detailed description address:—

COMMANDER G. M. STACKHOUSE (SC) U. S. N.
Senior Member, Board of Survey, Appraisal and Sale
LEAGUE ISLAND NAVY YARD PHILADELPHIA, PENNSYLVANIA
Bell Telephone: Dickinson 6300, Branch 557

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Phone: Franklin 5899
Complete list now ready.

568 West Washington Boulevard
Mail us your inquiries.

NEW, USED AND REBUILT MACHINERY for Immediate Delivery

LATHES

2" x 24" J. & L. Turret Lathe (new)
3½ x 60 Lo-swing Lathe.
No. 2 Niles Axle Lathe.
No. 3 Niles Axle Lathe.
18 x5 Willard Lathe, S.Q.C.G.
14 x 5 Willard Lathe, S.Q.C.G.
14 x6 Springfield Lathe, Taper Attach.
14 x 6 Reed Prentice Engine Lathe.
16 x6 Cuno Lathe, D.B.G.
16 x 7 Oliver Tool Room Lathe, Q.C.G. (new).
16 x 8 Rockford Lathe, S.Q.C.G.
17 x 10 LeBlond H.D.D.B.G. (new).
18x6 Putnam Q.C.G. Lathe.
18x7 Chard S.Q.C.G. Very good.
18x8 Rahn & Larmon, Q.C.G. Lathe.
20 x8 Hamilton Lathe, S.Q.C.G.
20 x8 Cisco Q.C.G. Lathe.
20 x8 Monarch Lathe, Q.C.G.
20 x10 Walcott Q.C.G. Lathe.
22 x10 Cisco Q.C.G. Lathe.
24 x 12 Bradford Q.C.G. c/s.
26 x 10 American with Turrets.
26x14 Bridgeford, H.D.Q.C.G.
28 x 10 Pond Engine Lathe Q.C.G.
52" Niles Tire Lathe
Fifield Lathes 50" to 96" swing any length bed (manufactured by the Wright Works, Chicago).

BORING MILLS

2½" Niles Boring.
4" Newark Boring.
48" Bullard Vert.
60" Niles Vert.
60" Bullard Vert.
60" Colburn Vert.
14' Niles Vert.

CUT-OFF MACHINES

⅞" Cap. Nat. Acme Bolt Cutter.
1¼" Cap. Nat. Acme Dbl. Head Bolt Cutter.
3" Cap. Nat. Acme Bolt Cutter.
3" Cap. Bignal-Keeler Pipe Machine.
3" Cap. Hurlbut-Rogers Cut-off Machine.
6" Cap. Davis Cut-off Machine.

DRILLING MACHINES

24" Aurora, B.G.P.F., S.H. Tap. Attach.
25" Barnes, B.G.P.F., S.H.
26" Barnes, B.G.P.F., S. Head.
32" Barnes, B.G.P.F., S. Head.
34" Barnes, B.G.P.F., S. Head.
36" Mechanics, B.G.P.F., S. Head.
42" Cinn. B.G.P.F., S. Head.
2½" Carlton Radial Drills Tap. Attach.
3' Bickford Radial Drills Tap. Attach.
3' Morris Radial Drills Tap. Attach.
4' Fosdick Radial Drills Tap. Attach.
4' Bickford Radial Drills Tap. Attach.
5' American Full Radial Drill.
10 Spdl. Natco ⅛" Cap. Multiple.
12 Spdl., Prat & Whitney Multiple.
D-4 Colburn Drills.
D-8 Colburn Drills.

GRINDERS

26" Diamond Disc Grinder.
No. 1 LaSalle Surface Grinder.
6 x 20 Fitchburg Plain Grinder.
10 x 20 Landis Plain Grinder.
8 x30 Modern Self-cont. Grinder.
12 x 30 Fitchburg Grinder.
12 x 30 Fitchburg Plain Grinder.
12 x 60 Modern Plain Grinder.
18 x 96 B. & S. Plain Grinder.
20 x 96 Landis Plain Grinder.

MILLERS

No. 2 Carter & Hakes Hand Miller.
No. 3½ Fox Hand Miller.
No. 12 B. & S. Mfg. Miller.
No. 25 Bilton Miller.
No. 3 LeBlond Plain Miller.
No. 3 K. & T. Plain Miller.
No. 3 Hendey Plain Miller.
No. 4 LeBlond Plain Miller.
No. 1½ Rockford Universal Miller.
No. 3 Owen Universal Miller.
No. 3 B. & S. Universal Miller.
No. 4 B. Becker Vert, Miller.

PUNCH PRESSES

No. 1 Toledo O.B.I. Press.
No. 3 Sidney O.B.I. Press.
No. 16 Bliss Horning Press.
No. 12 Rock River, P & S 5¾" cap.
48" Gang wheel tire punch ¾" cap.
2" Single End Punch, L. & A. No. A.

SHAPERS

16" Steptoe Crank Shaper.
20" Queen City Crank Shaper.
24" Queen City Crank Shaper.
24" Ohio Crank Shaper.

MISCELLANEOUS

Rockford Production Lathe.
¾" B. & S. Auto Screw Machine.
¾" Chicago Auto Screw Machine.
No. 0 LaPointe Broaching Machine.
No. 1 LaPointe Broaching Machine.
No. 2 Moore Screw Press.
No. 201 David Bell Hammer.
160 lb. Drop Hammer.
3" Acme Heading & Forging Machine.
500 lb. N.B.P.S.F. Steam Hammer.
1½" Acme Upsetting Machine.
Complete stock of compressors.

We Buy Complete Plants **What Have You to Sell?**

DAVID A. WRIGHT, 568 West Washington Boulevard CHICAGO, ILL.



One Shepard Elec. Crane & Hoist Co. 10-ton Standard Elec. Traveling 37 ft. 8 in. Span, 2 part double hoisting rope, Maximum lift 27 ft. Main hoist only, one 220 V. D. C. Motor. Location: Shepard Elec. Crane & Hoist Co., Montour Falls, N. Y.

One Shepard Elec. Crane & Hoist Co. 15-ton Standard Elec. Traveling 37 ft. 8 in. Span. 2 part double hoisting rope, Maximum lift 27 ft. Main hoist only, one 220 V. D. C. Motor. Location: Shepard Elec. Crane & Hoist Co., Montour Falls, N. Y.

HYDRAULIC PRESS

One General Electric Co. 1300-ton Hydraulic Cartridge Case Headings. Location: Rome Mfg. Co., Rome, N. Y.

The above equipment is offered for sale by negotiation by the Rochester District of the Ordnance Salvage Board, 1044 University Ave., Rochester, N. Y. Complete information may be obtained from the Chairman of the District at the address given above. Proposals to purchase should be similarly addressed. Directions for the purchase of these cranes and presses, as well as description of other machinery and industrial equipment, is contained in the Bulletin of the Rochester District, which will be sent upon request.

WAR DEPARTMENT

Ordnance Salvage Board
Surplus Property Sales
Get the District Bulletins

Rochester District
1044 University Avenue
Rochester, New York

An Unusual Lot of Tools of the Better Kind

List of exceptional equipment which is in first-class condition and *ready for immediate delivery*

LOCATED AT WATERTOWN, N. Y.

LARGE TOLEDO PRESSES, including :

1—59¼ double geared straight column, stroke 8-in.; weight approx. 70,000 lbs.
4—No. 59 double geared straight column; stroke 12-in.; weight, each, approx. 50,000 lbs.
1—No. 58 double geared straight column; stroke 14-in; weight, each, approx. 33,000 lbs.
3—No. 57 double geared straight column; stroke 18-in.; weight, each, approx. 20,000 lbs.
4—No. 666 Knuckle-Joint Embossing; stroke 2¼-in.; weight, each, approx. 80,000 lbs.
6—No. 857 geared Rack and Pinion Reducing; weight, each, approx. 22,000 lbs.

LOCATED AT OUR WAREHOUSE IN NEW YORK CITY

VERTICAL BORING MILLS

1—84-In. Gisholt, 2 heads on rail, single pulley drive, NEW.
1—84-In. Gisholt, 2 heads on rail, single pulley drive,
1—60-In. Niles, 2 heads on rail, cone pulley drive.
2—42-In. Baush, 2 heads on rail.
1—36-In. Bullard Vertical Turret Lathe with side head, rapid production type.

HORIZONTAL BORING MILLS

1—No. 31 Lucas single pulley drive.
1—No. 2 Rockford boring and drilling machine, motor drive, direct current motor.
2—Bement-Niles.

PLANERS: All latest type and design:

1—48 x 48 x 30 Putnam, 4 heads.
3—26 x 26 x 10 Putnam, 2 heads, NEW.
6—26 x 26 x 8 Putnam, 2 heads, NEW.
1—30 x 30 x 8 Powell, 2 heads.
1—36 x 36 x 12 Gray, 2 heads.
1—24 x 24 x 6 Gray, 1 head.
1—30 x 30 x 10 Flather, 1 head.
1—36 x 36 x 14 Ohio, 4 heads, heavy duty motor driven. Set up but never used.

MILLING MACHINES

1—No. 3 Kempsmith, plain.
1—No. 2-A Fox Universal, NEW.
1—No. 2 LeBlond heavy duty, plain.
40—No. 6 Whitney hand.
30—Stand Hand Power Feed.
8—No. 10 Pratt & Whitney hand.
8—No. 0 Bristol hand.
10—No. 3½ Fox hand.
6—4-In. Pratt & Whitney spline.
8—2-In. Pratt & Whitney spline.

DRILLS

2—Henry & Wright single spindle high speed.
1—25-In. Silver back geared, NEW.
1—28-In. Cincinnati with tapping attachment.
1—24 In. Prentice.
6—Moline Hole Hogs.
1—34-In. Prentice, back geared.
10—Single spindle Allen high speed ball bearing.
12—2-Spindle Allen high speed ball bearing.
14—3-Spindle Allen high speed ball bearing.
20—4-Spindle Allen high speed ball bearing.
11—5-Spindle Allen high speed ball bearing.
15—6-Spindle Allen high speed ball bearing.
2—3-Spindle Avey heavy duty high speed ball bearing—one with tapping attachment—NEW.

GEAR CUTTERS

1—48-In. Cincinnati.
1—36-In. Cincinnati.
1—36-In. Brown & Sharpe.
1—No. 4 Farwell gear hobber.
2—8-In. Hercules gear hobbers, NEW.

RADIAL DRILLS

4—6-ft. Baush, cone pulley drive, NEW.
1—6-ft. Reed-Prentice, motor-driven single pulley drive.
1—3-ft. Fosdick, cone drive.

GRINDERS

1—10 x 96 Norton plain.
7—10 x 36 Norton plain.
2—10 x 36 Modern plain.
2—10 x 30 Modern plain.
1—No. 11 Brown & Sharpe plain.
5—6 x 32 Norton plain.
1—No. 2 Brown & Sharpe universal.
1—No. 2 Modern universal.
1—No. 1 Landis universal.
1—No. 1 Fraser universal.
2—No. 1½ Walker Surface with magnetic chuck.
1—La Salle Surface with magnetic chuck.
2—No. 70 Heald.
70—No. 1 Blount Bench Grinders.
2—Brown & Sharpe Surface with magnetic chuck—NEW.
12—No. 20 Bryant Chucking—NEW.

LATHES:

1—42 x 17 Pond.
6—24 x 12 Boye & Emmes quick change gear.
4—22 x 12 Greaves Klusman quick change gear.
1—25 x 10 LeBlond quick change gear.
1—20 x 12 Prentice single pulley drive, geared head.
1—18 x 6 Reed quick change gear.
4—18 x 8 Rockford Economy quick change gear.
6—16 x 6 Oliver with pan and pump, quick change gear.
3—12 x 5 Hercules.
6—3½ x 60 Lo-Swing.
2—8 x 84 Lo-Swing.
20—Sidney medium pattern quick change gear Lathes with 6-ft. to 12-ft. beds and 14-in. to 20-in. swings, NEW.

TURRET LATHES

4—No. 2 Southworth screw machines.
3—Greenlee turret lathes.
1—No. 4 Warner & Swasey screw machine.
7—No. 4 Brown & Sharpe screw machines.
1—No. 12½ Garvin screw machine, fully equipped.
1—No. 3 Foster, geared head, single pulley drive, fully equipped.
1—No. 5 Foster geared head, single pulley drive, fully equipped.
8—Wood Tilted Turret Lathes, 1½-in. capacity.
10—No. 6-A Potter & Johnson, latest type.
5—No. 0 Foster.
2—No. 2 Warner & Swasey screw machines.
15—No. 1-B Foster Universal Turret.

POWER PRESSES

35—No. 16 Bliss horning.
5—No. 20 Bliss inclinable.
15—No. ¾ Toledo Bench.
1—No. 20-C Bliss with dial feed.
4—No. 42 Toledo horning.
1—No. 4 Adriance inclinable.
3—No. 14-A Stoll inclinable.
3—No. 2½ Chambersburg straight side trimming.

MISCELLANEOUS

2—No. 52 National Acme Automatics.
1—No. 54 National Acme automatic motor driven.
1—Rheinecke Relieving Machine.
1—Flather Relieving Machine.
1—Becker Backing-Off Machine.
4—No. 0 LaPointe Broaching Machines.
3—No. 1 LaPointe Broaching Machines.
2—No. 2 LaPointe Broaching Machines.
6—No. 80-B Grant Riveters.

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18″ x 10′ Bradford Heavy Pattern Lathe, 3 step cone, double back gears.
32″ x 18′ Bradford lathe, c.r.
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No. 1 Foster Screw Machine.
No. 1 Pratt & Whitney Screw Machine.
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14x6 Vernon Q.C.G.
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18x8 Prentice Bros.
20x10 Sidney Q.C.G.
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No. 1 Cleveland Horizontal Boring, Milling and Drilling Machine.
51″ Bertram Vert. Boring and turning Mill, two swivel heads.

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21″ Gisholt turret.

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1 spindle Taylor & Fenn.
3 spindle Henry & Wright.
4 spindle Allen b.b.
4 spindle Reed-Prentice b.b.
4 spindle Rockford.
8 spindle Taylor & Fenn.

22¼″ Barnes b.g.p.f.
24″ Aurora Sliding Head.
36″ Foote Burt Heavy Duty.
3′ Taylor & Fenn Sensitive Radial.
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Cleveland Profile Grinder.
No. 6 Bryant Hole Grinder.
10x72 Brown & Sharpe Plain Grinder.
18x120 Norton Plain Grinder.
No. 2 Brown & Sharpe Universal Grinder.

MILLING MACHINES

Becker Heavy Hand.
Bickford Hand P.F.
10x28 Bristol Vertical.
No. 13 Garvin B.G.
No. 4 Hendey Lincoln.
Thurston Die.

MISCELLANEOUS

100 lb., 150 lb., 200 lb., Standard Plain Drop Hammers.
No. 5 Stiles Pattern Bliss Press.
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No. 5A Standard Power Press S.A.
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1—5-ft. Universal Radial Drill.
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1—10 x 36-in. Thompson Full Universal
1—No. 2-A Landis 16 x 32-in. Universal.
1—No. 2 Manhattan Suface Grinder; new.
1—Grand Rapids Drill Grinder, ½ to 2½-in. cap.
1—No. 2 Oakley Universal Cutter and Tool Grinder.
1—Greenfield Universal Cutter and Tool Grinder.
1—Wells Cutter and Tool Grinder.
1—No Ja Yankee Drill Grinder.
1—60 Heald Internal Cyl. Grinder.

SHAPERS

2—16-in. Streine B. G. Shapers; new.
3—16-in. Whipp S. G. Crank Shapers; new.
2—20-in. Ohio B. G. Crank Shapers; new.
1—Each 16, 18, 21, 24-in. Hollingsworth B. G. Crank Shapers; new.

MILLERS

1—No. 2 American Plain Mill; used.
1—Each Nos. 2-B and 2 Rockford Universal Mills; new.
1—No. O Bickett Vertical Mill and Profiler; new.
2—No. 1 U. S. Hand Millers.
10—No. 25 Becker Plain Millers.
10—No. 32 Kempsmith Lincoln type Millers.

PRESSES AND PUNCHES

3—No. 2 Pratt & Whitney Trimming Press.
1—Willard Presses 2, 3, 4, 5-A Inc.
1—62-in. Badger Combined Stake Riveter and Punch; Dia. of stake 14-in.; riveting cap. ⅝-in.; punching cap. ⅝-in. x ½-in.; good as new.
1 Doty Combined Punch and Shear—Geared; Cap. about ¾ x ¾-in.; with 7-in. throat.

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15—No. 2 Smith Hand Screw Machines, round collet, capacity 1 1-16-in. wire feed and auto. chuck, independent stops to turret.

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1—Baush Multiple Spindle Drill, arranged for 24 spindles, now with 12 spindles; takes 60-in. between colums, drills in any circle 12-48-in. diam.; approximate weight 30,000 lb.
1—No. 1 Baush High Speed Multiple Spindle Drill, rectangular head 16 x 20-in., arranged for 16 spindles, now with 10¾-in. spindles, No. 2 M. T.; cone drive.
1—No. 1 Baush High Speed Multiple Spindle Drill, equipped with round head 13½-in., with 8 1¼-in. spindles, No. 2 M.T.; cone drive.

BENDING ROLL

1 10-ft. Bertsch Pyramid Type Bending Roll, capacity ½-in. plate, drop end housing 9-in. olls.

LATHES

1—25-in. x 8-ft. Economy Heavy Duty Single Purpose Lathe, D.B.G. 3-step cone, C.R., Hol. sp., quick change feed.
1 Each Sidney Medium Pattern Lathes, 14, 16, 18, 20-in. by 6, 8, 10, 14-ft. beds; D.B.G. 3-step cone. Q.C.G.
1 each Sidney Heavy Duty Lathes 15, 17, 19, 25, 27-in long by 6, 8, 10 12, 14-ft. beds; D.B.G. 3-step cone. Q.C.G
1—14-in. x 6 ft. Flather Engine Lathe, screw cutting. S.B.G. cone.
2—12 and 14-in. x 6-ft. Wooster Tool Room Lathe, taper attachment, pan and collet.
2—Used 18-in. x 10-ft. Hamilton Lathes, complete C.R., H.S. quick change and semi-quick change gears, countershaft, tail stock, equipped with turret.
1—32-in. x 16-in. Obl Engine Lathe; with 4-in. raising blocks to swing 40-in., D.R.G., 5-step cone, 4-in. belt C.R.
1—20-in. x 12-ft. Engine Lathe, C.R. H.S., with Hex turret on way.
1—20-in. x 10-ft. Lodge & Davis C.R. H.S.
1—17-in. by 8-ft. Cincinnati—not screw cutting H.S., plain rest.
1—16-in. x 6-ft. Lodge & Davis—solid spindle, plain rest.

PLANERS

1—24 x 24 x 6 Gray Planer, single head.
1—26 x 24 x 8 Pond Planer, two heads.
1—40 x 40 x10-ft. New Haven, single head.

MISCELLANEOUS

1—No. 0 Quickwork Rotary Shear 48-in. th., 1-in. cap.
1—26-in. B. & S. No. 3 Gear Cutter.
1—40-lb. Bradley Cushion Helve Hammer.
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1—5-A Potter-Johnston Automatic Chucking Machine.
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8—3¾" Single Spindle Cleveland Model "A."
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4—3 x 36" J. & L. turret lathe.
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5—2" x 24" Jones & Lamson turret lathe.
10 No. 2 Bardons & Oliver turret lathe.
4 No. 1 Pratt & Whitney turret lathe.
3 No. 2 Pratt & Whitney turret lathe.

LATHES

14—16" x 8 and 14" x 6' Monarch G. H. D. B. G. Q. C. G. and 3-step Cone—like new.
6—12" x 5' Reed Q. C. G. D. B. G.
6—12" x 5' Worcester Q. C. G.—used two months.
15—14" x 6' Blaisdell Loose C. G. R. & F. Tool Post—cheap.
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1—11" x 6' Cincinnati D. B. G.—Q. C. G.

MISCELLANEOUS

1 No. 6 Rivet Grinder.
1 No. 1 Lapointe M.T. Co. Broaching Machine.
1 No. 3 B. J. M. Lapointe Broaching Machine with Support.
1 No. 1½ Kearney & Trecker Plain Miller, Vertical Attachment.
1 No. 3 Pratt & Whitney Die Sinking Machine.
1 No. 2 Blake & Johnson Grinder.
1 No. 4 Industrial Knee Type Plain Miller.
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1—24" x 24" x 5' Gray Planer, one head.
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12x5 Hendey quick change.....800.00
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25"x18' Lowell.....650.00
8—26x14 Bridgeford D. B. G., Q. C. G. Engine Lathes
2—26x16 Bridgeford D. B. G., Q. C. G. Engine Lathes
1—26x18 Bridgeford D. B. G., Q. C. G. Engine Lathes
8—28x10 Pond D. B. G., Q. C. G. Engine Lathes.
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28x13 Niles-Bement-Pond.....1500.00
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1—8" Bore x 24" stroke, single, Pittsburgh Steam Hammer, 600 lb. drop.
1—Westinghouse Type SK 60 direct current, 15 H.P. 220 volt, 1700 R.P.M., Shunt Wound Motor, complete with starter.
1—Buffalo No. 6 blower, 12" outlet pipe.
1—Buffalo No. 10 blower, 21" outlet pipe.
1—Birmingham 16"x30" 2 roll rubber mill with end caps, gears 56"x3", cast iron guides 2½" pitch spur gear, 12" pinion, with safety throw out jaw clutch and one extra cracker roll.
1—Taylor Stiles Rubber Tire Stock Cutter, Style No. 2 with 12" counter shaft.
1—No. 2 Rotary Ball & Jewel Cutter.
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1—24" Detrick & Harvey open side Planer with 7½' table single head and cross rail.

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1—No. 12 Modern Grinder.
1—36" Fellows Gear Shaper.
1—No. 17 Besly Disc Grinder.
1—No. 3 Brown & Sharpe Heavy Gear Cutter.
1—No. 13 Brown & Sharpe Spur & Bevel Gear Cutter.
2—6 x 32 Norton Grinders.
1—6" Gleason Automatic Gear Generator.
1—3 spindle Gould & Eberhardt Gear Rougher.
1—22 x 10 ft. Lodge & Shipley Lathe.
1—30 x 14 ft. Boye & Emmes Engine Lathe.
1—A. B. Becker Vertical Milling Machine.
1—No. 3 Kempsmith Universal Milling Machine.
1—24" x 8 Hall Brown Woodworking Planer.
9—3½" Gridley Single Spindle Automatics.
3—2½ Gridley Four Spindle Automatics.
2—2¼" Cleveland—5 hole turret Screw Machines.
1—⅝" Cleveland 6 hole Turret Automatic.
1—2⅝" Gridley 4 spindle Automatic.
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30" Warner Swasey Vertical.
36" and 60" Niles Vert. 2 hd.
42" and 50" Bullard Vert., 2 hd.
48" Colburn Vert., 2 hd.

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20" Silver Drills, Plain & Bk. Gd.
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24" Prentice, B.G.
40" New Haven, B.G.
40" Prentice, B.G.
Garvin 4-Spindle Drill, No. 3 Taper.
3' Baush Radial.
3' Prentice Radial, Tap. Att.
5' Dreses, Radial, M.D.

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Bliss No. 76½ Str. Side, D.G., 11" stroke.
No. 30 Perkins Inclinable.
No. 56 Double Housing Power Press.

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Long-Abstatter Type A.
Sgl. End Punch or Shear, shear 9" x 1" flat.
No. 6 Long-Alstatter DE Punch & Shear.
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Rees 18" Sgl. End Punch.
Young Power Punch, cap. ¼" x 3/16".
Rees 18" Sgl. End Shear.
Mesta Plate Shear, Cap. ¾" x 156".
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48" x 28' Niles, C.R.
36" x 18' 8" Niles, C.R.
28" x 12' Boye-Emmes q.c.g., d.b.g.
27" x 12' Pittsburgh, D.B.G.
26" x 20'6" Putnam, B.G., C.R.
26" x 10' 6" Walcott, Q.C.G.
24" x 16' 6" Johnson, C.R.
24" x 12' Amee, B.G.
22" x 12' Greaves & Klueman, q.c.g.
19" x 10' LeBlond M.D., 220 V., D.C.
14" x 6' Hendey, q.c.g.
24" x 6' Gisholt Turret, 6¼", H.S.
22" x 8' 6" Bullard Turret.
Becker No. 6 Vertical Miller.
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LeBlond No. 2½ and No. 3 Plain.

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72" x 56" x 12' Betts Planer, 2 hds.
60" x 60" x 10' Bement Miles Planer, 4 hd.
30" x 30" x 10' Flather, Planer, 1 hd.
16" Lodge & Davis Shaper.
24" Cincinnati B.G. Shaper, M.D.
26" G. & E. Crank Shapers.
26" Smith Slik Rack Shaper.

MISCELLANEOUS

Binsaee Hor. Boring Mch. 3" bar.
Bement-Miles Boring, Drilling & Milling Mch. M.D., 6½" dia. bar.
Plymouth Grindere Nos. 13-14-17-20-23.
Greenfield Un. Cutter & Tool Grinder.
Williams White No. 1 Bulldozer.
Bement 1500 lb. Steam Hammer.
Niles 15" Slotter.
Cleveland Straightening.
Rolls, 84" x 10" dia.

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1—No. 3 Brown & Sharpe Universal, complete.
1—No. 7-H Becker Lincoln Type.

SHAPERS

1—24" Cincinnati back geared, with vise and Countershaft.
1—24" Queens City back geared, with vise and Countershaft.

LATHES

1—30" x 10' Pond Engine Lathe, massive pattern.
1—26" x 18' Niles Bement Pond, triple geared.
1—24" x 10' Pittsburg, QCG., DBG.
1—18" x 8' F.E. Reed Engine Lathe.

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6—No. 56 National Acme Automatics.
6—No. 55 National Acme Automatics.
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10—20"x10' Walcott Lathes, D.B., Q.C.
5—27"x10' Bridgeport Heavy Duty, Q.C., D.B.
5—26"x12' Putnams, D.B., Q.C.
2—24" Baker Drill Presses, heavy duty.
2—No. 148 Frankford Furnaces, Oil, NEW.
2—Frankford Furnaces, oil, about 36"x20' long.
2—14"x14" Bury Air Compressors, 550 f.p.m. 80 lbs.
1—Ingersoll-Rand Air Compressor, 2 stage, 850 cu. ft. per min., 100 lbs.
1—Reihle Test Machine.

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1—16 x 8 Lodge & Shipley, Q.C.G. Engine Lathe, complete with standard equipment, taper attachment, draw-in collets and three jawed chuck, like new 1000.00
1 Lathe & Morse 26x26x8 Planer, 1 head on rail..... 900.00
1—24" Gould & Eberhardt Shaper, like new 1000.00
1—20" Davis Shaper, like new 1000.00
1—600 lb. Merril Board Drop, used very little.....800.00
1 No. 3 Cincinnati Plain Miller with vertical attachment 1200.00
50 ton 1 15/16 Cold Rolled Steel Shafting 90% new, 2000 lb. lots ..... .06 per lb.
2 Garvin No. 1 Automatic Tapping Machines like new Each 150.00
2000 new and slightly used American Split Pulleys, 25% off list.
20 ton 1st grade used belting, all sizes at $.10 cents for 1 ft. x 1" x single ply.

Terms 25% with order, balance sight draft with bill of lading.

Botwinik Bros.

21 Sylvan Ave.

New Haven Conn.

Machinery's GREEN SECTION

Inquiry Department

will help you find any special equipment not listed here—write us. There is no charge for the service—we *want* to help you.

Machinery's Green Section

Machinery—For Sale

10—250 ton Southwark Hydraulic Presses.
1—200 H.P. Ideal Motor 40 cycle, 550 Volts.
3—Steel Tanks with Agitators 12' x 3' x 4' deep.
1—Goodell-Pratt Toolmakers lathe 5" swing.
1—Forbes Power Pipe Cutting and Threading Mch. 1" to 6" pipe.
1—Pratt & Whitney bolt cutter, self-opening dies, cuts ¾" x 1".
1—Merrill No. 6 Hand power portable pipe threading mch., cute 1" to 6" pipe.
1—Five foot Radial Drill.
1—Warren Shaper—traverse shaper 20" stroke, 10 ft. table.
1—Beaudry 200 lb. belt driven hammer.
1—Buffalo Blower No. 9.
1—Sellers & Co. No. 1 Tool Grinder.

INTERSTATE MACHINERY CO.

TROY, N. Y.

Practically New Tools For Sale

Have Only Been in Use Six Months

1—No. 3 Owen Universal Milling Machine.
1—20" Cincinnati H.D. Back-Geared Shaper.
1—W. & M. Yankee Drill Grinder.
1—25" Weigel Sliding Head Drill.
1—14 x 6 Whitcomb-Blaisdell Lathe, Q.C.
1—Sterling Universal Cutter Grinder.
1—Robertson No. 5 High Speed Economy Hacksaw.
2—No. 7 Foster Screw Machines, complete.

Corley-DeWolfe Company

323 PINE STREET, ELIZABETH, N. J.

DETROIT STOCK

BEVEL GEAR GENERATORS

2—16" Bilgrams. Regular equipment.

SPUR GEAR MACHINES

3—36" Fellows. Regular equipment.
1—No. 2B 24" Newark for spurs and bevels.

GRINDERS

1—No. 23 Brown & Sharpe for cylinders.
1—No. 4 Gardner Double End Ring Wheel.
1—No. 120 Gardner Combination Disc Grinder.
1—No. 2 Landis Internal.
3—20" Wet Tool Grinders.

TURRET LATHES

1—17" 2-spindle Jones & Lamson.
3—3 x 36" Jones & Lamsons. Geared feed.
2—24" Steinles. Single pulley drive.
2—No. 24 Geo. G. Prentice 4-spindle. Semi-automatics.

MILLING MACHINES

2—No. 6 Beckers. 62" table feed.
1—No. 5 Ingersoll, Combination horizontal and vertical.
1—42 x 42 x 12' Ingersoll. Slab type.

RADIAL DRILLS

1—5' Western. Heavy type, plain, triple geared.

DRILL PRESSES

1—1 x 6 Baker Bros. Vertical Automatic.
1—No. 13 D. Moline. Heavy duty.
2—8-spindle Baush Adjustable Drill Heads. Cap. 8½" circle. ¾" drills.
1—No. 17 Foote-Burt 4-spindle, rail type.
1—No. 1½ Foote-Burt 4-spindle, rail type.
3—No. 3 30-spindle Baush Multiples.

PLANERS

1—24 x 24 Pond. Heavy duty. One hd.

BOLT CUTTERS

1—2" Landis. Single head.

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What Have You For Sale?

E. B. Stickley Machinery Co.

217-221 E. Congress St. Detroit, Mich.

FOR SALE

The following machinery in good condition. Selling to make room for special production machinery.

DELIVERY—IMMEDIATE

1 only Norton Grinder 10 x 36 Universal $2,000.00
1 only Landis Grinder 12 x 32 Universal 1,000.00
1 only Engine Lathe—Perkins 14 x 6 ..... 170.00
1 only Engine Lathe—South bend 13 x 6 ..... 160.00
1 only Wood Tilted Turret Lathe—one inch 625.00
1 only Drill Press—20" Star Lever 125.00
1 only Special Lathe—Heavy duty 200.00

DELIVERY—SEPT. 1st

2 only Engine Lathes—Fulton 18 x 6 ..... $750.00 ea.
2 only Engine Lathes—Sidney 15 x 6 ..... 700.00 ea.
3 only Engine Lathes—Willard 13 x 6..... 400.00 ea.
1 only Engine Lathe—Le Blond 13 x 6..... 200.00

AMERICAN MACHINE PRODUCTS CO.
MARSHALLTON, IOWA

Used Tools—Excellent Condition

BORING MILLS

1—52" Rogers & Hemphill vertical, two heads.

GEAR CUTTERS

1—14" Lees-Bradner gear generator.
1—36" Brown & Sharpe spur gear cutter.

LATHES

1—16" x 8' Gray, l.c.g., plain rest.
1—16" x 8' Walcott & Wood, h.s., c.r.
1—16" x 6' Milwaukee, c.r., 12" chuck.
1—20" x 8' Sidney, q.c.g., c.r.
1—26" x 12' Bullard, triple geared, taper att.

BOLT CUTTERS AND PIPE MACHINES

1—1½" National double head bolt cutter.
1—2½" x 6" Curtis power pipe machine.

TURRET LATHES AND SCREW MACHINES

1—No. 1 Pratt & Whitney ⅝" cap. hand screw machine.
1—24" Steinle heavy turret lathe, 4" h.s.
2—2¼" x 24" Jones & Lamson geared head turret lathes.

MISCELLANEOUS

1—No. 1 Stewart gas oven furnace.
1—No. 9 Stewart gas oven furnace.
1—No. 13 Stewart crucible furnace.
1—No. 3-D Minster high duty drill.
1—No. 1 Fraser universal cylindrical grinder.
1—12" x 24" Modern plain grinder.
1—Springfield univ. gauge grinder with motor.
1—No. 8 American Can inclinable power press, 2" stroke.
1—16" x 16" x 36" Hendey planer, one head.
1—No. 2 Burr cold saw.
1—No. 11½ Higley cold saw, 3" cap.
2—No. 2 Marvel saws.
1—No. 1 Racine saw with pump.
1—No. 10 Racine saw.
1—20" Ohio back geared crank shaper.
1—No. 1 Garvin tapping machine.
1—No. 8 Lees-Bradner thread miller, 4' 6" centers.

FEDERAL MACHINERY SALES CO.
CHICAGO 14 N. Jefferson St.
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16"x6' Blaisdell Engine Lathe, pl. ch., R.R.
18"x8' Greaves-Klusman Lathe, Q.C.G., D.B.G.
2—20"x10' S.B. & E. Lathes, Q.C.G., D.B.G.
20"x10' Lodge & Shipley Lathe, Q.C.G.
24"x12' Lodge & Shipley Lathe, Q.C.G., T.A.
24"x12' Pittsburgh Lathe, raising blocks to 34".
28"x8' Warner & Swasey Plain Turning Lathe.
48" Niles Car Wheel Lathe.
2—3"x36" J. & L. Turret Lathes, Grd. Hd., S.F.D.
2—16" Crank Shapers—New.
20" Back Geared Crank Shaper—New.
24" Gould & Eberhardt Shaper.
No. 3 Cincinnati Plain Miller.
No. 2 Kempsmith Plain Miller.
2' Baush Plain Radial.
3' Foodle Plain Radial.
60" Bullard Vertical Boring Mill, 2 swivel heads, belt drive.
48" Colburn Vertical Boring Mill, 2 heads.
42" Bullard Vert. Boring Mill, 2 swivel heads.
42" Colburn Vert. Boring Mill, 2 swivel heads.
36" Niles Vert. Boring Mill, 2 swivel heads.
No. 4 Hilles & Jones Shear, S.E., throat 36".
Reads Single End Punch, 50" throat, 1¼" x 1½".
Single End Punch, geared, ¾"x¾".
No. 3 Bliss Plain Double Seamer.
52" Niagara Power Squaring Shear, 14 gauge.
6'10" Bending Rolls, cap ¾" plate.
No. 86 Niagara Double Acting Cam Press, geared.
2—No. 3 Losbough-Jordan Presses, 2000 lbs., 2½" stroke—New.
No. 4 Losbbough-Jordan Press, 3500 lbs., 3" stroke—New.
No. 4—A Willard Press, 1400 lbs., 2" stroke—New.
No. 1 Draper & Hall Surface Grinder—New.
Draper & Hall Imp. Univ. Grinder—New.
Partial List. Send us your inquiries.

Reliance Machinery Sales Co., Pittsburgh, Pa.

WANTED

TWO ENGINE LATHES

20" x 10 or 12', complete for screw cutting, and with the ordinary attachments. Must be motor driven for 220 volt, DC current, and in good condition. Give full particulars

THE OWENS BOTTLE COMPANY
Purchasing Department Toledo, Ohio

WANTED: One Adriance Combination Horning and Wiring Press No. 24. Also one Bliss No. 2 Press. State price and location.

WM. A. ROGERS, Limited,
Niagara Falls, N. Y.

Used Equipment

2—No. 55 S. P. Blowers—Mfg. by Clarage Fan Co.
1—Hall Air Compressor No. 5080—Major 9 x 9 x 9.
1—Hall Air Compressor No. 4224—Model 5½ x 8 x 7.
1—Deane Outside Packed Plunger Pump No. 70286.
2—No. 34 Stoll Double Seamers.
2—No. 308 Toledo Double Seamers.
2—No. 6 Stoll Beading Machines.
2—No. 100A Niagara Beading Machines. Ready for immediate shipment.

GILBERT & BARKER MFG. CO.
SPRINGFIELD MASS.

USED MACHINERY

Immediate Delivery

38" Bridgeport Vertical Boring Mill.
60" Betts Horiz. Boring Machine.
60" Bullard Vertical Mill.
⅛" Acme single Hd. Bolt Cutter.
20" Barnes All Geared Drill.
22" G & E Std. Head Drill (6).
No. 25—24" Foote-Burt Hvy. D. Drill.
25" P & W Sliding Head Drill.
No. 3—28" B. & S. Gear Cutter.
No. 1½ Bilton Auto. Gear Miller.
10" x 26" Ott Universal Grinder.
No. 24 Landis 14" x 48" Plain Grinder.
No. 3 B & S Plain Grinder.
800-lb. Massillon Steam Hammer.
No. 2 LaPointe Broscher.
800-lb. W. W. & Co. Board Drop Hammer.
18" x 3' Whitcomb Blaisdell Lathe, q.c.g.
18" x 10' Prentice Lathe, q.c.g.
21" x 12' Lodge & Davis Lathe.
22" x 12' Greaves-Klusman Lathe.
24" x 18' Prentice Lathe.
25" x 18' Bradford Lathe.
26" x 12' Putnam Pacific Coast type Lathe, motor driven, with motor.
32" x 24' Fay & Scott Lathe.
No. 33 Kempsmith Prod. Miller.
24" x 24" x 8' Ingersoll Slab Miller.
No. 3 B. & S. Universal Miller.
No. 2 M. P. & J. Horiz. Auto. Miller.
No. 2 V. P. & J. Vert. Auto. Miller.
32" x 32" x 8' New Haven Planer.
36" x 36" x 8' Betts Planer.
48" x 60" x 16' Betts Planer.
2" x 24" J. & L. Turret Lathe.
No. 2 Pratt & Whitney Turret Lathe.
2" x 2¼" Cleveland Auto. Screw Mach.
No. 3 and 4 Foster Hand Screw Machine.
18" Niles traveling head shaper.
24" Conradson Turret Lathe.

E.L. ESSLEY MACHINERY CO.
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WANTED

Nut Blanking Machines for making Cold Punched Chamfered and Trimmed Hexagon Nuts, sizes ¼" to ¾" inclusive.

Rivet Machines for making Rivets cold, sizes ½" to 1" inclusive. Address Box 328, care MACHINERY, 148 Lafayette St., New York.

Surplus Machine Tool Equipment

FINE CONDITION

Gridley 4¼" Automatic Screw Machines;
Chicago Automatic Screw Machines;
Pratt & Whitney Automatic Screw Machines;
2" x 24" Jones & Lamson Turret Lathes;
Thirty-eight Hand Screw Machines: Brown & Sharpes, Warner & Swasey, Acme, Pratt & Whitney. Millholland—⅜" to 2" capacity;
Engine Lathes; various sizes;
Wisconsin Hand Milling Machines;
Springfield Mch. Tool Co. 7" x 60" Spindle and Axle Boring Lathe;
Henry & Wright Bench Drills;
Baker Bros. High Duty Drill Press;
Landis Self-Contained Plain Grinder;
Brown & Sharpe No. 23 Cylinder Grinder;
Webster & Perks Single Spindle and Double Spindle Threading Machines;
Bristol & Beighley Pyrometers;
Davis-Bournonville Co., Oxygraph;
Eveland Electric Riveting Machine;
Brownell Steam Engine.

WRITE OR TELEGRAPH

DAVIS SEWING MACHINE COMPANY, Dayton, Ohio

FOR SALE

the following

MACHINERY

all in first class condition for immediate delivery—prices on application.

Milling Machines
Profilers, Drill Presses
Grinders
Broaching Machines
Woodworking Machines

NORDYKE & MARMON COMPANY
INDIANAPOLIS IND., U. S. A.

Screw Machine Parts

We have a large stock of cold drawn and machinery steel in rounds and are prepared to handle orders promptly

FEDERAL SIGNAL CO.
ALBANY, N. Y.

SECOND HAND MACHINERY

BORING MACHINES

2—24" Bullard vertical turret lathes, latest pattern, excellent condition.
52" Baush vertical, two swivel heads, good as new.
6 ft. Cincinnati vertical, two swivel heads.
Nicholas & Waterman horizontal cylinder, boring bar and facing machine, 6" bar.

DRILLING MACHINES

6—Moline No. 117 single spindle "hole hog," excellent condition.
14" Myers single spindle sensitive.
No. 510 Baker Bros. high speed.
4 ft. Foedick plain radial speed box drive.
4½ ft. old style full universal radial.

ENGINE LATHES

24" x 14' Lodge & Shipley Selective geared head, with taper attach.
32" x 16' Fay & Scott, compound rest, power feed turret on sheers, fine condition.
42" x 24' Davis-Egan, with compound rest, suitable for thread cutting.

MILLING MACHINES

No. 4 Cincinnati high power universal, single pulley driver heavy vert. attachment.

PLANERS

36" x 36" x 8' Niles, three heads.
36" x 36" x 10' Niles, three heads.
36" x 36" x 12' Rockford, two heads.
60" x 60" x 12' Gleason, 3 heads.

SHAPERS

16" Rockford back geared crank.
16" Steptoe back geared crank.
3-24" Walcott geared shifting belt.
3-20" Walcott geared shifting belt.

MISCELLANEOUS

5-Ton Whiting crane, 22 ft. span, 102 ft. runway.
Detroit centerless grinder, good condition.
2" Oster cutting off and reaming machine.
Garvin No. 00-S horizontal duplex tapping machine, NEW.

MARSHALL & HUSCHART MACHINERY CO.
17 So. Jefferson St. Chicago, Ill.

Immediate Shipment

Subject to Prior Sale

15 Tons New Brass Rod
2½ Dia. Mill Length

1000 Lbs. New Brass Wire, No. 7 Stubbs Ga. in Coils.

GILBERT & BARKER MFG. CO.
SPRINGFIELD, MASSACHUSETTS

Immediate Delivery

AUTOMATICS AND TURRET LATHES

1—⅝" Cleveland Model A Automatic.
1—1" Cleveland Model Automatic.
2—No. 2 Pratt & Whitney Screw Machines, ⅝" wire feed.

DRILLING MACHINES

1—3½ 'Arm Canedy Otto Radial.
2—No. 2½ 16" Canedy Otto Sensitive Drills.
3—No. 86 20" Canedy Otto Back Geared Power Feed Drills.

GRINDERS

1—No. 2 Norton Universal Tool and Cutter Grinder, complete.
1—No. 2 LaSalle Automatic Surface Grinder.

HAMMERS

1—1000 lb. Williams & White Board Lift Drop Hammer.
1—1500 lb. Billings & Spencer Board Lift Drop Hammer.

LATHES

1—16"x6' Davis.
1—16"x7' Union.
2—18"x8' Greaves Klusman.
1—18"x10' Robbins.
1—26"x11' Walcott.

MILLING MACHINES

1—No. 1 Dow Plain Miller, complete.
3—No. 12 Pratt & Whitney Semi-automatic Milling Machine, complete.
1—No. 0 Steptoe Plain, Vertical Attachment and Dividing Heads, complete.

MISCELLANEOUS

2—6"x6" Peerless High Speed Hack Saws.
1—9"x0"Peerless High Speed Hack Saw.
2—2-ton Cantoo floor frames.

Morton Machinery Co.
139 North 3rd St., Philadelphia, Pa., U. S. A.

FOR SALE

Machine Shop Business

The most complete small shop in Baltimore, Maryland; highest class equipment, all nearly new; millers, planers, grinders, presses, turrets, gear cutters, furnaces, and abundant fixtures and small tools. Capacity for about 75 men.
Address Box 320, care MACHINERY, 140 Lafayette St., New York.

THE OSBORNE & SEXTON MACHINERY COMPANY, Columbus, Ohio

Dayton Office: Room 1118 Lindsey Bldg.

Reliable Machine Tools, New and Rebuilt

SPECIAL

50 New 16" Quick Change Lathes 6' and 8' bed.

For immediate delivery

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No. 32 Kempsmith Lincoln Type (3).
No. 1¼ Valley City Universal, new.
No. 1 Knight Milling & Drilling.
No. 2 Heavy B & S Plain.
Gooley & Eduud, Briggs Type (3).
No. 2½ Becker, Plain (2).
No. 1½ B & S Plain.
Hand and Small Power Millers.

Planers and Shapers

66" x 66" x 20' New Haven, 2 head.
60" x 60" x 20' Sellers, 4 head.
54" x 54" x 16' Sellers, 4 head.
48" x 48" x 16' Beament-Miles, 2 head.
44" x 44" x 12' Pond, 4 head.
36" x 36" x 18' Pond, 1 head.
22" x 22" x 6' Gray.
24" x 24" x 6' Pease.
14" Niles traveling head.
16" Rockford.

Turret Lathes and Screw Machines

1¼" Tilted Turret Friction Back Geared.
2" x 24" and 3" x 36" J. & L. Sing, Pulley.
No. 2 Warner & Swasey Hollow Hex. 2¼".
National Acmes, No. 52, No. 53, No. 56, 2 x 24 and 3 x 36 J. & L.'s.

Grinders

Madison for Cylinders in Block.
Wells, Cutter & Tool, new (2).
No. 1 Capitol Internal.
10" x 30" W. & P. Univ., new.
10" x 24" Landis Universal.
10" x 20" Litter Plain.

Lathes

25" x 12' LeBlond, Heavy Duty.
24" x 48" x 16' Rahn-Larmon Gap.
8" x 60" Fitchburg Low Swing.
28" x 12' Fay & Scott.
12" x 5' Geared Head (3).
24" x 12' Pond Hollow Spindle Comp. Rest.

Drills and Radials

Sensitive 1, 2, 3, 4, and 6 Spindle.
24", 26" and 28" Sliding Head.
20" Barnes all geared.
3' Bickford Plain, Gear Box.
No. ½ Avey Bench High Speed (5)
3' Hildreth plain gear box.
3' Canedy-Otto Plain, new.

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No. 856 Toledo, 36" stroke, 15,000 lbs.
No. 35 Niagara, Stiles Type (2).
No. 6-A Willard, 3400 lbs. Inclinable.
No. 1½ Robinson 1500 lbs. inclinable (3).
Perkins Dbl. Crank 16" x 24" Bolster.

SPECIAL

Yates New Plate Grinders 36" and 66" capacity.

10 of each size

Miscellaneous

Hammers, 40 and 50 lb. Bradley.
Hammer, Toledo 5000 lbs. Friction Board.
Gear Cutter G & E, 36".
Oil Groover, Garvin, nearly new.
Compressors 8 x 8 and 10 x 12.
75 H.P. Motor, 220 volt, 3-phase.
Plating Dynamo, 2500 Amperes.

SOME BIG ONES: 84" x 84" x 32' Betts Planer; 4 Head Johnson 36" Motor Driven Lathe; 12' Boring Mill 2 Hds.

LUCAS
MACHINERY SERVICE

10 absolutely new 4" Pratt & Whitney Spline Millers with Countershafts, on original skids. Cost $1,200 each, will sell for . . **$600** each, f. o. b. Bridgeport.

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Large Stock
MACHINE TOOLS
for immediate delivery
We solicit your inquiries.
PETER A. FRASSE & CO., Inc.
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WANTED: No. 2 Universal Milling Machine, Brown & Sharpe, Cincinnati or Milwaukee preferred. Advise price, condition and age of machine.

CORLISS CARBON COMPANY
Bradford, Pa.

FOR SALE

3—2 x 24 J & L Turret Lathes.
1—20" x 7' Fay & Scott Combination Turret Lathe.
1—Small Rickert & Shafer Tapping Machine.
1—18" x 12' Lathe.
1—No. 4 Garvin Miller.
2—Pilton Bench Drill Presses.

ED. VERSTRAETE & SONS, 10 Railroad Pl. Newark, N. J.

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LATHES—PLANERS
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Write for our Latest Big Bulletin
ZELNICKER IN ST. LOUIS

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Consult it. Note the concerns advertising. They are well-known dealers and ready to serve you in an efficient manner.

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will help you find equipment not listed here—write us or send the coupon below. There is no charge for the service—we *want* to help you.

8-20

MACHINERY'S Green Section, Date.....
140-148 Lafayette Street, New York City.

I should like particulars in regard to the following used equipment:

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Name .....

Address .....

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REAMERS



High grade H. S. and Carbon Steel Reamers made to your order—*guaranteed to meet your needs.* Highly specialized equipment, an adequate working force and large quantities of raw material always on hand, enable us to promise 10 day deliveries on special work; our large stocks of standard reamers insure immediate shipment for all orders of tools on our list.

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Wanted—Accurate Holes
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Catalog No. 6 lists our stock of standard tools. Send for it.

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Non-corrosive Steel

High silicon, chromium steel. Completely resistant to fruit and acids.

Especially adaptable for exposed surfaces which have to withstand the combined action of salt water and the atmosphere, also for cutlery and surgical instruments. When hardened it is file hard. Does not warp, crack or check.

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A high silicon chromium alloy steel, intended to be used in the soft condition. Is more rust resisting than any other metal yet produced. Can be forged with ease, and when annealed can be easily machined.

Highly resistant to acids and high pressure steam. Will not corrode or erode.

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Heat Resisting Steel

Can be heated for months up to 1800° F. without any appreciable scale forming on surface.

Very resistant to the action of acids, organic or inorganic. Particularly adaptable for resistance wire elements, carburizing boxes, automobile valves, etc.

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Non-erodable, non-corrodable and non-oxidizable. Can be heated at 2000° F. for months without any material scale forming. Particularly adapted for electrical resistance elements. Can be readily hot rolled, cold drawn and machined.

Four New Ludlum Steels

After extensive investigations we have finally produced a *silicon chromium alloy steel* which has resulted in a more non-corrosive metal than any previous records have ever shown.

This new patented alloy can be forged and rolled with ease, hardened without difficulty and annealed so that it will machine easily. It is capable of taking a very high mirror finish, and is highly resistant to the action of nitric, sulphuric, hydrochloric, acetic and fruit acids, and also to atmospheric and salt water corrosion.

This remarkable alloy combination is also extremely durable at high temperature and has a very high specific resistance.

We are now using this new alloy in the formulæ of four new Ludlum Steels described in the panel at the left.

Prompt shipments from warehouse stock at Watervliet, N. Y.; Detroit, Mich.; Chicago, Ill.; or Cambridge, Mass., handled through our Branch Offices.

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New York City Philadelphia Pittsburgh

ESTABLISHED LUDLUM 1854

ROUILLARD 4 in 1 TOOL HOLDER

EVERY ONE INDIVIDUAL



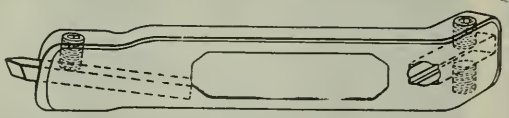
We Must Increase Factory Space to Keep Step With Sales Growth of This Remarkable Tool Holder. Study the Pictures—They Tell the Story

ROUILLARD 4 in 1 Tool Holder. Size No 3 (5/16″) cost you $7.00 where four of the usual or ordinary kind cost you from $12.00 up. Besides you save 75% in time "chasing" single holders for changes.

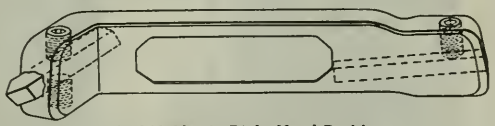
Ask for circular and our Guarantee. Better yet—send for a trial order, one will convince you.

Judge by comparison.

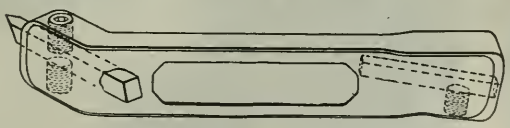
Here you see four tools in one with none of the shortcomings of the ordinary combination tool.



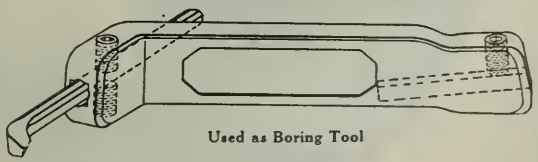
Tool Holder in Straight Position



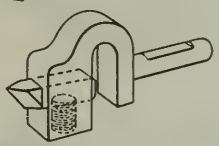
Tool Holder in Right Hand Position

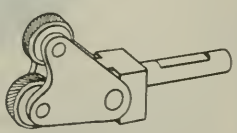


Tool Holder in Left Hand Position



Used as Boring Tool







Rouillard 3 in 1 Shaper Tool

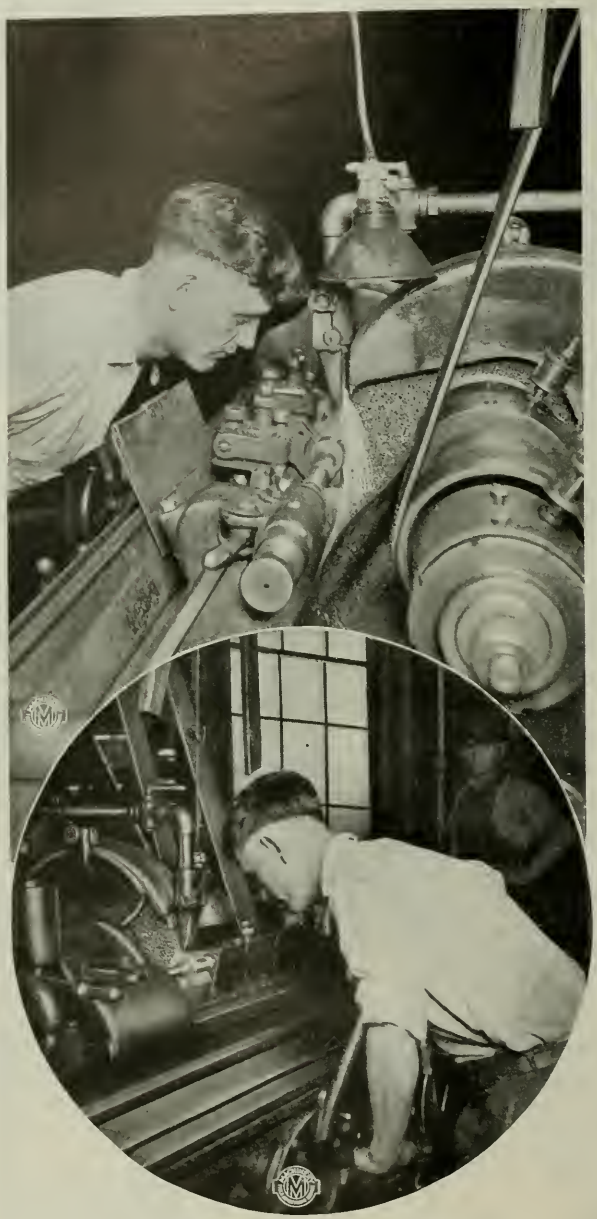
The Rouillard Shaper or Planer Tool Holder is a big brother to the Rouillard Universal. It is made expressly for shaper and planer work—has the rake left out, and makes good the claim that

"It always stays in the machine"

Straight—Right—Left

ROUILLARD TOOL CORPORATION, Philadelphia, Penna.

608 Chestnut Street



"Cadillac" Now Uses ECONOMY Grinding Lubricant

The Cadillac Motor Car Company, Detroit, have been using Economy Grinding Lubricant on about 30 grinding machines for the past six months. The photograph shows a Norton machine finishing a high carbon steel camshaft. "Economy" Lubricant is keeping the work cool, the wheel clean and is imparting a fine polish to the shaft.

The Cadillac grinding expert finds that by using "Economy" Lubricant the polish is much finer on ground work than is the case when soda water, oil or any other lubricant is used. The trouble experienced with these materials is their readiness to fill with dirt and the consequent tendency to glaze the wheel and scratch the work.

ECONOMY
EC
OMY

Trade Mark
Reg. U. S. Pat. Office.

With "Economy" Grinding Lubricant the dirt settles to the bottom of the tank, leaving the Lubricant always clean. Is it any wonder that "Economy" Lubricant is making good in the Cadillac plant?—and these same results can be duplicated in your case by using "Economy" Grinding Lubricants in your Grinding Machines. Write us for details.

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The specific data you must have in a hurry for any problem of machine shop, tool or drafting-room you will find in

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PEORIA, ILL. June 8, 1920

The Industrial Press,
140-148 Lafayette St.,
New York City, New York.

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Yours truly,
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TABLE OF CONTENTS

Mathematical tables, logarithms, areas, volumes, geometry, trigonometry, strength of materials, friction, bearings, cam design, spur, bevel, spiral, herringbone, epicyclic gearing, belts, pulleys, speeds, feeds, milling machine indexing, machine shop practice, tool-room practice, formulas for toolmaking, heat treatment of steel, foundry and pattern shop practice, welding, conversion tables, weights of materials, patent laws, drawing and blue printing, manufacturing shop appraisal.

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8-20

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CUTTING THE COST OF BUYING

FOR economical production it is necessary to locate factories where the labor and facilities are.

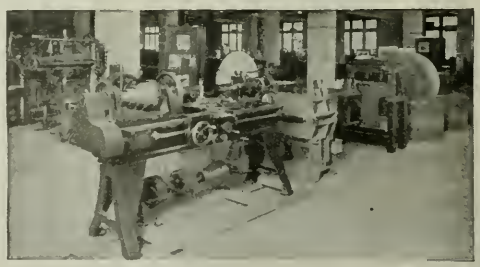
To sell economically it is necessary to send salesmen where sale possibilities abound.

To buy economically it is necessary for buyers to go where purchasing facilities exist.

The last statement applies with special force to foreign buyers. They lack the knowledge of the location of American factories or sales offices, the time to travel to them, and should not be obliged to incur the heavy expense of searching all over the United States for the goods they require.

International Exposition of Industries Reduces the High Cost of Buying

This exposition, centrally located in Grand Central Palace, in the heart of the commercial center of the world, holds under one roof the permanent exhibits and sales offices of nearly five hundred of America's leading manufacturers, with sales representatives in attendance and providing every facility for the display, demonstration and sale of products, appliances, and machinery.



BUYERS: Send for our free classified list of exhibitors and products. If contemplating a trip to New York, write or wire our Service Department to reserve hotel accomodation for you. Do not fail to visit the Exposition and see the displays of more than 450 American Manufacturers.

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Grand Central Palace New York



Our Specialties

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Beaver Falls Penna., U. S. A.

Branch Offices:

Chicago, Ill. Philadelphia, Pa.

Type A.S. Adjustable Speed RELIANCE MOTORS

To Change the Speed Turn the Handwheel



Are You Using the Motor Drive That Pays?

Between ordinary motor drive and machines driven by Type AS Motors there's a vast difference in production costs.

Ten years ago in the plant where this picture was recently taken, they purchased a Reliance Type AS Motor for individually driving a boring mill. Between then and now they have applied over 200 more Type AS Motors—many of them to belt-driven machines. And the increased production, better quality and lower costs from these machines have been so evident that all new machines are now purchased motor-driven.

The Type AS Reliance Motor on this Boring Mill enables the operator by simply turning the hand wheel to change speeds instantly without current loss and the horsepower output remains the same at all speeds.

Thus, he keeps cutting speeds at top notch as work changes. Type AS Reliance Motors run at any speed over any range up to 1 to 10.

Ponder this well. How else could you so assuredly increase production and obtain so many advantages that bring a bigger return? You'll need a copy of Bulletin 1014 to settle the question right, it is yours for the asking.

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Of The Ground Radial Relief Combination-center Drill and Reamer

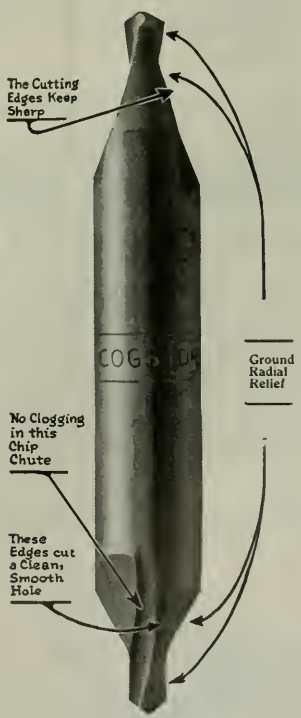
The COGS DRILL

By originators we mean exactly what we say.

We conceived the idea of grinding radial relief on the drill and countersinking portions of the center drill.

Conception with us meant action. We immediately proceeded to supply an article much in demand, therefore we believe credit will be awarded the persistent endeavor of the Cogsdill Manufacturing Co. for the ground center drill.

The Cogsdrill is the properly ground center drill. A test will conclusively demonstrate.



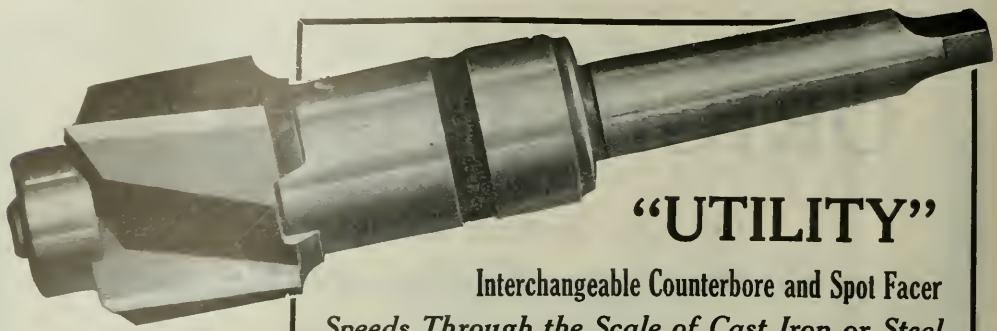
Cogsdill Mfg. Company

DETROIT MICHIGAN



Note the Spiral Fluted Chip Chute.

OUR CATALOG NO. 2 FOR THE ASKING



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Speeds Through the Scale of Cast Iron or Steel

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Careful and exacting buyers pick the "Utility" because of its unlimited capacity. We invite you to try this tool in your own shop on your own work—to make any comparison you please. Write us today.

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UP-TO-DATE DRAFTING METHODS *Number 8*

The Universal Drafting Machine

Beside his T-square the old-fashioned draftsman has a scale, a couple of triangles and a protractor lying loose on his board—all with a marked tendency to lose themselves.

The Up-to-Date draftsman, on the contrary, has all these tools combined in the Universal Drafting Machine with control centered under his left thumb and *his pencil never leaves his hand* as with swift, sure strokes he sets down his idea as fast as it develops in his brain.

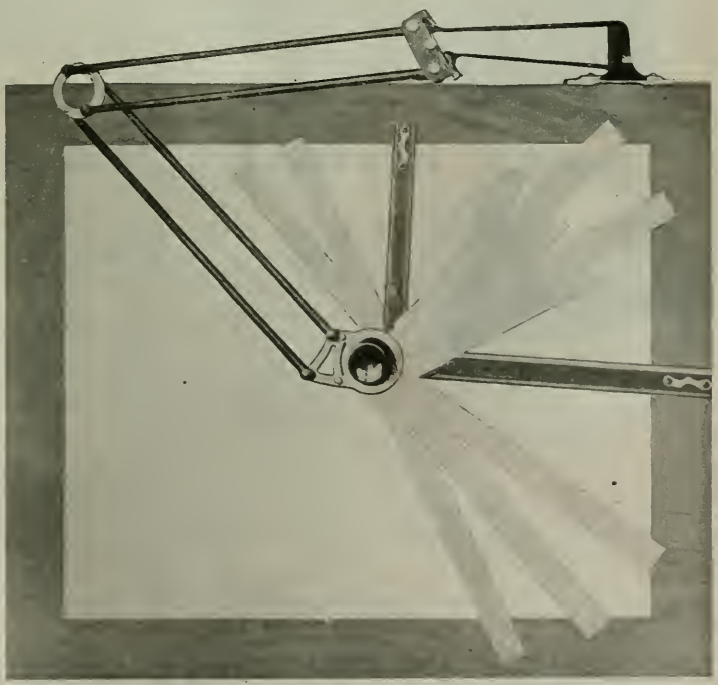
Old "T-square and Triangles," however, must toil through a succession of operations, laying down his pencil repeatedly to pick up first one tool and then another, constantly breaking his train of thought by the multiplicity of detail necessary to transcribe it.



Angle Work Is a Cinch

The Universal Drafting Machine has the 30°, 45° and 60° angles instantly available without referring to graduations and the "built-in" protractor permits setting the scales quickly and accurately at any other desired angle.





Other points to superiority of the Universal Drafting Machine are fully described in our 1920 Catalog and our 30 day, free trial offer will demonstrate their application to your work.

UNIVERSAL DRAFTING MACHINE COMPANY

CLEVELAND, OHIO, U. S. A.

WOLFRAM

HIGH SPEED STEEL of SUPERQUALITY



The Devil's Gold

THERE is a legend in the Tungsten Fields of Colorado which accounts for the likeness of Tungsten to Gold. The Devil, as is well known, long ago found gold the greatest source of trouble and evil to mankind. Therefore he got possession of vast deposits of the precious metal, and for centuries amused himself by plaguing men with it. Such a quantity, indeed, he accumulated, that there soon was more gold than there were men to plague, so that half his gold lay in glittering, useless heaps.

In a fiery rage because of this, he cried, "If I can not use my gold, then no one else shall!" and he waved his spiked tail once, twice, thrice. The gleaming yellow turned dull and dark, and behold the piles of gold were transmuted into mounds of black sand. When the gold miners passed that way they scarcely cast an eye upon it, for they knew it not for what it was. And the Devil laughed because of the trick his spite had played upon them.



But one day a wise man traveling through that country came unawares upon the Devil's gold, and, sitting on the ground to rest himself, let his fingers run idly through the dark sand. "'Tis strangely heavy," murmured he, "quite like to gold in weight." And so it was, for the Devil had not changed its weight at all (there are things the Devil himself can't do). The Wiseman then looked more closely and saw that it was a substance of great worth. Rising quickly he went back to his fellow-men and told them what he had found; and from that day to this the Devil's gold has been mined without ceasing, and no quiverings of the angry Devil's tail can alter its usefulness.



Parents in the Colorado Tungsten country, they say, still tell this legend to their children as proof that the ruler of the lower regions is not all-powerful. For Tungsten, with its many valuable properties, such as its stability and its high melting point (about 5400° F.), is just as necessary to men as gold.



Send us your inquiries

It is a peculiar co-incidence that the three things from which "Wolfram" High Speed Steel is named come from Colorado in the heart of the United States—the Wolf, the Mountain Ram, and Tungsten (another name for which is Wolfram). "Wolfram" is a fitting name for this typically American High Speed Steel.

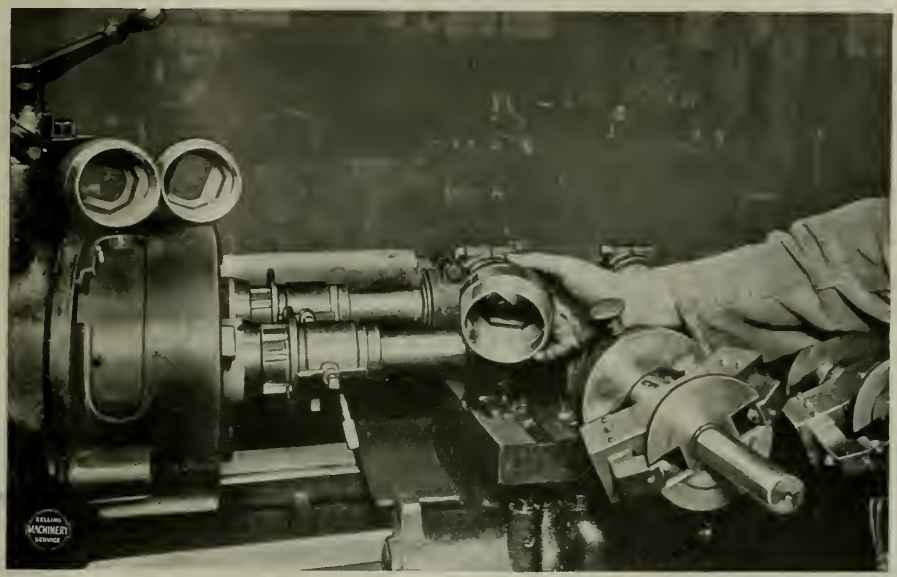
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Aliquippa *Established 1900* **Penna., U. S. A.**

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MURCHEY TAPS



Captured this Job on Speed

The "authorities" at the American Wire Wheel Corporation's plant, Buffalo, N. Y., are always open to conviction; if there's a better way of handling an operation they are ready to be shown. In this case it was Murchey Collapsing Taps that did the talking and what they said about cutting 12-pitch threads 3⅝" diameter by 1⅛" length in brass automobile hub caps closed the discussion. Of the four operations necessary to get the hub caps ready for use, threading is the most exacting and requires the least time to perform—with Murchey Taps.

Murchery Collapsing Taps and Expanding Dies have many advantages, among others chasers that recede when the thread is cut so that the tool can be *instantly* withdrawn. Murchey Tools are guaranteed for accuracy and speed. They are durable tools which we will be glad to have you put to the test. Any Murchey you select sent on approval. We also design special tools for special jobs.

At your service on any question pertaining to threads.

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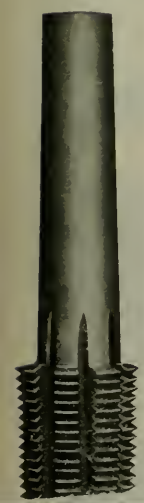




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By ERIK OBERG and FRANKLIN D. JONES

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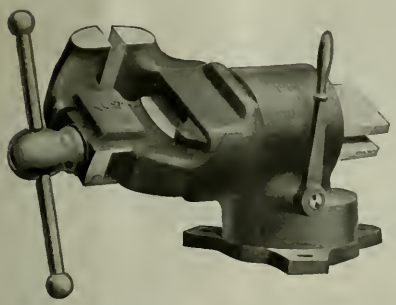
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Special Taps a Specialty

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A VISE FOR EVERY NEED

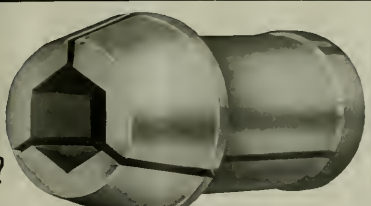


When the skilled mechanic—most critical of judges—needs a new vise he orders from the Yost catalog. He knows of old that it lists the vise he wants, the vise he can depend upon. His choice of Yost vises is entirely practical, he has neither time nor inclination for experiments in efficiency. And the Yost vise never "turns him down." Every job in the shop has its proper "holder" in the Yost line, materials, workmanship and service guaranteed.

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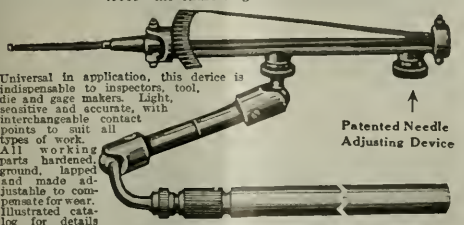


Then stop the waste of time by producing your square and hexagon holes by the old way.
Use the Watts method and drill your square and hexagon holes, either in lathe or drill press, from the hardest to the softest metal. The ONLY up-to-date method known; saves you 80 per cent in time. Time for drilling the hexagon spring collet shown is 2 minutes. No hand work. We have literature telling you how it is done. Write today.

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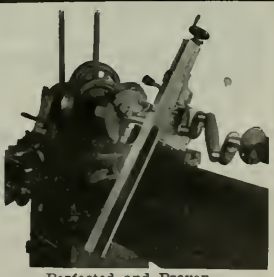
Universal in application, this device is indispensable to inspectors, tool, die and gage makers. Light, sensitive and accurate, with interchangeable contact points to suit all types of work. All working parts hardened, ground, lapped and made adjustable to compensate for wear. Illustrated catalog for details and prices.

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Manufactured by the
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No Jigs

The Weber Tool turns ALL Pins from ONE setting of the Crank Shaft, ON CENTERS. It is the only tool of its kind that will leave a pin absolutely parallel to the main bearings. The cutter used is a Forming Tool, cutting entire width of pin at once. A micrometer dial enables operator to gauge his cuts and turn all pins to a uniform size.



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How many times have you assembled a gas engine, knowing full well that the crank shaft needed trueing up? You did not want to send it out and delay your customer. You knew, too, that it would cost considerable to have it done.

With the Weber Tool you can do this work whenever necessary. NO DELAY—NO EXPENSE.

Why not do this work in your shop and have more satisfied customers and put more profits in your own pocket?

The Weber Tool is guaranteed to turn crank-pins within as close limits of accuracy as any other known method.

Picture at top shows Weber Tool in operation on 4-throw Crank Shaft. All four pins are turned and finished from this one setting. Write for Circular and prices.

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SAWYER-WEBER TOOL MFG. CO.
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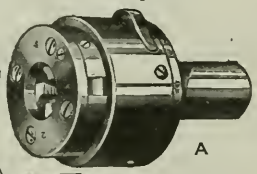
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A Complete Line of Transmission Machinery

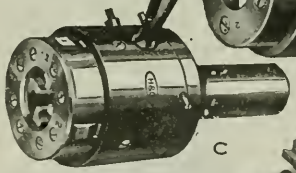
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H&G
DIE HEADS

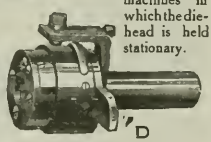
H & G dieheads are made in three standard styles, and each style in several sizes. They are adaptable to practically all machines on which threading is done.

Style A—is for automatics like the Cone, Gridley, National Acme, threading machines and bolt cutters in which the diehead rotates.





Style C—is for turret lathes, hand screw machines, and similar machines in which the diehead is held stationary.



Style D—is new and it is a masterpiece. It is especially designed for Brown & Sharpe automatics but can be used on other machines cutting small work.

Send for New 96 Page Catalog

This book is a real contribution to the science of thread-cutting and should be in the hands of every man in the business.

H & G Works—The Eastern Machine Screw Corp.
23-43 Barclay Street New Haven, Conn.



Wherever Costs Count

If machine work is part of the process, VIXEN FILES are welcomed, by both superintendent and labor.

VIXEN FILES do more work with less expenditure of energy and do it faster than any other type of file made. The teeth are so formed that they cut instead of scrape, at the same time that they shed the cuttings.

They cost more of course, but save money because they do more and can be sharpened and re-sharpened.

How much do they save?

Actual figures for you, if you write.

Vixen Tool Company, Newark, N. J.

VIXEN CURVED TOOTH FILES

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Tool chest economy means a "Union"—the chest of staunchest construction for enduring service. Built of solid oak, with top and bottom rabbeted in and frame joints lock-cornered, not dove-tailed, it outlasts the tools it contains.

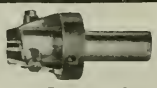
UNION TOOL CHESTS are built in 24 styles and sizes—ONE OF WHICH IS JUST THE KIND YOU WANT. An economical chest for every mechanic's needs. They are all sold on a "Satisfaction or Money-back" guarantee. Just look them over and be convinced.



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Save Steel, Time and Labor

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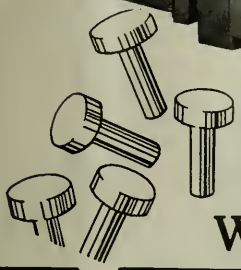
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REIFF & NESTOR CO., Lykens, Pa.

Watson
TANGENT CUT BOX TOOLS

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QUALITY
WITH
WATSON
TANGENT CUT
BOX TOOLS





This is Model D—Strong Rigid Compact—Look it over

All movable parts in this tool are mounted on strong one-piece steel body, so designed as to allow ample chip clearance—no clogging.

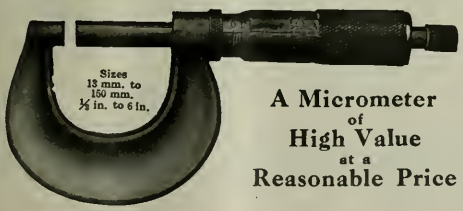
All movable parts travel in straight lines, providing proper bit clearance and work support at proper angles for all diameters. All movements backed up by direct thrust screws, allowing for sensitive adjustment and providing permanent lock when adjustment is made.

Cutting tool can be removed, ground and replaced without changing a single adjustment.

Be assured of quality and quantity production by using up-to-date Box Tools. Write for detailed information.

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The Reed "Reliable"



A Micrometer
of
High Value
at a
Reasonable Price

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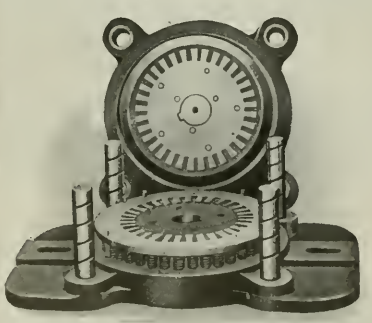


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Tools and Dies for same. Quality products at right prices. Send your blue prints, our prices and delivery will interest you.

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Our method gives you complete control of the work we are doing for you, while it is in progress, throughout the various steps—if you wish it—so that it is actually under your supervision, or, if you prefer we can relieve you of both supervision and detail; —such is our ability.

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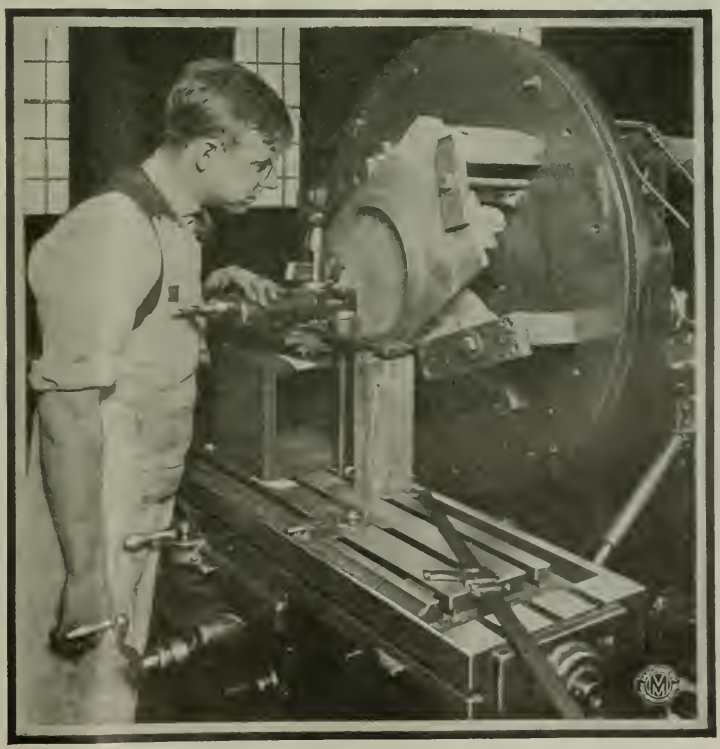
Our designers bring to each new problem the cumulative knowledge that comes from practice and long experience in making tools for particular manufacturers.

You reap the benefit when you place your order with us—whether for Dies, Jigs, Gages, Fixtures or other Special Equipment.

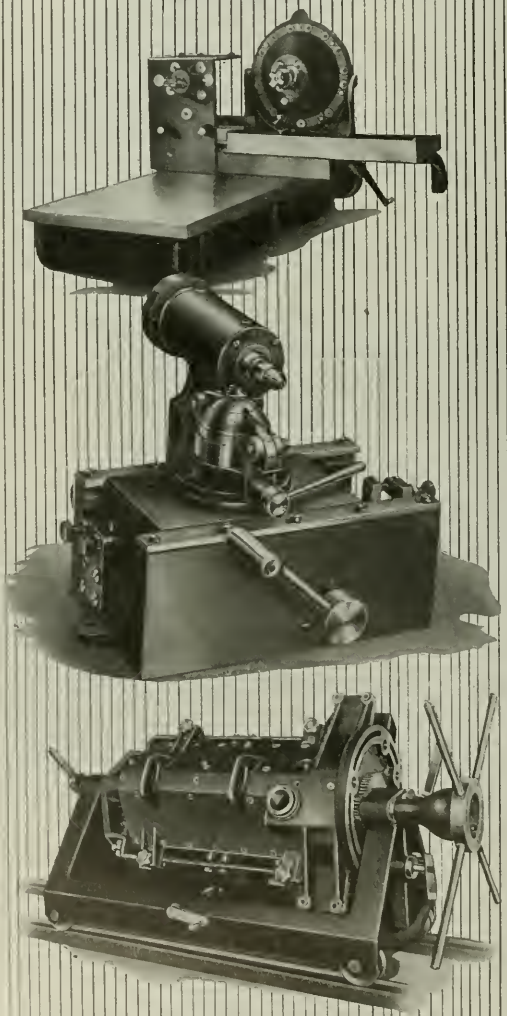
We would be glad for an opportunity to estimate.

URBANA TOOL & DIE COMPANY

URBANA **OHIO, U. S. A.**



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Insures Tools, Jigs and Fixtures That Guarantee the Accuracy of Your Finest Machines

The accuracy required in the manufacture of interchangeable parts is most economically achieved by the use of accurate and convenient jigs and fixtures.

Carroll Tools insure correct construction for intricate machine parts; engineers who know their business design the thoroughly practical jigs, fixtures, etc., that make big output possible on the most intricate work.

Are you planning something new? Carroll Engineers can help you make it economically.

Are you handling old work in a cumbersome way? Let Carroll Engineers simplify your manufacturing methods. They are at your service for whatever work you have to do.

THE CARROLL ENGINEERING CO.

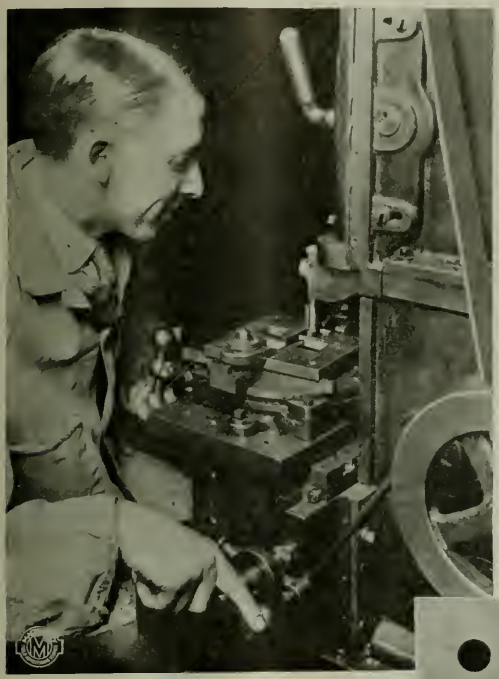
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Carroll ENGINEERING SERVICE

RELIANCE SERVICE



Toolroom, Contracting and Manufacturing Departments

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"From Idea to Finished Product"

is our slogan and we offer you the most advantageous form of service anywhere along the line — quality, delivery and cost.

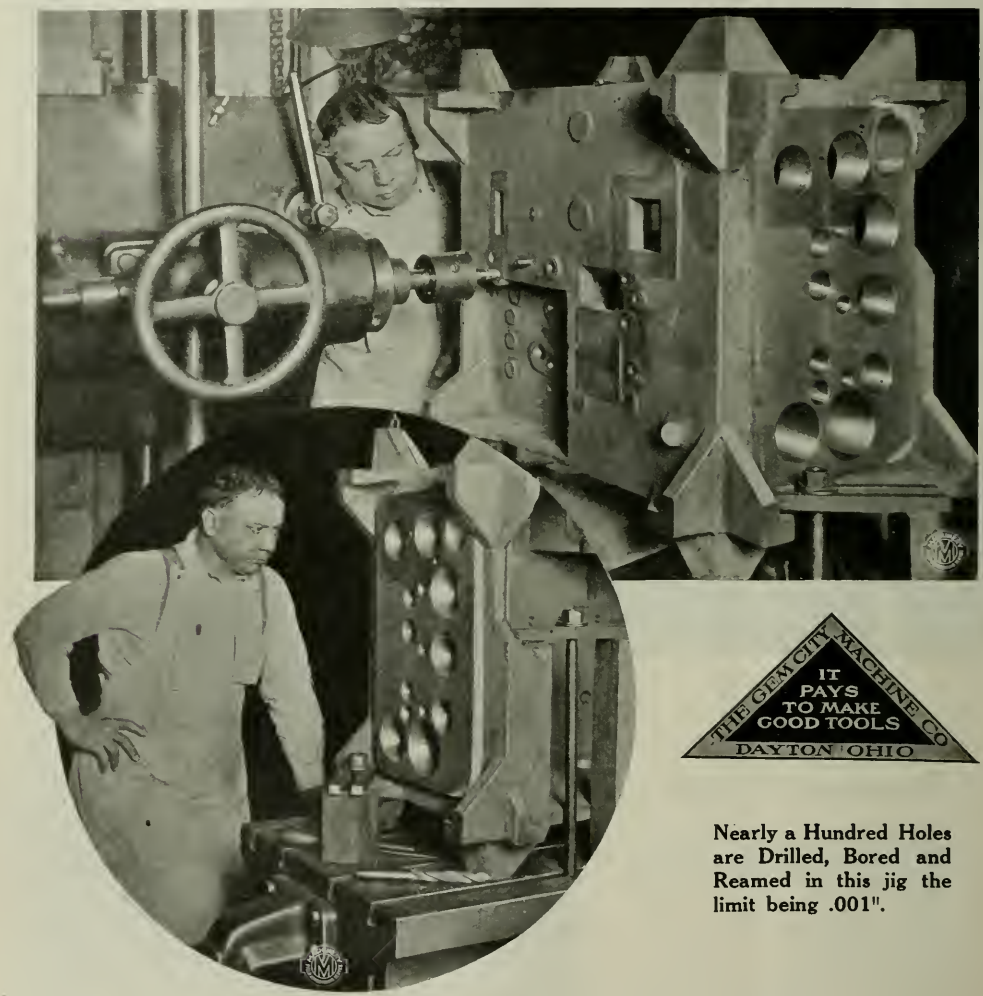
The accompanying photographs were taken in our die making department. The stripper plate shown complete and in process of machining is designed for use in stamping fan blades.

Tell us how we may serve you.

RELIANCE DIE & STAMPING COMPANY

515 North LaSalle Street CHICAGO, ILLINOIS, U. S. A.

Complicated Precision Jigs Present No Difficulties to Our Completely Equipped Plant



Nearly a Hundred Holes are Drilled, Bored and Reamed in this jig the limit being .001".

A mighty good boring job, you'll say. A hundred, odd, holes drilled, bored and reamed, and every one plus or minus .001" *at most.* Some of these holes are at an angle with the face of the other holes—the determination of such angles must be accurate. Some of the holes are for establishing gear centers—you know what that means. Interesting to note that there are 138 bushings, permanent and slip, in this jig. May we help you out? Write.

THE GEM CITY MACHINE COMPANY

Manufacturing Machinists

434 East First St. **DAYTON, OHIO**

Brehm Trimming Dies

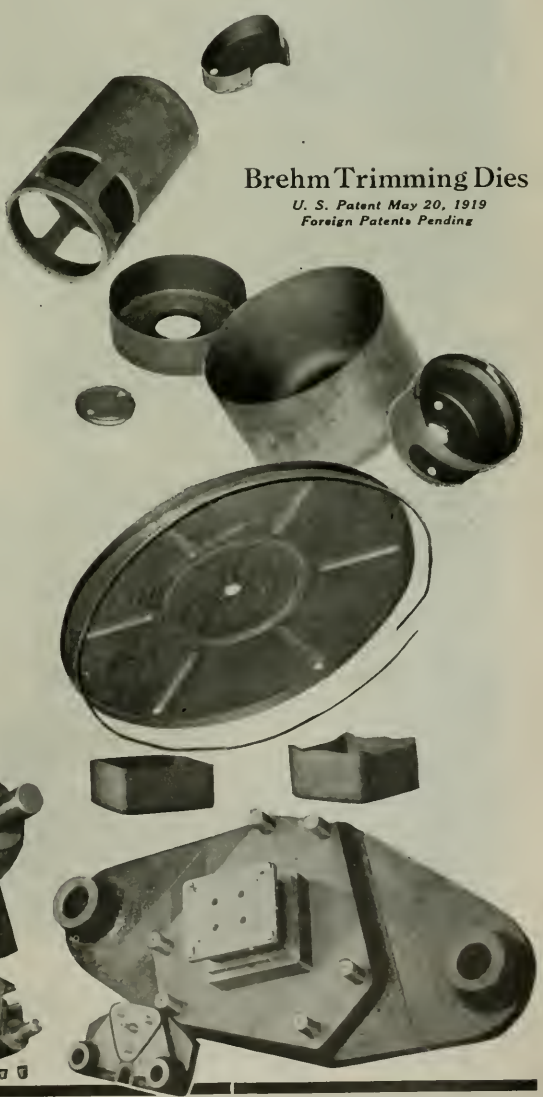
Cut Trimming Costs Three to Four Hundred Per Cent.

Below are two sets of Brehm Trimming Dies with "before and after" samples of their work. The large set trims switch boxes, 8″ square by 4″ deep, made of 1/16″ metal, at the rate of 750 per hour. The small die is used for ferrules—⅝″ diam., 9/16″ deep of 1/32″ metal — which are trimmed at a minimum rate of 1000 per hour.

Compare these figures with results obtained on similar work trimmed in a lathe or cutting-off machine and you'll readily understand why Brehm Trimming Dies are so extensively used for trimming practically all classes of stampings.

"Products" of some recently developed Brehm Dies are here shown together with a sketch illustrating the cam-actuated three-way motion by which the die strips off the superfluous metal. Estimates from samples or blueprints. Details on request.

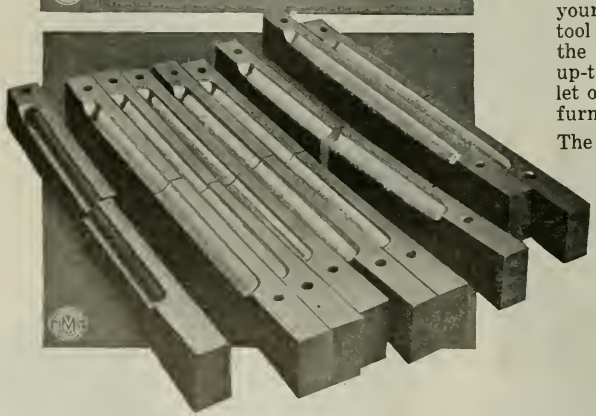




CITY ENGINEERING CO.
DAYTON, OHIO
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GAGES - SPECIAL MACHINERY







Put Our Roof Over Your Toolroom

Let us shoulder the responsibility for the production of your DIES, TOOLS, JIGS, FIXTURES and GAGES. Make our tool department your tool department. Entrust us with this part of your work—put our roof over your die, tool and jig division. We are equal to the largest demands. Equipment right up-to-the-minute. And our work—well, let our customers speak for that. We'll furnish list of clients on request.

The accompanying pictures show a number of Louver die sections for piercing and forming automobile hoods. These dies are built up in sections. The milling machine operation shows the roughing of one of these sections—note the curved lines in these pieces.

Drop us a line for particulars of "Columbus" Service.

THE COLUMBUS DIE, TOOL & MACHINE CO.

COLUMBUS OHIO, U. S. A.



Let Us Be Your Toolroom

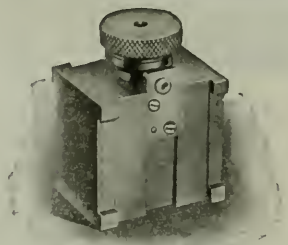
Quality, Prompt Delivery, Fair Price



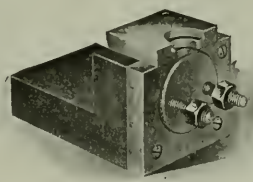
Tool-room swamped with work? Impossible to keep pace with the demands of modern shop practice?

Let us lend a hand.

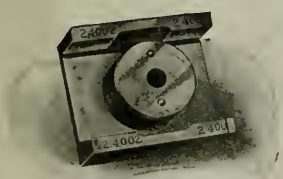
We're equipped to design and construct tools, dies, jigs, gages, etc., of the highest order, and are official tool-makers to many of the largest and most successful manufacturers in the country.



Tools, Dies, Jigs, Gages, Fixtures and Special Machinery.



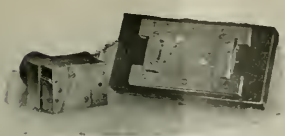
Foolproof, Easy to operate, Productive and Economical



Our "tool-room" occupies 35,000 square feet of floor space and contains 200 up-to-date machines. Our working force is 300 strong—the pick of the country's most skilful mechanics, and we have specialized for years on work such as the average tool-room has difficulty in handling.

We offer a real service to rapidly expanding industries which are handicapped in reaching or maintaining the necessary production: up-to-date tools that are foolproof, easy to manipulate and assure the largest possible production at minimum cost.

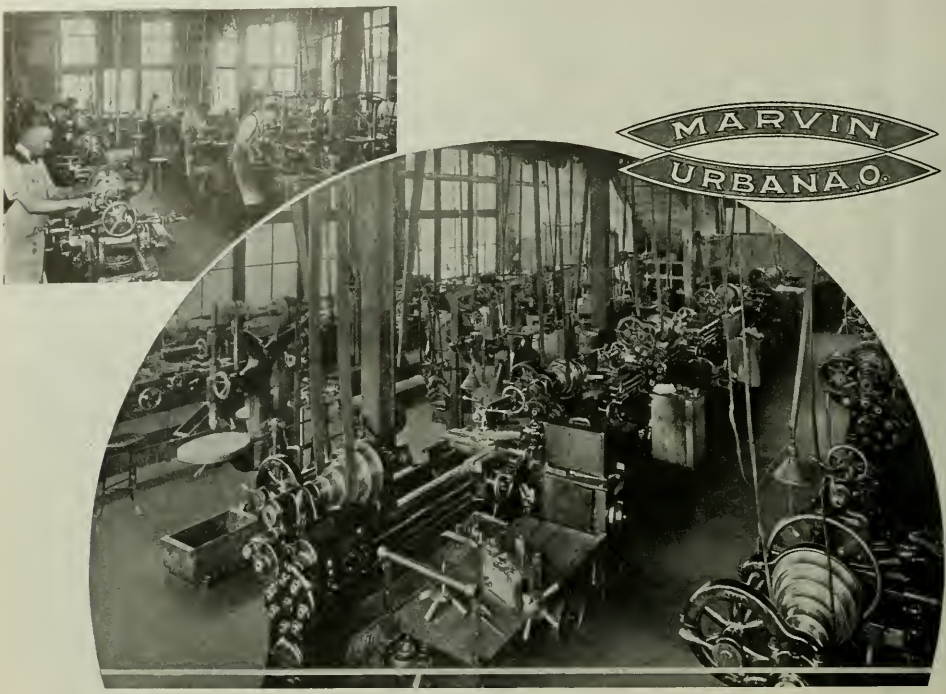
Let us estimate on your requirements.





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Equips Each Department With the Finest Machines for the Work

The "parts that make the whole" never received closer attention than in the Marvin endeavor to live up to their code of "Perfect Service."

Each machine in each department is as carefully considered as though the accuracy of each piece of work depended solely on the operation performed there.

The photograph shows one end of our lathe department equipped with standard machines of the most modern type, many of them especially arranged to meet our needs, all of them invaluable in the production of the fine tools and special machines manufactured by us.

Marvin Service and Marvin Products are the result of our carefully calculated effort to make Tools and Special Machinery in the way that is most profitable to our customers and ourselves. Try us.



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There are so many factors entering into the production of dies that the only way of being sure you are right is to see they have the right name behind them.

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We have recently produced a number of Dies for some of the largest concerns in the country. The completion of these contracts leaves us open for your business.

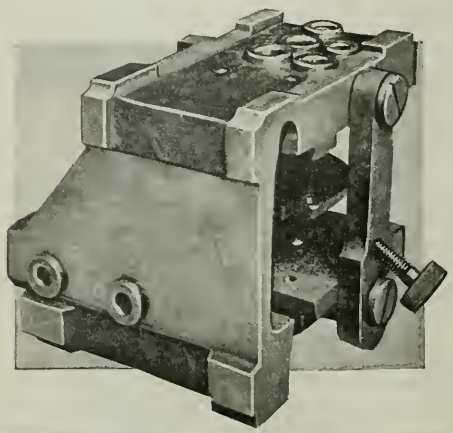
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We are toolmakers to manufacturers who are particular about their work. May we show you what we can do?

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Write for samples and prices.

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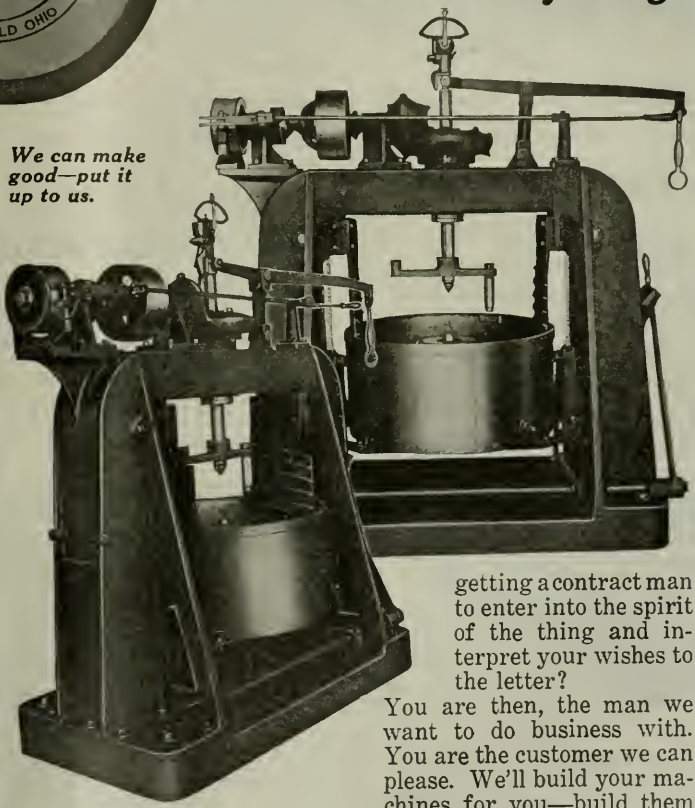
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DIES, JIGS, SPECIAL MACHINERY
Screw Machine Products
Spur Gear Cutting—Metal Stampings
THE LANG MANUFACTURING WORKS
OLEAN, N. Y., U. S. A.

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WE DESIGN and BUILD • SPECIAL • MACHINERY
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EFFICIENCY
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We'll Tackle Anything!

We can make good—put it up to us.



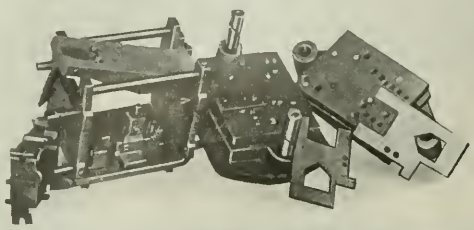
HAVE you ever found it necessary to build special machines for a special purpose? And couldn't build them yourself for various reasons? And then become thoroughly discouraged at the difficulty you found in getting a contract man to enter into the spirit of the thing and interpret your wishes to the letter?

You are then, the man we want to do business with. You are the customer we can please. We'll build your machines for you—build them the way you would do it yourself. And we don't care how intricate they come, either. If you have not entirely worked out your requirements tell us what you wish to accomplish and we'll develop the machinery for you.

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SIMPLE, ACCURATE AND ECONOMICAL

Quality and Prices Right

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Save time, tools and operations; eliminate grinding in many cases; beat the reamer at its own job. Adjustable to .00025".

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Tools, Jigs, Fixtures, Gages, Punches and Dies

Quality and Service Our Motto

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Moore-Eastwood Tools, Dies, Jigs *and* Special Machines

Quantity, quality and cost of production are decided to a great extent by the tools that are used. The best tools produce the best results—always. Try ours.

The Moore-Eastwood Mfg. Company
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GRAY JAEGERS—from the Jaegersfontein mine, South Africa—91 stones weighing 273 carats, average 3 carats. Used for heavy work on large emery wheels. About two-thirds actual size.

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The Wheel Trueing Tool Company stands entirely alone in the industrial diamond field as a house of bonifide service.

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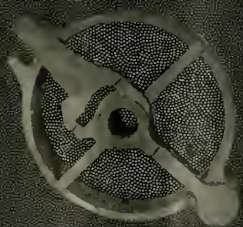
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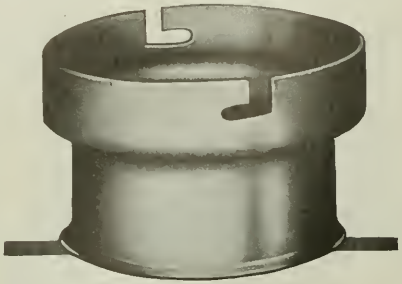
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SITUATIONS, HELP WANTED, FOR SALE, ETC.

Advertisements in this section, 25 cents a line, seven words to a line—minimum, $1.50. The money should be sent with the order. Answers addressed to our care will be forwarded. Original letters of recommendation should not be enclosed to unknown correspondents.

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WANTED: Experienced Mechanical Draftsman. State qualifications and salary wanted. E. and T. FAIRBANKS and CO., St. Johnsbury, Vt.

WANTED: MEN with machine shop practice and some technical training to become Methods and Time Study Men. S. F. BOWSER & CO., INC., Fort Wayne, Ind.

WANTED—DRAFTSMEN, experienced on tools, special and automatic machinery. State age, experience and salary wanted. Box 325, care MACHINERY, 148 Lafayette St., New York.

MANUFACTURING CONCERN wants men to open office and manage salesmen; wonderful opportunity to make big money; from $500 to $2,000 necessary. Write Director of Sales, CONNERY MACHINE & TOOL CO., Springfield, Mass.

WANTED: OFFICE MANAGER for large factory manufacturing small tools. Also manager for small tool department of large company selling small tools. Only thoroughly competent, efficient and able men should apply. State experience and salary wanted. Box 322, care MACHINERY, 148 Lafayette St., New York.

MACHINISTS WANTED—Positions are open for the following: Bench and floor men, milling machine hands, radial drill operators, key seaters, shaper hands, J. & L. screw machine operators, boring mill hands (vertical and horizontal). Steady work in open shop, with good compensation, ideal living and working conditions. Address Employment Office, Dept. 32, KENT-OWENS MACHINE CO., Toledo, Ohio.

WANTED.—FIRST CLASS MACHINIST of practical experience, marine work preferred, to take charge as foreman of a fairly well equipped machine shop employing 15 to 25 men. Character, energy and ability required. Open shop, no labor trouble. State experience, past employment and earnings. Box 211, care MACHINERY, 148 Lafayette St., New York.

FOREMAN WANTED to take charge of tool room of large Middle West manufacturing plant, building heavy machinery and contractors equipment. Must possess wide experience and be capable of handling men. State in your first letter education, age, nationality, experience, salary expected and when; answers held in strictest confidence. Box 324, care MACHINERY, 148 Lafayette St., New York.

WANTED: GENERAL SUPERINTENDENT for plant in Middle West employing from 125 to 150 men, manufacturing track, hangers, and building specialties. To take complete charge of production, including drafting and engineering departments. Must have had previous successful experience. Give references, age, and state salary expected. Box 318, care of MACHINERY, 148 Lafayette St., New York.

WANTED, — THOROUGHLY COMPETENT MECHANIC between 30 and 50 years of age for Master Mechanic to take charge of machine shop and press room of large shop manufacturing household utensils. Must be experienced designer of tools for this manufacture in steel and aluminum. Give full confidential details of past experience with references in first letter—also state salary expected. Box 307, care MACHINERY, 148 Lafayette St., New York.

DEMONSTRATOR with selling ability who is thoroughly familiar with machine shop practice, to demonstrate and sell the cutting lubricants of an old established concern in New York and Western New England. This is an excellent opportunity for a man whose qualifications are such that he could expect eventually to assume charge of his department. A reply should state age, training, experience and salary expected. Box 323, care MACHINERY, 148 Lafayette St., New York.

HELP WANTED

WANTED.—ENGINEER for research, experimental, testing and developing improvements of our standard lines of brushes, hardwares, novelties, etc. Applicant should have a technical education as well as practical mechanical experience. Excellent opportunity for advancement. Location, Cleveland, Box 330, care MACHINERY, 148 Lafayette St., New York.

WANTED.—ASSISTANT SUPERINTENDENT for iron foundry, pattern and machine shop, employing about 100 men; strictly open shop. Technical graduate with good shop experience preferred. In answering, advise training and practical experience and salary to start. Box 212, care MACHINERY, 148 Lafayette St., New York.

SPECIALTY TOOL SALESMEN. Write us regarding territory yet open for the sale of our Robinson Adjustable Point Center for all makes of lathes and grinders. This tool is an immediate result-producing proposition and a splendid and profitable line for you to carry. THE CLEVELAND CENTER CO., 3741 E. 93rd St., Cleveland, O.

WANTED.—ASSISTANT FOREMAN for machine shop employing 90 hands. Must be familiar with modern manufacturing methods on drill presses, milling machines and automatic screw machines. Someone familiar with instrument work preferred. Good opportunity for right party. In answering state experience and salary desired. Box 308, care MACHINERY, 148 Lafayette St., New York.

SITUATIONS WANTED

WANTED BY A YOUNG MAN, a position as mechanical superintendent. Has had twelve years of technical and practical experience, also has made extensive study of modern production methods. Box 326, care MACHINERY, 148 Lafayette St., New York.

MECHANICAL EXPERT, toolmaker, age 42; 27 years broad practical experience on all kinds of high-grade tools and production; up-to-date, can take full charge, estimate, planning or any responsibility. Salary, $60-$65 a week. Box 331, care MACHINERY, 148 Lafayette St., New York.

PRODUCTION MANAGER OR INDUSTRIAL ENGINEER, with eleven years experience in the automotive field, having direct charge of manufacturing, and possessing executive ability, pleasing personality and excellent character, desires a position as assistant to General or Works Manager. References and further detailed information will be gladly furnished upon request. Address Box 329, care of MACHINERY, 148 Lafayette St., New York.

SUCCESSFUL EXECUTIVE desires position as general superintendent or manager. Has thorough mechanical training. Familiar with the manufacture of machine tools or production specialties. Connected with the same firm for the last three years. Knows how to conduct business relations and credits. Speaks several languages besides English. Can be an excellent representative for a firm that wishes to establish direct connections for a European trade. Box 332, care MACHINERY, 148 Lafayette St., New York.

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PATENTS SECURED.—C. L. PARKER, Ex-member Examining Corps, U. S. Patent Office. Instructions upon request. McGill Building, Washington, D. C.

AUTOMATIC STREET CAR ANNUNCIATOR. Registers name of streets one block ahead automatically. Will accept royalty, or sell outright. HENRY J. APPLETON, 700 Sixth St., Detroit, Mich.

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WANTED.—MANUFACTURER for patent wire splicing plier containing ratchet spool, weight twenty ounces. A. F. MOORE, New Madrid, Mo.

A MACHINERY SELLING ORGANIZATION wants a company to finance and build patented machine. Write E. F. S., 11516 Kimball Ave., Richmond Hill, L. I.

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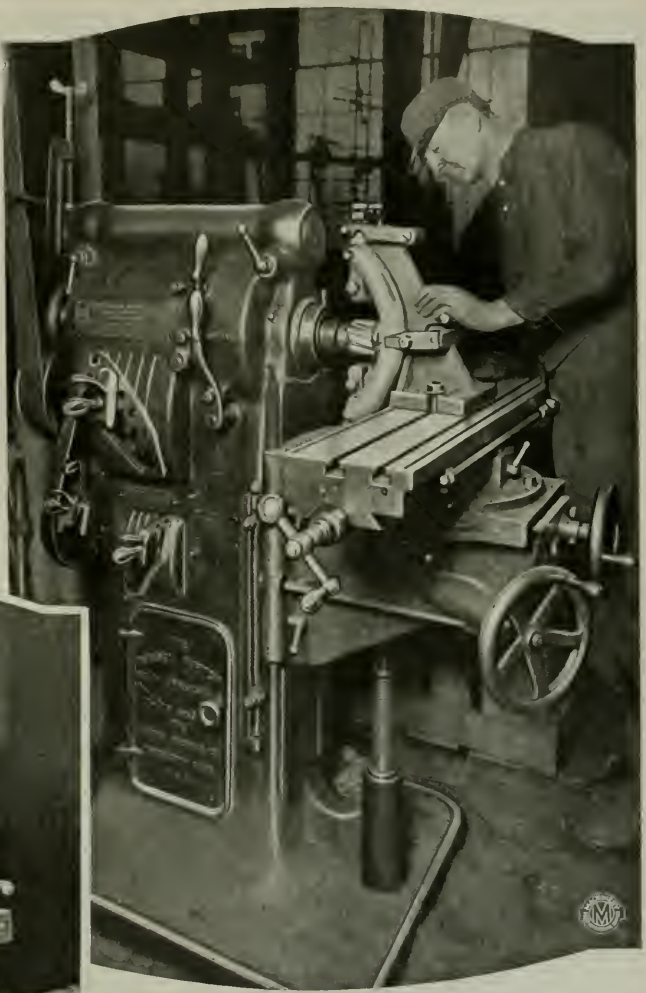
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Williams & Co., J. H., 61 Richards St., Brooklyn, N. Y.

Callpers, Bow
Brown & Sharpe Mfg. Co. Providence, R.I.
Consolidated Tool Works, Inc., 261 Broadway, New York.
Goodell-Pratt Co., Greenfield, Mass.
Greenfield Tap & Die Corp., Greenfield, Mass.
Starrett Co., L. S., Athol, Mass.

Callpers, Micrometer
Almond Mfg. Co., T. R., Ashburnham, Mass.
Brown & Sharpe Mfg. Co. Providence, R.I.
Consolidated Tool Works, Inc., 261 Broadway, New York.
Goodell-Pratt Co., Greenfield, Mass.
Reed Small Tool Wks., Worcester, Mass.
Slocomb Co., J. T., Providence, R. I.
Starrett Co., L. S., Athol, Mass.

Cams
American Machine & Foundry Co., 5520 Second Ave., Brooklyn, N. Y.
Bath & Co., Inc., John, Worcester, Mass.
Boston Gear Wks. Norfolk Downs, Mass.
Garvin Mch. Co., Spring and Varick Sts., N. Y.
Rowbottom Mch. Co., Waterbury, Conn.

Case-Hardening
Kasenit Co., 33 So. William St., N. Y.
Meisel Press Mfg. Co., 918 Dorchester Ave., Boston, Mass.
Steel Improvement & Forge Co., Cleveland, O.
Williams & Co., J. H., 61 Richards St., Brooklyn, N. Y.

Case-Hardening Compound
Buchanan Chemical Co., C. G., Cincinnati, O.
Kasenit Co., 23 So. William St., N. Y.

Case-Hardening Furnaces
See Furnaces, Case-Hardening.

Castings, Brass, Bronze and Aluminum
Ajax Metal Co., Philadelphia, Pa.
American Foundry Co., Newark, N. J.
Erie Bronze Co., Erie, Pa.
Light Mfg. & Fdry. Co., Pottstown, Pa.
Lumen Bearing Co., Buffalo, N. Y.
Machinery Co. of America, Big Rapids, Mich.
Newman Mfg. Co., Cincinnati, O
Sterling Special Co., Newcomerstown, O.

Castings, Die or Die-Molded
Acme Die-Casting Corporation, Brooklyn, N. Y.
Chatham Die Casting Co., Inc., 128 Mott St., New York.
Die Casting Co. of Ohio, Toledo, O.
Doehler Die-Casting Co., Court and Ninth Sts., Brooklyn, N. Y.
Erie Bronze Co., Erie, Pa.
Franklin Die-Castiog Corp., 738 Gifford St., Syracuse, N. Y.
Legler-Eilerman Co., Dayton, O.
Light Mfg. & Foundry Co., Pottstown, Pa.
Mt. Vernon Die-Casting Corp., Mt. Vernon, N. Y.
Precision Castings Co., Inc., Syracuse, N. Y.
Stewart Mfg. Corp., 4535 Fullerton Ave., Chicago, Ill.
Superior Die-Casting Co., Cleveland, O.
Veeder Mfg. Co., 39 Sargeant St., Hartford, Conn.

Castings, Gray Iron
Brady Foundry Co., Jas. A., 4514 Western Ave., Chicago, Ill.
Brown & Sharpe Mfg. Co. Providence, R.I.
Cresson-Morris Co., Philadelphia, Pa.
Hanson Clutch & Mchy. Co., Tiffin, O.
Hooven, Owens, Rentschler Co., Hamilton, O.
Machinery Co. of America, Big Rapids, Mich.
Whitcomb-Blaisdell Mch. Tool Co., Worcester, Mass.

Castings, Steel
Cresson-Morris Co., Philadelphia, Pa
Farrell-Cheek Steel Foundry Co., Sandusky, O.
Hooven, Owens, Rentschler Co., Hamilton, O.
Ohio Steel Foundry Co., Springfield, Ohio.

Castings, Malleable
Link-Belt Co., Chicago, Ill.

Castings, Nichrome
Driver-Harris Co., Chicago, Ill.

Cement, Disc Grinding Wheel
Badger Tool Co., Beloit, Wis.

Centering Machines
Hendey Mch. Co., Torrington, Conn.
Newton Mch. Tool Works, Inc., Philadelphia, Pa.
Niles-Bement-Pond Co., 111 B'way, N.Y.
Porter-Cable Mch. Co., Syracuse, N.Y.
Pratt & Whitney Co., Hartford, Conn.
Standard Eng. Wks., Pawtucket, R.I.
Whiton Mch. Co., D. E., New London, Ct.

Centers, Ball Bearing, Lathe
Kell, Hock Sales Co., Newark, N. J.

Centers, Planer and Miller
Cincinnati Planer Co., Cincinnati, O.
Federal Steel Co., Detroit, Mich.
Greenfield Tap & Die Corp., Greenfield, Mass.
Morse Twist Drill & Machine Co., New Bedford, Mass.

Chain Blocks
See Hoists, Chains, etc.

Chains, Driving, Etc.
Baldwin Chain & Mfg. Co., Worcester, Mass.
Boston Gear Wks., Norfolk Downs, Mass
Diamond Chain & Mfg. Co., Indianapolis, Ind.
Frasse & Co., Inc., Peter A., 417 Canal St., N. Y.
Link-Belt Company, Chicago, Ill.
Morse Chain Co., Ithaca, N. Y.
Morton, Thomas, 245 Centre St., N.Y.
Whitney Mfg. Co., Hartford, Conn.

Checks, Time, Tool and Pay
Matthews & Co. Jas. H. Pittsburgh, Pa.
Noble & Westbrook Mfg. Co., Hartford, Conn.
Pannier Bros. Stamp Co., Pittsburgh, Pa.
Schwerdtle Stamp Co., Bridgeport, Ct.

Chisel Blanks
Hunter Saw & Mch. Co., Pittsburgh, Pa.

Chucking Machines, Automatic
Gisholt Mch. Co., 9 So. Baldwin St., Madison, Wis.
Long-Henkel Mfg. Co., Reading, Pa.
McDonough Mfg. Co., Eau Claire, Wis.
New Britain Mch. Co., New Britain, Ct.
Potter & Johnston Mch. Co., Pawtucket, R. I.

Chucking Machines, Semi-Automatic
Brown & Sharpe Mfg. Co. Providence, R.I.
Gisholt Mch. Co., 9 So. Baldwin St., Madison, Wis.
National Acme Co., Cleveland, O.
New Britain Mch. Co., New Britain, Ct.
Wood Turret Mch. Co., Brazil, Ind.

Chucking Machines, Multiple Spindle, Automatic
McDonough Mfg. Co., Eau Claire, Wis.
New Britain Mch. Co., New Britain, Ct.

Chucks, Air
Bardons & Oliver, Cleveland, O
Frontier Chuck & Tool Co. Buffalo, N.Y.
Garvin Mch. Co., Spring and Varick Sts., N. Y.
Manufacturers Equipment Co., Waller and Fillmore Sts., Chicago, Ill.
Nelson-Blanck Mfg. Co., Detroit, Mich.
Payson Co., Frank G., 9 So. Clinton St., Chicago, Ill.

Chucks, Drill
Almond Mfg. Co., T. R., Ashburnham, Mass.
Cleveland Twist Drill Co., Cleveland, O.
Cushman Chuck Co., Hartford, Conn.
Detroit Twist Drill Co., Detroit, Mich.
Eastern Tube & Tool Co., Inc., B'klyn, N. Y.
Goodell-Pratt Co., Greenfield, Mass.
Federal Steel Co., Detroit, Mich.
Greenfield Tap & Die Corp., Greenfield, Mass.
Horton & Son Co., Windsor Locks, Ct.
Jacobs Mfg. Co., Hartford, Conn.
Johnson, Inc., C. E., Poughkeepsie, N. Y.
Marvin & Casler Co., Canastota, N. Y.
McCrosky Tool Corp., Meadville, Pa.
Modern Tool Co., 2nd and State Sts., Erie, Pa.
Morse Twist Drill & Machine Co., New Bedford, Mass.
Narragansett Mch. Co., Providence, R.I.
National Twist Drill and Tool Co., Detroit, Mich.
Newman Mfg. Co., Cincinnati, O.
Nielsen-Barton Chuck Co., 106 South Jefferson St., Chicago, Ill.
Skinner Chuck Co., New Britain, Ct.
Standard Tool Co., Cleveland, O.
Titan Tool Co., Erie, Pa.
Trump Bros. Mch. Co., Wilmington, Del.
Union Mfg. Co., New Britain, Conn.
Watts Bros. Tool Works, Turtle Creek, Pa.
Westcott Chuck Co., Oneida, N. Y.
Whiton Mch. Co., D. E., New London, Ct.

Chucks, Eccentric Boring
Marvin & Casler Co., Canastota, N. Y.
Meyers Gage Co., W. F., Bedford, Ind.

Chucks, Full Floating
Fairbanks Co., 416 Broome St., N. Y.
Watts Bros. Tool Works, Turtle Creek, Pa.

Chucks, Gear
Garrison Machine Works, Dayton, O.

Chucks, Lathe, Etc.
Almond Mfg. Co., T. R., Ashburnham, Mass.
Cushman Chuck Co., Hartford, Conn.
Foster Machine Co., Elkhart, Ind.
Gisholt Mch. Co., 9 So. Baldwin St., Madison, Wis.
Hardinge Bros., Inc., Bertean and Ravenswood Avea., Chicago, Ill.
Herbert, Ltd., Alfred, 54 Dey St., New York.
Hoggson & Pettis Mfg. Co., New Haven, Conn.
Horton & Son Co., E. Windsor Locks, Conn.
McCrosky Tool Corp., Meadville, Pa.
Moller Mch. Co., New Rochelle, N. Y.
Newman Mfg. Co., Cincinnati, O
Payson Co., Frank G., 9 So. Clinton St., Chicago, Ill.
Rivett Lathe & Grinder Co., Brighton District, Boston, Mass.
Skinner Chuck Co., New Britain, Conn.
Terkelsen & Wennberg, Boston, Mass.
Union Mfg. Co., New Britain, Conn.
Westcott Chuck Co., Oneida, N. Y.
Whiton Mch. Co., D. E., New London, Ct.

Chucks, Magnetic
Churchill-Morgan-Crittsinger, Inc., Worcester, Mass.
Heald Mch. Co., 16 New Bond St., Worcester, Mass.
Taft-Peirce Mfg. Co., Woonsocket, R.I.
Walker Co., O. S., Worcester, Mass.

Chucks, Planer
Cincinnati Planer Co., Cincinnati, O.
Cushman Chuck Co., Hartford, Conn.
Hoggson & Pettis Mfg. Co., New Haven, Ct.
Horton & Son Co., E. Windsor Locks, Ct.
Skinner Chuck Co., New Britain, Ct.
Union Mfg. Co., New Britain, Ct.

Chucks, Tapping
Beaman & Smith Co., Providence, R.I.
Bicknell-Thomas Co., Greenfield, Mass.
Errington Mechanical Laboratory, 39 Cortlandt St., New York.
McCrosky Tool Corp., Meadville, Pa.
Newman Mfg. Co., Cincinnati, O.
Peter Bros. Mfg. Co.,, 135 Railroad Ave., Algonquin, Ill.
Procunier, Wm. L., 18 So. Clinton St., Chicago, Ill.
Scully Jones & Co., 647 Railroad Exchange, Chicago, Ill.
Watts Bros. Tool Works, Turtle Creek, Pa.

Circuit Breakers
General Electric Co., Schenectady, N Y.
Westinghouse Electric & Mfg. Co., E. Pittsburgh, Pa.

Clamps
Armstrong Bros. Tool Co., 313 North Francisco Ave., Chicago, Ill.
Besly & Co., Chas. H., 120-B North Clinton St., Chicago, Ill.
Billings & Spencer Co., Hartford, Ct.
Brown & Sharpe Mfg. Co., Providence, R.I.
Hammacher, Schlemmer & Co., Fourth Ave. and 13th St., New York.
Knauel Tool Works, Rock Island, Ill.
Starrett Co., L. S., Athol, Mass.
Western Tool & Mfg. Co., Springfield, O.
Williams & Co., J. H., 61 Richards St., Brooklyn, N. Y.

Cleaning Compound
See Compound, Cleaning.

Clocks, Watchmen's
Hardinge Bros., Inc., Berteau and Ravenswood Avea., Chicago, Ill.

Clutches, Friction, Etc.
Bicknell-Thomas Co., Greenfield, Mass.
Bond Foundry & Mch. Co., Manheim, Lancaster Co., Pa.
Brown Co., A. & F., 79 Barclay St., N. Y.
Brown Engineeriog Co., 313 N. 3rd St., Reading, Pa.
Caldwell & Son Co., H. W., 17th and Western Ave., Chicago, Ill.
Cresson-Morris Co., Philadelphia, Pa.
Edgemont Mch. Co., Dayton, O.
Fletcher Works, Philadelphia, Pa.
Hanson Clutch & Mchy Co., Tiffin, O.
Hilliard Clutch & Mchy. Co., Elmira, N. Y.
Johnson Mch. Co., Carlyle, Manchester, Ct.
Link-Belt Company, Chicago, Ill.
Moore & White Co., 2707-2737 N. 15th St., Philadelphia.
Production Mch. Co., Greenfield, Mass.
Reliance Gauge Column Co., 6008 Carnegie Ave., Cleveland, O.
Wood's Sons Co., T. B., Chambersburg, Pa.

Collars, Safety
Bond Foundry & Mch. Co., Manheim, Lancaster Co., Pa.
Bridgeport Safety Emery Wheel Co., Inc., Bridgeport, Conn.
Brown Co., A. & F. 79 Barclay St., N.Y.
Link-Belt Company, Chicago, Ill.
Royersford Foundry & Mch. Co., 54 N. 5th St., Philadelphia, Pa.
Standard Pressed Steel Co., Philadelphia, Pa.

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Machines Do Their Share to Keep Down the Cost of a Good Night's Rest

It is nearly ten years since Simmons' world-famous beds "arrived," necessitating an immediate increase in production at the Simmons plant at Kenosha, Wis. Two Shuster Automatic Wire Straightening and Cutting-off Machines were at once installed and two years later another, all three having worked day and night for several years. One man operates the lot, the only attention required being to attach a new coil of wire when needed and to remove the finished rods from time to time.

The machine here shown is straightening 1/4-inch wire and cutting it into 14-foot lengths at the rate of 8 seconds per length—450 rods per hour.

Details in Catalog "R"

Shuster machines are made in styles and sizes to handle wire of all shapes and sizes.



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Standard Tool Co., Cleveland, O.
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Collets, Spring
See Chucks, etc.
Ames Co., B. C., Waltham, Mass.
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Wagner Elec. Mfg. Co., St. Louis, Mo.
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

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Oakley Chem. Co., 26 Thames St., N.Y.

Compound, Cutting, Grinding, Etc.
American Petroleum Products Co., 1034 Williamson Bldg., Chicago, Ill.
Fiske Bros. Refining Co., 24 John St., New York.
Oakley Chemical Co., 26 Thames St., New York.
Sun Company, Philadelphia, Pa.
Swan & Finch Co., 522 Fifth Ave., N.Y.
White & Bagley Co., Worcester, Mass.

Compressing Plants, Acetylene
Davis-Bournonville Co., Jersey City, N.J.

Compressors, Air and Gas
Chicago Pneumatic Tool Co., 6 E. 44th St., N. Y.
Curtis Pneumatic Machinery Co., 1568 Kienlen Ave., St. Louis, Mo.
General Electric Co., Schenectady, N.Y.
Ingersoll-Rand Co., 11 B'way, N.Y.
Jackson Compressor Co., Inc., Denver, Col.
Taylor Instrument Companies, Rochester, N. Y.

Conduits
Breeze Mfg. Co., Newark, N. J.
Eastern Tube & Tool Co., Inc., Brooklyn, N. Y.
General Electric Co., Schenectady, N.Y.

Connectors, Frankel Solderless
Westinghouse Electric & Mfg. Co., E. Pittsburgh, Pa.

Contract Work
American Machine and Foundry Co., 5520 Second Ave., Brooklyn, N. Y.
American Tool & Mfg. Co., Urbana, O.
Atcheson Tool & Die Co., Columbus, O.
Arcow Tool Co., Bridgeport Conn.
Baltzley, O. F., Hagerstown, Md.
Bath & Co., Inc., John, Worcester, Mass.
B-J Stamping Co., Toledo, O.
Brady Foundry Co., Jas. A., 4514 Western Ave., Chicago, Ill.
Breeze Mfg. Co., Newark, N. J.
Bristol Mch. Tool Co., Bristol, Conn.
Brock Tool & Mfg. Works, Arthur, Jr., Philadelphia, Pa.
Brown & Sharpe Mfg. Co., Providence, R. I.
Canton Art Metal Co., Canton, O.
Carroll Engineering Co., Dayton, O.
City Engineering Co., Dayton, O.
Columbus Die, Tool & Mch. Co., Columbus, O.
Craftsman Tool Co., Conneaut, O.
Davis Mch. Co., Inc., C. F., Rochester, N. Y.
Detroit Reamer & Tool Co., Detroit, Mich.
Diefendorf Gear Corp., Syracuse, N. Y.
Fortune Tool & Mfg. Co., F. R., Wooster, O.
Gardner Bryan Co., Cleveland, O.
Gisholt Mch. Co., 9 S. Baldwin St., Madison, Wis.
Globe Mch. & Stamping Co., Cleveland, O.
Grand Tool & Mch. Wks., 161 Grand St., New York.
Hanna Engineering Works, 1763 Elston Ave., Chicago, Ill.
Harris Engineering Co., H. E., Bridgeport, Conn.
Hooven, Owens, Rentschler Co., Hamilton, O.
Kremer-Cummins Mch. Co., Cleveland, O.
Langelier Mfg. Co., Arlington, Cranston, R. I.
Lang Mfg. Works, Olean, N. Y.
Lansing Stamping & Tool Co., Lansing, Mich.
Legler-Eilerman Co., Dayton, O.
Liberty Tool & Mch. Co., Derby, Ct.
Manufacturers' Consulting Engineers, Syracuse, N. Y.
Marvin & Casler Co., Canastota, N. Y.
Marvin Mfg. Co., W. B., Urbana, O.
Mehl Mch. Tool and Die Co., Roselle, N. J.
Meisel Press Mfg. Co., 948 Dorchester Ave., Boston, Mass.
Meldrum, Semon, Greiner, Lowry Co., Syracuse, N. Y.
Meyers Gage Co., W. F., Bedford, Ind.
Miami Tool & Die Co., Dayton, O.
Monitor Controller Co., Baltimore, Md.
Modern Tool & Mch. Works, Newark, N. J.
Moore-Eastwood Mfg. Co., Dayton, O.
Morrison Mch. Products, Inc., Rochester, N. Y.
Mulliner Bros., Syracuse, N. Y.
Newman Mfg. Co., Cincinnati, O.
New Britain Machine Co., New Britain, Conn.
Nicholson & Co., W. H., Wilkes-Barre, Pa.
Perfect Tool Works, Inc., 187 Lafayette St., New York.
Potter Tool & Mch. Works, S. A., 77 E. 130th St., New York.
Progressive Tool Mfg. Co., Beloit, Wis.
Reliance Die & Stamping Co., 515 N La Salle St., Chicago, Ill.
Sloan & Chace Mfg. Co., Ltd., Newark, N. J.
Smalley-General Co., Inc., Bay City, Mich.
S P Mfg. Co., Cleveland, O.
Standard Gauge Steel Co., Beaver Falls, Pa.
Steel Products Engineering Co., Springfield, O.
Steiner Bros., Lima, O.
Taft-Peirce Mfg. Co., Woonsocket, R. I.
Taylor-Shantz Co., Rochester, N. Y.
Thomas Spacing Mch. Co., Pittsburgh, Pa.
Urbana Tool & Die Co., Urbana, O.
V & O Press Co., Glendale, Long Island, N. Y.
Watson Mfg. Co., Toledo, O.
Whiting & Comstock, Hartford, Conn.
Windau Tool Co., Cleveland, O.
Woods Engineering Co., Alliance, O.

Controllers
General Electric Co., Schenectady, N.Y.
Reliance Elec. & Eng. Co., 1056 Ivanhoe Road, Cleveland, O.
Westinghouse Electric & Mfg. Co., E. Pittsburgh, Pa.

Conveyers, Belt
Link-Belt Company, Chicago, Ill.
Medart Patent Pulley Co., St. Louis, Mo.

Conveyers, Gravity
Caldwell & Son Co., H. W., 17th St. and Western Ave., Chicago, Ill.
Link-Belt Co., Chicago, Ill.
Mathews Gravity Carrier Co., 144 10th St., Ellwood City, Pa.

Cotter Pins
Whitman & Barnes Mfg. Co., Akron, O.

Counterbores
American Mch. Products Co., Detroit, Mich.
Blancke Co., Inc., L. C., 10-12 Thomas St., New York.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cleveland Twist Drill Co., Cleveland, O.
Cost-Cut Counterbore Co., Detroit, Mich.
Detroit Reamer & Tool Co., Detroit, Mich.
Detroit Twist Drill Co., Detroit, Mich.
Eclipse Interchangeable Counterbore Co., Inc., 1620 St. Aubin Ave., Detroit, Mich.
Fortune Tool & Mfg. Co., F. R., Wooster, O.
Genesee Mfg. Co., Rochester, N. Y.
Glenzer Co., J. C., Detroit, Mich.
Kelly Reamer Co., Cleveland, O.
Morse Twist Drill & Mch. Co., New Bedford, Mass.
National Tool Co., Cleveland, O.
National Twist Drill & Tool Co., Detroit, Mich.
Pratt & Whitney Co., Hartford, Conn.
Production Tool Co. of America, Detroit, Mich.
Standard Tool Co., Cleveland, O.
Starrett Co., L. S., Athol, Mass.
Whitman & Barnes Mfg. Co., Akron, O.
Windau Tool Co., Cleveland, O.

Countershafts, Friction, Etc.
Bardons & Oliver, Cleveland, O.
Brown Co., A. & F., 75 Barclay St., New York.
Brown & Sharpe Mfg Co., Providence, R. I.
Builders Iron Fdry., Providence, R. I.
Chicago Pulley & Shafting Co., 40 So. Clinton St., Chicago, Ill.
Dalton Mfg. Corp., Sound Beach, Ct.
Davis Mch. Co., Providence, R. I.
Diamond Mch. Co., Providence, R. I.
Edgemont Mch. Co., Dayton, O.
Garvin Mch. Co., Spring and Varick Sts., New York.
Gisholt Mch. Co., 9 S. Baldwin St., Madison, Wis.
Hanson Clutch & Mchy. Co., Tiffin, O.
Hilliard Clutch & Mchy. Co., Elmira, N. Y.
Hyatt Roller Bearing Co., 6th Ave. and 41st St., New York.
Jones Foundry & Mch. Co., W. A., 4409 W. Roosevelt Rd., Chicago, Ill.
LeBlond Mch. Tool Co., R. K., Cincinnati, O.
Medart Patent Pulley Co., St. Louis, Mo.

Countershaft Standards, Bench
New Britain Mch. Co., New Britain, Conn.

Countersinks
Eclipse Interchangeable Counterbore Co., Inc., 1620 St. Aubin Ave., Detroit, Mich.

Countersinks, Friction, Etc.
Chicago Pulley & Shafting Co., 40 So. Clinton St., Chicago, Ill.

Counters, Revolution
Bristol Co., Waterbury, Conn.
Brown Instrument Co., Philadelphia, Pa.
Goodell-Pratt Co., Greenfield, Mass.
Grant Mfg. & Mch. Co., N. W. Station, Bridgeport, Conn.
Starrett Co., L. S., Athol, Mass.
Veeder Mfg. Co., 39 Sargeant St., Hartford, Conn.

Counting Machines
Veeder Mfg. Co., 39 Sargeant St., Hartford, Conn.

Couplers, Hose
Greene, Tweed & Co., 109 Duane St., New York.
Ingersoll-Rand Co., 11 Broadway, New York.

Couplings, Cut-Off, Friction
Edgemont Mch. Co., Dayton, O.
Hanson Clutch & Mch. Co., Tiffin, O.
Johnson Machine Co., Carlyle, Manchester, Conn.
Medart Patent Pulley Co., St. Louis, Mo.

Couplings, Flexible Shaft
Boston Gear Works, Norfolk Downs, Mass.
Caldwell & Son Co., H. W., 17th St., and Western Ave., Chicago, Ill.
Cresson-Morris Co., Philadelphia, Pa.
Karge-Baker Corp., Phoenix, N. Y.
Nicholson & Co., W. H., 112 Oregon St., Wilkes-Barre, Pa.
Nuttall Co., R. D., Pittsburgh, Pa.
Smith & Serrell, 46 Central Ave., Newark, N. J.
Uniflex Coupling Co., Philadelphia, Pa.
Wood's Sons Co., T. B., Chambersburg, Pa.

Couplings, Pipe
Dart Mfg. Co., E. M., Providence, R.I.

Couplings, Shaft
Bond Foundry & Mch. Co., Manheim, Lancaster Co., Pa.
Brown Co., A. & F., 79 Barclay St., New York.
Brown Engineering Co., 133 N. 3rd St., Reading, Pa.
Caldwell & Son Co., H. W., 17th St. and Western Ave., Chicago, Ill.
Cincinnati Ball Crank Co., Cincinnati, Ohio.
Cresson-Morris Co., Philadelphia, Pa.
Fletcher Works, Philadelphia, Pa.
Link-Belt Co., Chicago, Ill.
Hilliard Clutch & Mchy. Co., Elmira, N. Y.
Karge-Baker Corp., Phoenix, N. Y.
Medart Patent Pulley Co., St. Louis, Mo.
Moore & White Co., 2707-2737 North 15th St., Philadelphia, Pa.
Nicholson & Co., W. H., 112 Oregon St., Wilkes-Barre, Pa.
Royersford Foundry & Mch. Co., 54 N. 5th St., Philadelphia, Pa.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Smith & Serrell, 46 Central Ave., Newark, N. J.
Wood's Sons Co., T. B., Chambersburg, Pa.

Cranes
Armington Engineering Co., Euclid, O.
Box & Co., Inc., Alfred, Philadelphia, Pa.
Chisholm-Moore Mfg. Co., Cleveland, O.
Curtis Pneumatic Machinery Co., 1568 Kienlen Ave., St. Louis, Mo.
Harrington, Son & Co., Inc., Edwin, Philadelphia, Pa.
Link-Belt Co., Chicago, Ill.
Manning Maxwell & Moore, Inc., 119 W. 40th St., New York.
Milwaukee Electric Crane & Hoist Co., Milwaukee, Wis.
Niles-Rement-Pond Co., 111 Broadway, New York.
Northern Engineering Works, Detroit, Mich.
Q. M. S. Co., 1763 Elston Ave., Chicago, Ill.
Shaw Electric Crane Co., Muskegon, Mich.
Shepard Elec. Crane & Hoist Co., Montour Falls, N. Y.
Toledo Bridge & Crane Co., Toledo, O.
Vandyck Churchill Co., 149 Broadway, New York.
Wright Mfg. Co., Lisbon, O.
Yale & Towne Mfg. Co., 9 E. 40th St., New York.

Cranes, Electric Traveling
Armington Engineering Co., Euclid, O.
Box & Co., Inc., Alfred, Phila., Pa.
Fairbanks Co., 416 Broome St., New York.
Fairbanks-Morse & Co., 30 Church St., New York.
Link-Belt Company, Chicago, Ill.
Manning, Maxwell & Moore, Inc., 119 W. 40th St., New York.
Milwaukee Electric Crane & Hoist Co., Milwaukee, Wis.
Niles-Bement-Pond Co., 111 Broadway, New York.
Northern Engineering Works, Detroit, Mich.
Pawling & Harnischfeger Co., Milwaukee, Wis.
Shaw Electric Crane Co., Muskegon, Mich.
Shepard Electric Crane & Hoist Co., Montour Falls, N. Y.
Toledo Bridge & Crane Co., Toledo, O.

Cranes, Electric Truck
General Electric Co., Schenectady, N.Y.

Cranes, Hand Traveling
Armington Engineering Co., Euclid, O.
Hanna Engineering Works, 1763 Elston Ave., Chicago, Ill.
Manning, Maxwell & Moore, Inc., 119 W. 40th St., New York.
Shaw Electric Crane Co., Muskegon, Mich.
Toledo Bridge & Crane Co., Toledo, O.

Cranes, Locomotive
Link-Belt Company, Chicago, Ill.

Cranes, Portable
Canton Foundry & Mach. Co., Canton, O.

Crank Pin Turning Machines
American Tool Works Co., Cincinnati, Ohio.
LeBlond Mch. Tool Co., R. K., Cincinnati, O.
Lodge & Shipley Mch. Tool Co., Cincinnati, O.
Pedrick Tool & Mch. Co., 3639 North Lawrence St., Philadelphia, Pa.
Sawyer-Weber Tool Mfg. Co., Los Angeles, Cal.
Underwood Corp., H. B., Philadelphia, Pa.

Crucibles
Dixon Crucible Co., Jos., Jersey City, N. J.

Cutters, Milling
American Mch. Products Co., Detroit, Mich.
Barber-Colman Co., Rockford, Ill.
Bath & Co., Inc., John, Worcester, Mass.
Becker Milling Mach. Co., Hyde Park, Mass.
Blancke Co., Inc., L. C., 10-12 Thomas St., New York.
Bridgeport Cutter Works, Bridgeport, Conn.
Brown & Sharpe Mfg. Co., Providence, R. I.
Chrobaltic Tool Co., Railway Exchange, Chicago, Ill.
Clark-Mesker Co., Cleveland, O.
Cleveland Twist Drill Co., Cleveland, Ohio.
Columbus Die, Tool & Mch. Co., Columbus, O.
Cowles Tool Co., Cleveland, O.
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Whitney Mfg. Co., Hartford, Conn.
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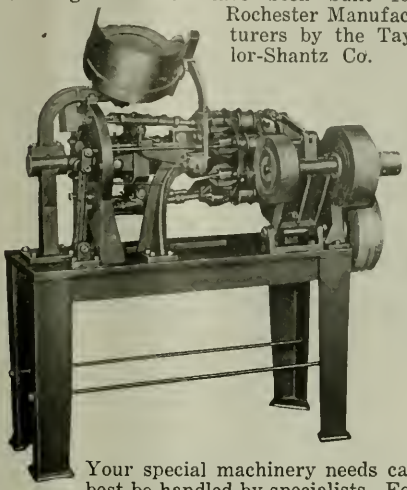
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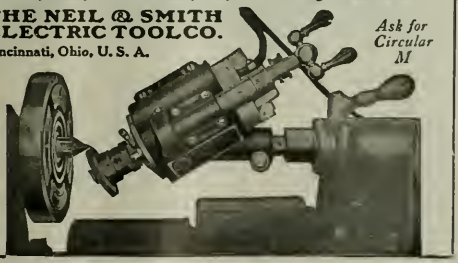
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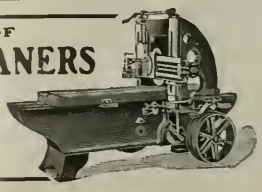
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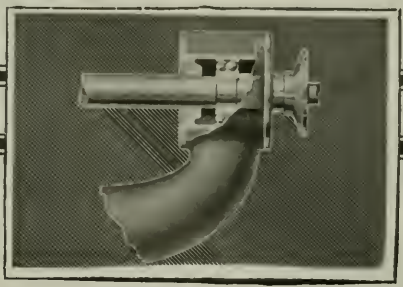
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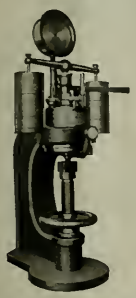
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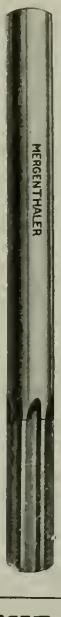
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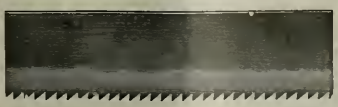
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Whiton Mch. Co., D. E., New London, Conn.

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Barber-Colman Co., Rockford, Ill.
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Morey & Co., Inc., 50 Church St., New York.
Lees-Bradner Co., Cleveland, O.
Meisselbach-Catucci Mfg. Co., Newark, N. J.
Newark Gear Cutting Mch. Co., Newark, N. J.
Reynolds Machine Co., Massillon, O.

Gear Cutting Machines, Helical and Spur (Shaper and Planer Type)
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Gear Cuttin Machines, Spiral Bevel
Gleason Works, Rochester, N. Y.

Gear Cutting Machines, Spiral Pinion Rougher
Gleason Works, Rochester, N. Y.

Gear Cutting Machines, Spur (Rotary Cutter)
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Brown & Sharpe Mfg. Co., Providence, R. I.
Cincinnati Gear Cutting Mch. Co., Cincinnati, O.
Flather Mfg. Co., Nashua, N. H.
Gould & Eberhardt, Newark, N. J.
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Boston Gear Works, Norfolk Downs, Mass.
Cincinnati Gear Cutting Machine Co., Cincinnati, O.
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Hercules Machine Tool Co., Inc., 50 Church St., New York.
Morey & Co., Inc., 50 Church St., New York.
Lees-Bradner Co., Cleveland, O.
Meisselbach-Catucci Mfg. Co., Newark, N. J.
Newark Gear Cutting Mch. Co., Newark, N. J.
Reynolds Machine Co., Massillon, O.

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Machina Products Co., Cleveland, O.

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Chicago Rawhide Mfg. Co., 1301 Elston Ave., Chicago, Ill.
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Earle Gear & Mch. Co., 4705 Steeton Ave., Philadelphia, Pa.
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Ganschow Co., Wm., Washington Blvd. and Morgan St., Chicago, Ill.
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Harrington, Son & Co., Inc., Edwin, Philadelphia, Pa.
Horsburgh & Scott Co., Cleveland, O.
Meisel Press Mfg. Co., 948 Dorchester Ave., Boston, Mass.
Newark Gear Cutting Mch. Co., Newark, N. J.
Nuttall Co., R. D., Pittsburgh, Pa.
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Simonds Mfg. Co., Pittsburgh, Pa.
Van Dorn & Dutton Co., Cleveland, O.
Westingohuse Electric & Mfg. Co., E. Pittsburgh, Pa.

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Albro-Otem Elevator Co., 501 Erie Ave., E. Philadelphia, Pa.
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Bilgram Mch. Works, 1231 Spring Garden St., Philadelphia, Pa.
Boston Gear Works, Norfolk Downs, Mass.
Brown Co., A. & F., 79 Barclay St., New York.
Brown & Sharpe Mfg. Co., Providence, R. I.
Caldwell & Son Co., H. W., 17th and Western Ave., Chicago, Ill.
Cincinnati Gear Co., Cincinnati O.
Crofoot Gear Works, Inc., 33 Ames St., Cambrige 39, Boston, Mass.
Cross Gear & Engine Co., Detroit, Mich.
Cullman Wheel Co., 1339 Altgeld St., Chicago, Ill.
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Earle Gear & Mch. Co., 4705 Stenton Ave., Philadelphia, Pa.
Fawcus Machina Co., Pittsburgh, Pa.
Fellows Gear Shaper Co., Springfield, Vt.
Flather Mfg. Co., Nashua, N. H.
Foote Bros. Gear & Mch. Co., 210 N. Carpenter St., Chicago, Ill.
Ganschow Co., Wm., Washington Blvd. and Morgan St., Chicago, Ill.
General Electric Co., Schenectady, N. Y.
Gleason Gear Works, Rochester, N. Y.
Grant Gear Works, Inc., Boston, Mass.
Harrington, Son & Co., Inc., Edwin, Philadelphia Pa.
Hindley Gear Co., Philadelphia, Pa.
Horsburgh & Scott Co., Cleveland, O.
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Meisel Press Mfg. Co., 948 Dorchester Ave., Boston, Mass.
Meisselbach-Catucci Mfg. Co., Newark, N. J.
Newark Gear Cutting Mch. Co., Newark, N. J.
Nuttall Co., R. D., Pittsburgh, Pa.
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Simonds Mfg. Co., Pittsburgh, Pa.
Stahl Gear & Mch. Co., Cleveland, O.
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

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Fawcus Machine Co., Pittsburgh, Pa.
Newark Gear Cutting Mch. Co., Newark, N. J.
Lees-Bradner Co., Cleveland, O.
Harrington, Son & Co., Inc., Edwin, Philadelphia, Pa.

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Grant Gear Works, Inc., Boston, Mass.
Harrington, Son & Co., Inc., Edwin, Philadelphia Pa.
Meisel Press Mfg. Co., 948 Dorchester Ave., Boston, Mass.
Simonds Mfg. Co., Pittsburgh, Pa.
Stahl Gear & Mch. Co., Cleveland, O.
Van Dorn & Dutton Co., Cleveland, O.

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Simonds Mfg. Co., Pittsburgh, Pa.

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Franklin Die-casting Corp., 738 Gifford St., Syracuse, N. Y.
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Crofoot Gear Works, Inc., 33 Ames St., Cambridge 39, Boston, Mass.
Diefendorf Gear Corp., Syracuse, N. Y.
Earle Gear & Mch. Co., 4705 Stenton Ave., Philadelphia, Pa.
Fawcus Machine Co., Pittsburgh, Pa.
Foote Bros. Gear & Mch. Co., 210 N. Carpenter St., Chicago, Ill.
Ganschow Co., Wm., Washington Blvd. & Morgan St., Chicago, Ill.
Grant Gear Works, Inc., Boston, Mass.
Harrington, Son & Co., Inc., Edwin, Philadelphia, Pa.
Horsburgh & Scott Co., Cleveland, O.
Meachem Gear Corporation, Syracuse, N. Y.
Meisel Press Mfg. Co., 948 Dorchester Ave., Boston, Mass.
Nuttall Co., R. D., Pittsburgh, Pa.
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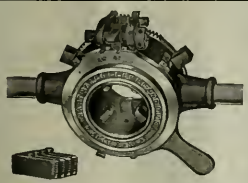
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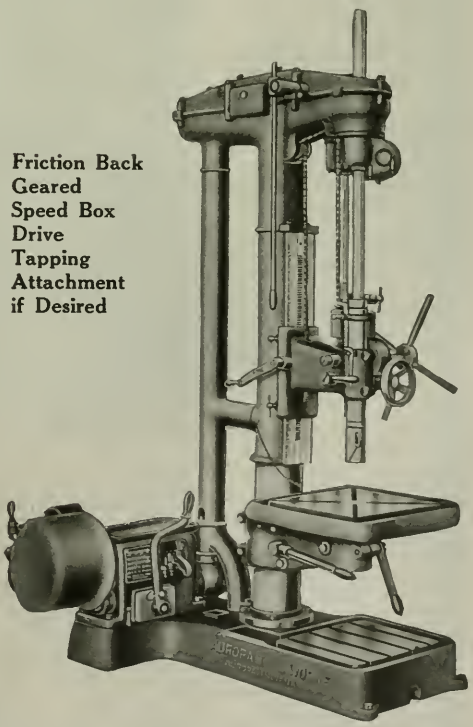
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Heald Machine Co., Cincinnati, O.
Independent Pneumatic Tool Co., Chicago, Ill.
Lafayette Tool & Equipment Co., Inc., Lafayette, Ind.
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Precision & Thread Grinder Mfg. Co. Philadelphia, Pa.
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Bristol Mch. Tool Co., Bristol, Conn.
Brown & Sharpe Mfg. Co., Providence, R. I.
Diamond Mch. Co., Providence, R. I.
Fairbanks Co., 416 Broome St., N. Y.
Fraser Co, Warren, F., Westboro, Mass.
Garvin Mch. Co., Spring and Varick Sts., New York.
Heald Machine Co., Worcester, Mass.
La Salle Tool Co., La Salle, Ill.
Newton Mch. Tool Works, Inc., Philadelphia, Pa.
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Wilmarth & Morman Co., 1180 Monroe Ave., N. W., Grand Rapids, Mich.
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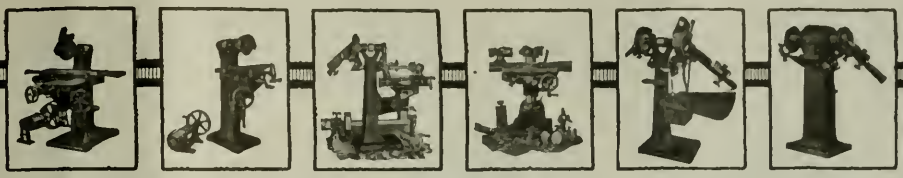
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Bath & Co., Inc., John, Worcester, Mass.
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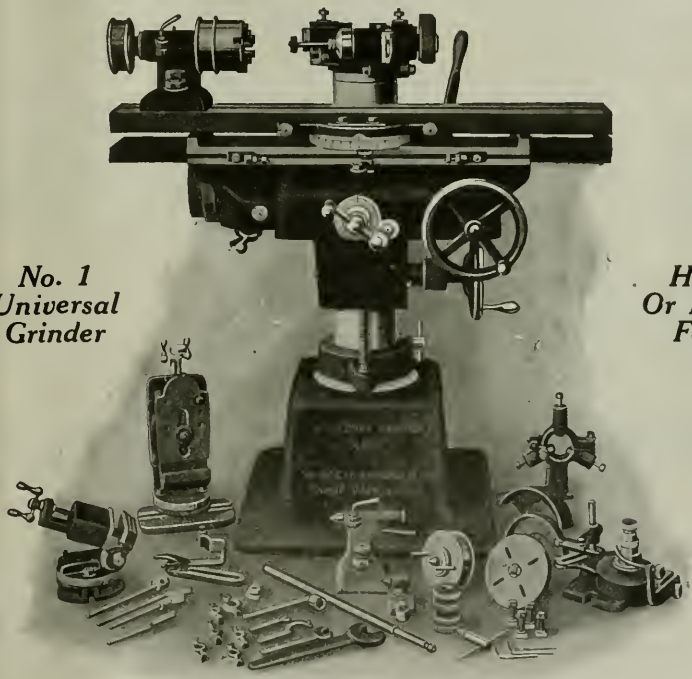
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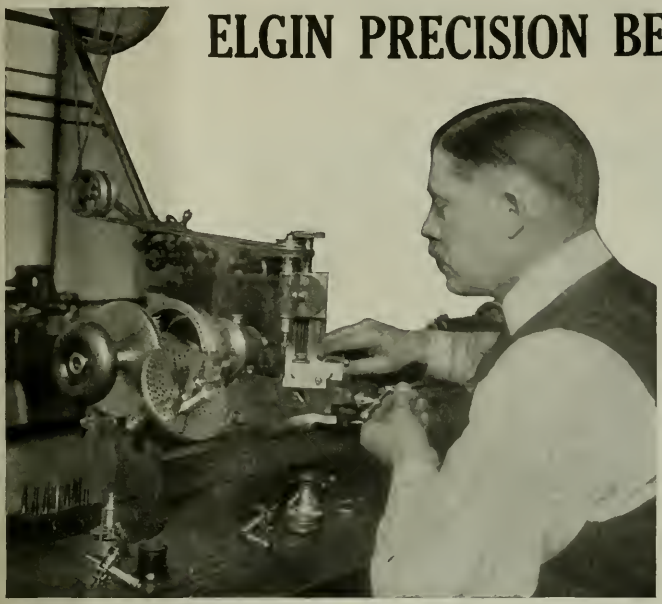
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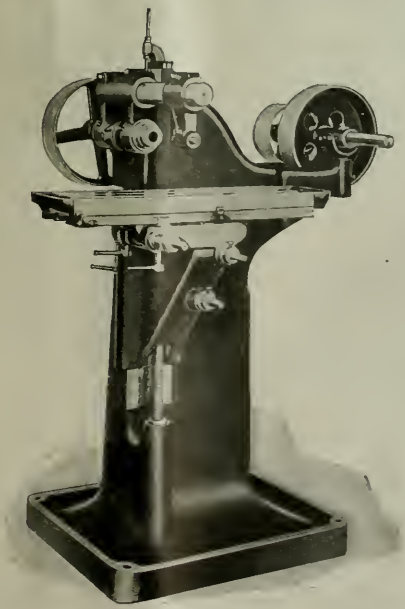
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Lehmann Mch. Co., 514 S. Broadway, St. Louis, Mo.
Lodge & Shipley Mch. Tool Co., Cincinnati, O.
Manning, Maxwell & Moore, Inc., 119 W. 40th St., New York.
McCabe Lathe & Mchy. Corp., J. J., 149 Broadway, New York.
Monarch Mch. Tool Co., Sidney, O.
Morris Mch. Tool Co., Cincinnati, O.
Mueller Mch. Tool Co., Cincinnati, O.
National Lathe Co., Cincinnati, O.
Niles-Bement-Pond Co., 111 Broadway, New York.
Oliver Machinery Co., Grand Rapids, Mich.
Pittsburgh Mch. Tool Co., Braddock, Pa.
Porter-Cable Mch. Co., Syracuse, N. Y.
Pratt & Whitney Co., Hartford, Ct.
Reed-Prentice Co., Worcester, Mass.
Rockford Lathe and Drill Co., Rockford, Ill.
Rockford Tool Co., 2502 Eleventh St., Rockford, Ill.
Ryerson, Son, Joseph T., 2558 W. 16th St., Chicago, Ill.
Sebastian Lathe Co., Rockford, Ill.
Seneca Falls Mfg. Co., Inc., 381 Fall St., Seneca Falls, N. Y.
Sidney Mach. Tool Co., Sidney, O.
South Bend Lathe Works, South Bend, Ind.
Springfield Mch. Tool Co., Springfield, O.
Summit Mch. Works, Worcester, Mass.
Victor Lathe Co., 151 Lafayette St., New York.
Whitcomb-Blaisdell Mch. Tool Co., Worcester, Mass.
Willard Mch. Tool Co., Cincinnati, O.
Wright, David A., Chicago, Ill.

Lathes, Extension Bed and Gap

Barnes Drill Co., Inc., 814 Chestnut St., Rockford, Ill.
Fairbanks Co., 416 Broome St., N. Y.
Harrington, Son & Co., Inc., Edwin, Philadelphia, Pa.
Manning, Maxwell & Moore, Inc., 119 W. 40th St., New York.
Sebastian Lathe Co., Cincinnati, O.

Lathes, Foot Power

Barnes Co., W. F. & John, 231 Ruby St., Rockford, Ill.
Fairbanks Co., 416 Broome St., N. Y.
Reed-Prentica Co., Worcester, Mass.
Seneca Falla Mfg. Co., Inc., 381 Fall St., Seneca Falls, N. Y.

Lathes, Gun Boring

Betts Machine Co., Rochester, N. Y.
LeBlond Machine Tool Co., R. K., Cincinnati, O.
Niles-Bement-Pond Co., 111 Broadway, New York.

Lathes, Patternmakers'

Blount Co., J. G., Everett, Mass.
Defiance Mch. Works, Defiance, O.
Oliver Machinery Co., Grand Rapids, Mich.
Seneca Falls Mfg. Co., Inc., 381 Fall St., Seneca Falls, N. Y.
Summit Mch. Works, Worcester, Mass.

Lathes, Pulley

Avey Drilling Mch. Co., Cincinnati, O.

Lathes, Shaft

Betts Machine Co., Rochester, N. Y.
Fitchburg Machine Works, Fitchburg, Mass.
Greaves Mch. Tool Co., Cincinnati, O.
Manning, Maxwell & Moore, Inc., 119 W. 40th St., New York.
Niles-Bement-Pond Co., 111 Broadway, New York.
Sellers & Co., Inc., Wm., Phila., Pa.

Lathes, Speed

Blount Co., J. G., Everett, Mass.
Diamond Mch. Co., Providence, R. I
Fairbanks Co., 416 Broome St., N. Y
Greenfield Tap & Die Corp., Greenfield, Mass.
Oliver Mchy. Co., Grand Rapids, Mich.
Potter Tool & Mch. Works, S. A., 77 E. 130th St., New York.
Summit Mch. Works, Worcester, Mass.

Lathes, Turret

See also Chucking Machines.
Acme Mch. Tool Co., Cincinnati, O.
Bardons & Oliver, Cleveland, O.
Betts Machine Co., Rochester, N. Y.
Brown & Sharp Mfg. Co., Providence, R. I.
Bullard Mch. Tool Co., Bridgeport, Conn.
Davis Machinery Tool Co., Inc., Rochester, N. Y.
Dreses Mch. Tool Co., Cincinnati, O.
Foster Machine Tool Co., Elkhart, Ind.
Garvin Mch. Co, Spring and Varick Sts., New York.
Gisholt Mch. Co., 9 So. Baldwin St., Madison, Wis.
Greaves-Klusman Tool Co., Cincinnati, Ohio.
Greaves Mch. Tool Co., Cincinnati, O
Herbert Ltd, Alfred, 54 Dey St., New York.
International Machine Tool Co., Indianapolis, Ind.
Jones & Lamson Mch Co., Springfield. Vt.
Le Blond Mch. Tool Co., R. K., Cincinnati, O.
Lodge & Shipley Machine Tool Co., Cincinnati, O.
Morris Mch. Tool Co., Cincinnati, O.
New Britain Machine Co., New Britain, Conn.
Niles-Bement-Pond Co., 111 Broadway, New York.
Pratt & Whitney Co., Hartford, Conn.
Oliver Machinery Co., Grand Rapids, Mich.
Reed-Prentice Co., Worcester, Mass.
Rivett Lathe & Grinder Co., Brighton, Boston, Mass.
Springfield Mch. Tool Co., 631 Southern Ave., Springfield, O.
Steiole Turret Mch. Co., Madison, Wis.
Warner & Swasey Co., Cleveland, O.
Wood Turret Mch. Co., Brazil, Ind.

Lathes, Woodworkers'

Barnes Co., W. F. & John, 231 Ruby St., Rockford, Ill.
Defiance Mch. Works, Defiance, O.
Fairbanks Co., 416 Broome St., N. Y
Oliver Machinery Co., Grand Rapids, Mich.
Reed-Prentice Co., Worcester, Mass.

Leather Belting, Round

See Belting, Round Leather.

Levels

Dietzgen Co., Eugene, 166 W. Monroe St., Chicago, Ill.
Keuffel & Esser Co., Hoboken, N. J.
New York Blue Print Paper Co., 102 Reade St., New York.
Rieker Instrument Co., Phila., Pa.
Starrett Co., L. S., Athol, Mass.

Lighting Fixtures, Adjustable

Breeze Mfg. Co., Newark, N. J.
Manufacturing Equipment & Engineering Co., Framingham, Mass.

Lubricants

Besly & Co., Chas. H., 120-B N. Clinton St., Chicago, Ill.
Dixon Crucible Co., Joseph, Jersey City, N. J.
Fiske Bros. Refining Co., 24 State St., New York.
Lumen Bearing Co., Buffalo, N. Y.
Oakley Chemical Co., 26 Thames St., New York.
Roversford Foundry & Mch. Co., 54 N. 24th St., Philadelphia, Pa.
Sun Company, Philadelphia, Pa.
Swan & Finch Co., 522 Fifth Ave., New York.
Texas Co., 17 Battery Place, N. Y.

Lubricators

Besly & Co., Chas. H., 120-B N. Clinton St., Chicago, Ill.
Bowen Products Corp., Auburn, N. Y.
Greene, Tweed & Co., 109 Duane St., New York
Michigan Lubricator Co., Detroit, Mich.

Machinists' Small Tools

See Calipers, Hammers, Wrenches, Drills, Taps, etc.

Mallets, Rawhide

Chicago Rawhide Mfg. Co., 1301 Elston Ave., Chicago, Ill.

Mandrels, Expanding and Solid

See Arbors and Mandrels, Expanding and Solid.

Marking Machines

Grant Mfg. & Mch. Co., N. W. Station, Bridgeport, Conn.
Noble & Westbrook Mfg. Co., Hartford, Conn.
V & O Press Co., Glendale, Long Island, N. Y.

Measuring Machines, Precision

Golden Co., 405 Lexington Ave., N. Y.
Herbert Ltd, Alfred, 54 Dey St., New York.
Johansson, Inc., C. E., Poughkeepsie, N. Y.
Pratt & Whitney Co., Hartford, Ct.
Rogers Works, J. M., Gloucester City, N. J.
Taft-Peirce Mfg. Co., Woonsocket, R. I.

Metals, Bearing

See Bearings, Bronze, Babbit, etc., and Bushings, Brass, Bronze, etc.

Metals, Perforated

Chicago Perforating Co., 244 W. 24th Place, Chicago, Ill.

Milling and Drilling Machines, Upright

See Drilling and Milling Machines, Vertical.

Milling and Shaping Machines

Cochrane-Bly Co., Rocheater, N. Y.

Milling Attachments

Adams Co., Dubuque, Iowa.
Bath & Co., Inc., John, Worcester, Mass.
Becker Milling Machine Co., Hyde Park, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Clark-Mesker Co., Cleveland, O.
Cleveland Milling Machine Co., Cleveland, O.
Fairbanks Co., 416 Broome St., N. Y.
Garvin Mch. Co., Spring and Varick Sts., New York.
Hendey Mch. Co., Torrington, Conn.
Hinckley Mch. Works, Hinckley, Ill.
Ingersoll Milling Mch. Co., Rockford, Ill.
Kearney & Trecker Co., Milwaukee, Wis.
Kempsmith Mfg. Co., Milwaukee, Wis.
LeBlond Mch. Tool Co., R. K., Cincinnati, O.
Oesterlein Mch. Co., Cincinnati, O.
Porter-Cable Mch. Co., Syracuse, N. Y.
Pratt & Whitney Co., Hartford, Conn.
Rivett Lathe & Grinder Co., Brighton, Boston, Mass.
Rockford Milling Mch. Co., Rockford, Ill.
Staodard Engineering Works, Pawtucket, R. I.
Whitney Mfg. Co., Hartford, Conn.

Milling Machines, Automatic

Brown & Sharpe Mfg. Co., Providence, R. I.
Fairbanks Co., 416 Broome St., N. Y.
Pratt & Whitney Co., Hartford, Ct.

Milling Machines, Bench

Ames Co., B. C., Waltham, Mass.
Burke Machine Tool Co., 516 Sandusky St., Conneaut, O.
Carter & Hakes Co., Sterling Place, Winsted, Conn.
Greenfield Tap & Die Corp., Greenfield, Mass.
Hardinge Bros., Inc., Berteau and Ravenswood Aves., Chicago, Ill.
Rockford Milling Mch. Co., Rockford, Ill.
Sloan & Chace Mfg. Co., Ltd., Newark, N. J.
Van Norman Mch. Tool Co., Waltham Ave., Springfield, Mass.

Milling Machines, Circular Continuous

Becker Milling Mch. Co., Hyde Park, Mass.
Kearney & Trecker Co., Milwaukee, Wis.
Gould & Eberhardt, Newark, N. J.

Milling Machines, Hand

Becker Milling Mch. Co., Hyde Park, Mass.
Bristol Mch. Tool Co., Bristol, Conn.
Burke Machine Tool Co., 516 Sandusky, St., Conneaut, O.
Carter & Hakes Co., Sterling Place, Winsted, Conn.
Clark-Mesker Co., Cleveland, O.
Defiance Mch. Works, Defiance, O.
Garvin Mch. Co., Spring and Varick Sts., New York.

Le Blond Rapid Production Lathes on Remy Ignition



From One Machine to Two Dozen in Less Than Three Years

We are indebted to the Remy Electric Company, Anderson, Ind., for the facts and photographs. The pictures, taken in this company's production department, show the commutator end of a motor-cycle generator frame being turned and faced, also a "before and after" close-up view of the work.

Length of the turned section is 1 5/16", its diameter not less than 3.552" or more than 3.557". Material is malleable iron and the floor-to-floor time four minutes to each piece. The Rapid Production Lathe has carried a SPEED UP message to the Remy Shops. The instantaneous start and stop to spindle, the Heavy Duty Bed section, the box section apron with positive feed clutch, and the increased power and convenience factors have enabled it to MAKE GOOD.

The R.K.Le Blond Machine Tool Co.

Cincinnati.Ohio.

Greenfield Tap & Die Corp., Greenfield, Mass.
Pratt & Whitney Co., Hartford, Conn.
Rockford Milling Mch. Co., Rockford, Ill.
Standard Engineering Works, Pawtucket R. I.
Van Norman Mch. Tool Co., Waltham Ave., Springfield, Mass.
Whitney Mfg. Co., Hartford, Coon.

Milling Machines, Horizontal, Plain
Reaman & Smith Co., Providence, R. I.
Becker Milling Mch. Co., Hyde Park, Mass.
Bilton Mch. Tool Co., Bridgeport, Ct.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cincinnati Milling Mch. Co., Oakley, Cincinnati, O.
Clark-Mesker Co., Cleveland, O.
Defiance Mch. Works, Defiance, O.
Fairbanks Co., 416 Broome St., N. Y.
Fox Machine Co., Jackson, Mich.
Gabrielson Mfg. Corp., Syracuse, N. Y.
Garvin Mch. Co., Spring and Varick Sts., New York.
Gooley & Edlund, Inc., Cortland, N. Y.
Hendey Machine Co., Torrington, Ct.
Herbert Ltd, Alfred, 54 Dey St., New York.
Ingersoll Milling Mch. Co., Rockford, Ill.
Kearney & Trecker Co., Milwaukee, Wis.
Kempsmith Mfg. Co., Milwaukee, Wis.
LeBlond Mch. Tool Co., R. K., Cincinnati, O.
Newton Machine Tool Works, Inc., Philadelphia, Pa.
Niles-Bement-Pond Co., 111 Broadway, New York.
Oesterlein Mch. Co., Cincinnati, O.
Pratt & Whitney Mfg. Co., Hartford, Conn.
Rockford Milling Mch. Co., Rockford, Ill.
Ryerson & Son, Joseph T., 2558 W. 16th St., Chicago, Ill.
Standard Engineering Works, Pawtucket, R. I.

Milling Machines, Horizontal, Universal
Becker Milling Machine Co., Hyde Park, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cincinnati Milling Mch. Co., Oakley, Cincinnati, O.
Clark-Mesker Co., Cleveland, O.
Defiance Mch. Works, Defiance, O.
Fairbanks Co., 416 Broome St., N. Y.
Hendey Mch. Co., Torrington, Conn.
Herbert Ltd, Alfred, 54 Dey St., New York.
Kearney & Trecker Co., Milwaukee, Wis.
Kempsmith Mfg. Co., Milwaukee, Wis.
LeBlond Mch. Tool Co., R. K., Cincinnati, O.
Niles-Bement-Pond Co., 111 Broadway, New York.
Oesterlein Mch. Co., Cincinnati, O.
Rockford Milling Mch. Co., Rockford, Ill.
Rowbottom Mch. Co., Waterbury, Ct.
Ryerson & Son, Joseph T., 2558 W. 16th St., Chicago, Ill.
Van Norman Mch. Tool Co., Waltham Ave., Springfield, Mass.

Milling Machines, Lincoln Type
Beaman & Smith Co., Providence, R. I.
Becker Milling Mch. Co., Hyde Park, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Gabrielson Mfg. Corp., Syracuse, N. Y.
Garvin Mch. Co., Spring and Varick Sts., New York.
Hendey Machine Co., Torrington, Ct.
Kempsmith Mfg. Co., Milwaukee, Wis.
Pratt & Whitney Co., Hartford, Conn.
Reynolds Mch. Co., Massillon, O.
Van Norman Mch. Tool Co., Waltham Ave., Springfield, Mass.

Milling Machines, Multiple Spindle
Beaman & Smith Co., Providence, R.I.
Ingersoll Milling Mch. Co., Rockford, Ill.
Newton Mch. Tool Works, Inc., Philadelphia, Pa.
Niles-Bement-Pond Co., 111 Broadway, New York.

Milling Machines, Oscillating Head
Superior Mch. & Engineering Co., Detroit, Mich.

Milling Machines, Portable
Newton Mch. Tool Works, Inc., Philadelphia, Pa.
Pedrick Tool & Mch. Co., 3639 North Lawrence St., Philadelphia, Pa.
Underwood Corp., H. B., Phila., Pa.

Milling Machines, Spline
Lees-Bradner Co., Cleveland, O.
Pratt & Whitney Co., Hartford, Ct.
Standard Eng. Works, Pawtucket, R. I.
Taylor & Fenn Co., Hartford, Conn.

Milling Machines, Vertical
Beaman & Smith Co., Providence, R. I.
Becker Milling Mch. Co., Hyde Park, Mass.
Bristol Mch. Tool Co., Bristol, Ct.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cincinnati Milling Mch. Co., Oakley, Cincinnati, O.
Cochrane-Bly Co., Rochester, N. Y.
Fairbanks Co. 416 Broome St., N. Y.
Garvin Mch. Co., Spring and Varick Sts., New York
Herbert Ltd, Alfred, 54 Dey St., New York.
Ingersoll Milling Mch. Co., Rockford, Ill.
Kempsmith Mfg. Co., Milwaukee, Wis.
LeBlond Mch. Tool Co., R. K., Cincinnati, O.
Newton Machine Tool Works, Inc., Philadelphia, Pa.
Niles-Bement-Pond Co., 111 Broadway, New York.
Pratt & Whitney Co., Hartford, Conn.
Reynolds Mch. Co., Massillon, O.
Rockford Milling Mch. Co., Rockford, Ill.
Van Norman Mch. Tool Co., Waltham Ave., Springfield, Mass.

Milling Tools, Hollow Adjustable
Geometric Tool Co., New Haven, Conn.
Rogers Works, Inc., J. M., Gloucester City, N. J.

Model and Experimental Work
See Special Machinery and Tools.

Molding Machines
Adams Co., Dubuque, Iowa.
Hanna Engineering Works, 1763 Elston Ave., Chicago, Ill.

Motors, Electric
Dillon Electric Co., Canton, O.
Electro Dynamic Co., Bayonne, N. J.
Fairbanks Co., 416 Broome St., N. Y.
General Elec. Co., Schenectady, N. Y.
Reliance Elec. and Engineering Co., 1056 Ivanhoe Road, Cleveland, O.
Wagner Electric Mfg. Co., St. Louis, Mo.
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

Name Plates, Cast Bronze
Matthews & Co., Jas. H., Pittsburgh, Pa.
Newman Mfg. Co., Cincinnati, O.
Pannier Bros. Stamp Co., Pittsburgh, Pa.
Schwerdtle Stamp Co., Bridgeport, Ct.

Name Plates, Etched
Matthews & Co., Jas. H., Pittsburgh, Pa.
Newman Mfg. Co., Cincinnati, O.
Noble & Westbrook Mfg. Co., Hartford, Conn.
Pannier Bros. Stamp Co., Pittsburgh, Pa.
Schwerdtle Stamp Co., Bridgeport, Ct.

Name Plates, Stamped
Matthews & Co., Jas. H., Pittsburgh, Pa.
Newman Mfg. Co., Cincinnati, O.
Noble & Westbrook Mfg. Co., Hartford, Conn.
Pannier Bros. Stamp Co., Pittsburgh, Pa.
Schwerdtle Stamp Co., Bridgeport, Ct.

Nichrome Castings
Driver-Harris Co., Harrison, N. J.

Nipple Threading Machinery
Bignall & Keeler Machine Works, Edwardsville, Ill.
Landis Mch. Co., Inc., Waynesboro, Pa.
Merrell Mfg. Co., 15 Curtis St., Toledo, Ohio.
Murchey Mch. & Tool Co., 34 Porter St., Detroit, Mich.
Saunders Sons, D., Yonkers, N. Y.
Standard Eng. Works, Pawtucket, R. I.

Nut Castellating Machines
Craftsman Tool Co., Conneaut, O.

Nuts, Castellated
National Acme Co., Cleveland, O.

Nut Tappers
See Bolt and Nut Machinery.

Odometers
Veeder Mfg. Co., 39 Sargeant St., Hartford, Conn.

Oil Cups
American Galco Co., Inc., Grand Central Palace, New York.
Besly & Co., Charles H., 120-B North Clinton St., Chicago, Ill.
Bowen Products Corp., Auburn, N. Y.
Gits Bros. Mfg. Co., 1901 South Kilbourne Ave., Chicago, Ill.
Michigan Lubricator Co., Detroit, Mich.
Purves Mfg. Co., Syracuse, N. Y.
Tucker, W. M. & C. F., Hartford, Ct.

Oilers
American Galco Co., Inc., Grand Central Palace, New York.
Gem Mfg. Co., Pittsburgh, Pa.

Oilers, Loose Pulley
Brown Engineering Co., 133 N. 3rd St., Reading, Pa.
Michigan Lubricator Co., Detroit, Mich.

Oil Extractors
Telhurst Mch. Works, Troy, N. Y.

Oil Gages
Michigan Lubricator Co., Detroit, Mich.

Oil Hole Covers
Bowen Products Corp., Auburn, N. Y.
Gits Bros. Mfg. Co., 1901 So. Kilbourne Ave., Chicago, Ill.
Tucker, W. M. & C. F., Hartford, Ct.

Oil Pans, Sheet Steel
Littleford Bros., Cincinnati, O.

Oils, Lubricating
Besly & Co., Chas. H., 120-B North Clinton St., Chicago, Ill.
Fiske Bros. Refining Co., 24 State St., New York.
Sun Co., Philadelphia, Pa.
Swan & Finch Co., 522 Fifth Ave., New York.
Texas Co., 17 Battery Place, N. Y.

Oils, Quenching and Tempering
Fiske Bros. Refining Co., 24 State St., New York.
Sun Co., Philadelphia, Pa.
Swan & Finch Co., 522 Fifth Ave., New York
Texas Co., 17 Battery Place, N. Y.

Oils, Soluble
See Compound, Cutting, Grinding, etc.

Ovens, Baking
American Gas Furnace Co., 24 John St., New York.
General Elec. Co., Schenectady, N. Y.
Reichhelm & Co., E. P., 24 John St., New York.

Ovens, Tempering
Baker & Co., Inc., H., 101 Duane St., New York.
General Elec. Co., Schenectady, N. Y.

Oxy-Acetylene Apparatus
See Welding and Cutting, Oxy-Acetylene Equipment.

Oxygen
Air Reduction Co., Inc., 120 Broadway, New York.
Linde Air Products Co., 30 E. 42nd St., New York.

Packing, Leather
Chicago Rawhide Mfg. Co., 1301 Elston Ave., Chicago, Ill.

Paints, Machinery
Du Pont de Nemours & Co., E. I., Wilmington, Del.

Pans, Shop and Lathe
Canton Art Metal Co., Canton, O.
Littleford Bros., Cincinnati, O.
New Britain Mch. Co., New Britain, Conn.

Parallels
Taft-Peirce Mfg. Co., Woonsocket, R. I.
Walker Co., O. S., Worcester, Mass.

Patents
Parker, C. L., Washington, D. C.

Pattern Letters and Figures
Maughlin Co., H. P., Columbus, O.

Pattern Shop Machinery
Crescent Machine Co., 56 Main St., Leetonia, O.
Defiance Mch. Works, Defiance, O.
Oliver Machinery Co., Grand Rapids, Mich.

Pattern Shop Tools
Hammacher, Schlemmer & Co., Fourth Ave. and 13th St., New York.
Oliver Machinery Co., Grand Rapids, Mich.

Patterns, Metal
Grant Mfg. & Machine Co., N. W. Station, Bridgeport, Conn.
S-P Manufacturing Co., Cleveland, O.

Patterns, Wood
S-P Manufacturing Co., Cleveland, O.
V & O Press Co., Glendale, Long Island, N. Y.

Pencils, Drawing
Dietzgen Co., Eugene, 166 W. Monroe St., Chicago, Ill.
Dixon Crucible Co., Joseph, Jersey City, N. J.

Phosphor Bronze
See Bronze.

Pipes
National Tube Co., Pittsburgh, Pa.
Newman Mfg. Co., Cincinnati, O.

Pipe Bending Tools
American Pipe Bending Mch. Co., 73 Pearl St., Boston, Mass.
Underwood Corp., H. B., Phila., Pa.

Pipe Cutting and Threading Machines
Armstrong Mfg. Co., 297 Knowlton St., Bridgeport, Conn.
Bignall & Keeler Mch. Works, Edwardsville, Ill.
Curtis & Curtis Co., 324 Gardau St., Bridgeport, Conn.
Fairbanks Co., 416 Broome St., N. Y.
Foote-Burt Co., Cleveland, O.
Fox Machine Co., Jackson, Mich.
Greenfield Tap & Die Corp., Greenfield, Mass.
Harrington, Son & Co., Inc., Edwin, Philadelphia, Pa.
Hart Mfg. Co., E. 20th and Marion Ave., Cleveland, O.
Landis Mch. Co., Inc., Waynesboro, Pa.
Merrell Mfg. Co., 15 Curtis St., Toledo, Ohio.
Murchey Mch. & Tool Co., 34 Porter St., Detroit, Mich.
Saunders' Sons, Inc., D., Yonkers, N.Y.
Standard Engineering Co., Ellwood City, Pa.
Victor Tool Co., Waynesboro, Pa.

Pipe Fittings
Newman Mfg. Co., Cincinnati, O.

Planer Attachments
Cincinnati Planer Co., Cincinnati, O.
Gray Co., G. A., Cincinnati, O.
Reed-Prentice Co, Worcester, Mass.

Planers
American Tool Works Co., Cincinnati, Ohio.
Betts Machine Co., Rochester, N. Y.
Cincinnati Planer Co., Cincinnati, O.
Cleveland Planer Co., 3152 Superior Ave., Cleveland, O.
Fairbanks Co., 416 Broome St., N. Y.
Gray Co., G. A., Cincinnati, O.
Hamilton Mch. Tool Co., Hamilton, O
Libby Mch. Tool Co., Hamilton, O.
McCabe Lathe & Mchy. Corp., 149 Broadway, New York.
Morley Mchy. Corp., Rochester, N. Y.
Morton Mfg. Co., Muskegon Heights, Mich.
Niles-Bement-Pond Co., 111 Broadway, New York.
Ohio Machine Tool Co., Kenton, O.
Powell Mch. Co., Worcester, Mass.
Rockford Mch. Tool Co., Rockford, Ill.
Ryerson & Son, Joseph T., 2558 W. 16th St., Chicago, Ill.
Sellers & Co., Inc., Wm., Phila., Pa.
Whitcomb-Blaisdell Mch. Tool Co., Worcester, Mass.
Woodward & Powell Planer Co., Worcester, Mass.

Planers, Bench
Wallace & Co., J. D., 1421 W. Jackson Blvd., Chicago, Ill.

Planers, Crank
Cincinnati Shaper Co., Cincinnati, O.

Planers, Open Side
Automatic Mch. Co., Bridgeport, Ct.
Cleveland Planer Co., Cleveland, O.
Simmons Mch. Co., Inc., Albany, N. Y.

Planers, Portable
Morton Mfg. Co., Muskegon, Mich.
Underwood Corp., H. B., Phila., Pa.

Planers, Rotary
Newton Mch. Tool Works, Inc., Philadelphia, Pa.
Niles-Bement-Pond Co., 111 Broadway, New York.
Pedrick Tool & Machine Co., 3639 N. Lawrence St., Philadelphia, Pa.
Underwood Corp., H. B., Phila., Pa.

Plate Rolls
Niles-Bement-Pond Co., 111 Broadway, New York.
Ryerson & Sons, Jos. T., 2558 W. 16th St., Chicago, Ill.

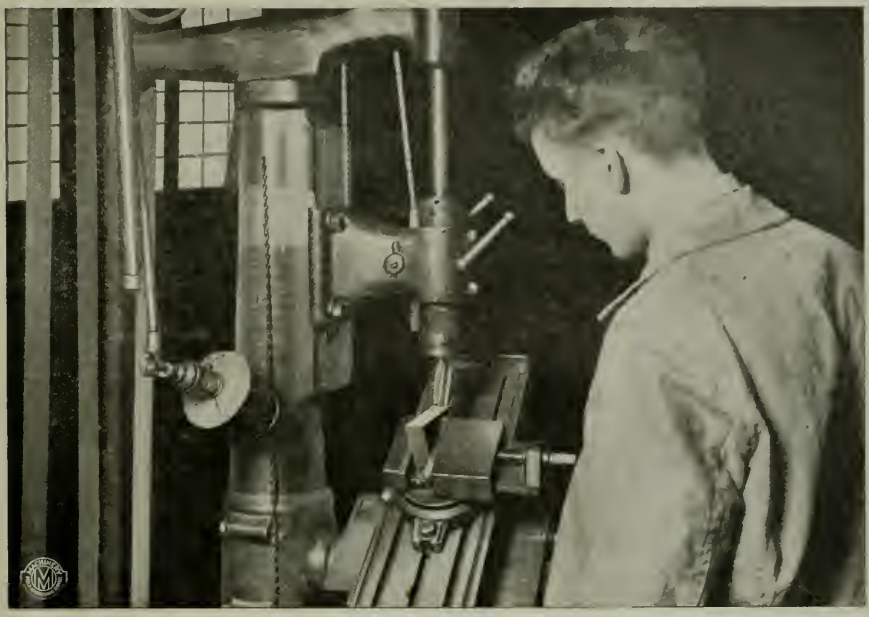
Plates, Steel
Moltrup Steel Products Co., Beaver Falls, Pa.
Ryerson & Son, Jos. T., 2558 W. 16th St., Chicago, Ill.

Plates, Surface
Brown & Sharpe Mfg. Co., Providence, R. I.
Taft-Peirce Co., Woonsocket, R. I.

Pneumatic Tools
Chicago Pneumatic Tool Co., 6 E. 44th St., New York.
Independent Pneumatic Tool Co., Chicago, Ill.
Ingersoll-Rand Co., 11 Broadway, N.Y.
Manning, Maxwell & Moore, Inc., 119 W. 40th St., New York.
Shepard Electric Crane & Hoist Co., Montour Falls, N. Y.
Titan Automatic Tool Co., Inc., 25 W. Broadway, New York.

Polishing Machines
Abbott Ball Co., Elmwood, Hartford, Conn.
Besly & Co., Chas. H., 120-B North Clinton St., Chicago, Ill.
Bridgeport Safety Emery Wheel Co., Inc., Bridgeport, Conn.
Brown & Sharpe Mfg. Co., Providence, R. I.
Builders' Iron Fdry., Providence, R. I.
Defiance Mch. Works, Defiance, O.
Diamond Mch. Co., Providence, R. I.

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KNIGHT

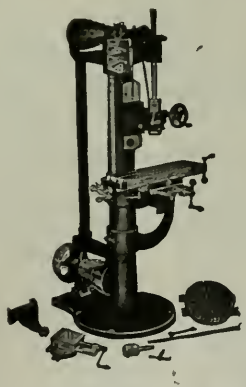
MILLING AND DRILLING MACHINES

The Tilting Table is a Great Convenience in Milling Angular Cuts

There's nothing to beat the Knight Milling and Drilling Machine for milling angular cuts. The work is almost instantly adjusted to the desired position by means of the tilting table. Then, of course, the same machine does all your drilling; there is no time wasted.

In the plant of the M. S. Wright Company, Worcester, Mass., the "Knight" is used for milling, recessing, T-slotting, elongating holes, die sinking and drilling. Photograph shows the milling of an angle for a forming die for wire bending. A 1" diameter end mill is used.

Ask these people what they think about the Knight Machine—or write us for the catalog and more information.



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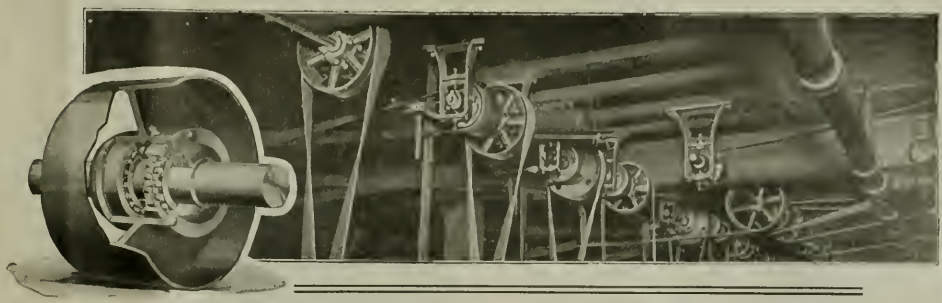
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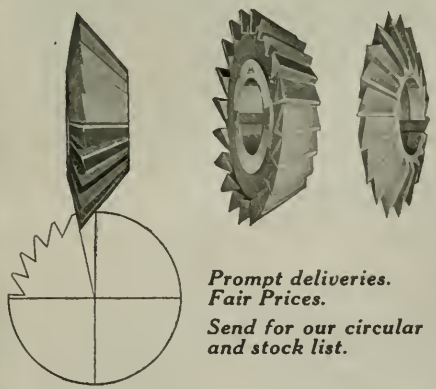


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Ryerson & Son, Joseph T., 2558 West 16th St., Chicago, Ill.

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Thompson & Son Co., Henry G., New Haven, Conn.

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Wardwell Mfg. Co., Cleveland, O.

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Springfield Automatic Screw Mch. Corp., Fitchburg, Mass.

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Bardons & Oliver, Cleveland, O.
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Dreses Machine Tool Co., Cincinnati, O.
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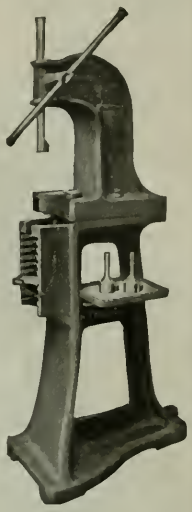
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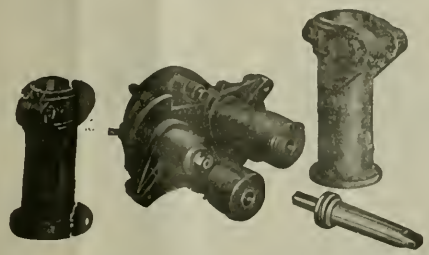
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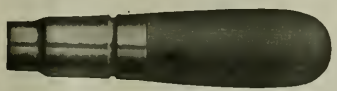


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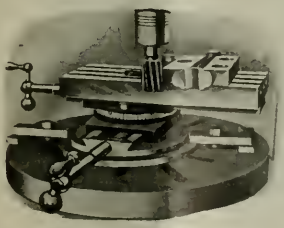
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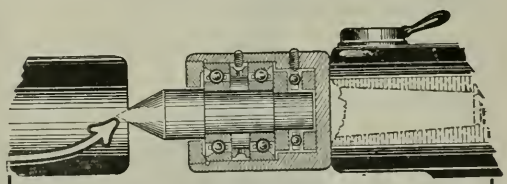
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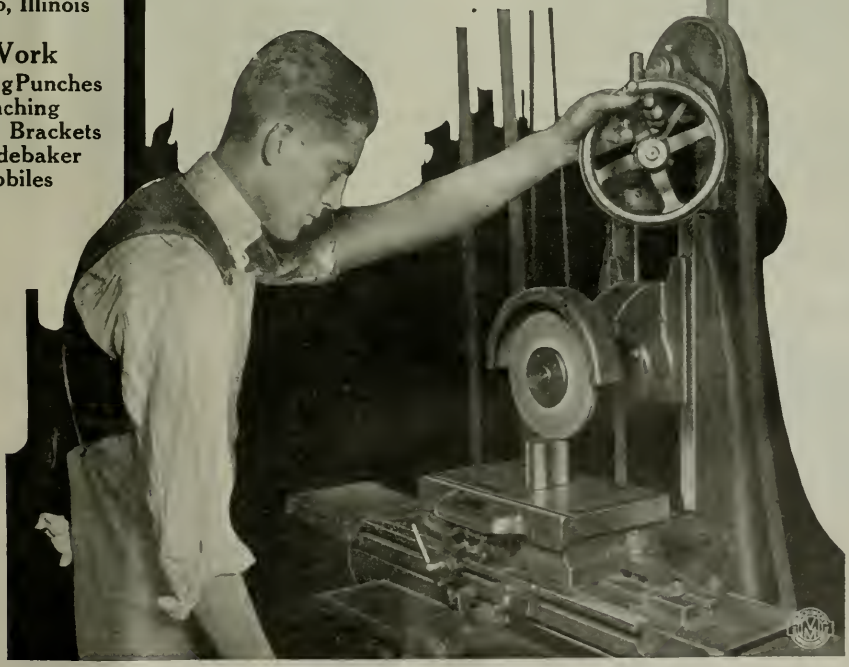
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